Lesson 4, Activity 2

John Snow, the First Epidemiologist (1 hour 3 minutes)

Section
Diseases

Investigative Questions
How do epidemiologists use scientific methods to find the cause of infectious diseases?
How can disrupting the environmental conditions stop the spread of infectious disease?
What did John Snow contribute to the field of epidemiology?

Description of Content
In this activity, students will learn about John Snow, considered to be the father of epidemiology. They will learn how he used scientific methods to identify the environment in which cholera was spreading. By disrupting this environment, he ended the epidemic. Then students will learn more about modern-day "disease detectives," deciding whether this would be a possible career for them to pursue.

Relevant Standards
This activity fulfills science and health education standards.

Objectives
Students will:

- Describe the scientific methods that John Snow used to identify the environment in which cholera could spread
- Apply what they have learned about environmental conditions as a factor in the spread of infectious diseases

Materials

- Student Reproducible 1: *Finding the Real Cause of Cholera*
- Student Reproducible 2: *Assignment for Group A*
- Student Reproducible 3: *Assignment for Group B*
- Student Reproducible 4: *John Snow's Methods*
- Student Reproducible 5: *Disease-Causing Microbes*

Safety
Normal classroom safety procedures should be followed.

Teacher Background

Environment
This lesson gives students further information about the third vertex of the Epidemiologic Triangle, Environment. In this context, environment is defined as the physical surroundings of the hosts and agents such as altitude, climate, geography, dust, amount of sunlight, etc. The season of the year or the time of day, week, or month that illnesses or deaths occur also can be considered as an environmental factor.

John Snow
When there is an outbreak of disease somewhere in the world, students expect that doctors and scientists will be sent to the scene to do scientific research on its causes and on possible treatments. But not long ago, diseases were seen as divine punishments or as unfavorable influences of heavenly bodies.

John Snow was one of the pioneers who changed all that. In 1854, there was an outbreak of cholera in the Soho section of London. Snow believed that the disease was spread by water contaminated by sewage. In those days, people did not have running water in their homes. They carried in water from pumps located around the neighborhood.

At the time, most people believed cholera was caused by invisible gasses called miasma. John Snow did not agree.

John Snow mapped the area showing where all the pumps were located and where all the people who got sick lived. He was able to show them that all the people who got sick took water from a particular pump. He presented his data to the local authorities. Eventually, he convinced them of his theory. They removed the handle to a pump in the center of the neighborhood and the outbreak ceased.

Scientists do not always agree. They formulate and test various explanations of nature using observation and experiments. Scientists do and have changed their ideas about nature when they encounter new evidence that does not match their existing explanations.

That is what happened in the case of cholera. Scientists had different explanations. They formulated experiments and collected data. Through this activity, your students will do that, too. They will have the chance to think like a "disease detective." Then they will put that thinking to work as they devise ways to disrupt the spread of other infectious diseases.

Procedure
Engagement (3 minutes)

1. Today, disease detectives go all over the world to research the causes of disease. Ask students if they can think of some times in the last few years when scientists went to research the causes of an epidemic.

   Students may list, for example, SARS, HIV/AIDS, or avian flu. (For more information, on SARS visit the *BAM!* Web site at

www.bam.gov/sub_diseases/diseases_sars.html. For information on SARS, HIV/AIDS, and avian flu, visit the CDC Web site at www.cdc.gov/.)

2. Tell students that today they are going to learn about a time when people were first learning how to study diseases.

3. Share with students that scientists do not always agree. They formulate and test various explanations of nature using observation and experiments. Scientists do and have changed their ideas about nature when they encounter new evidence that does not match their existing explanations.

   That is what happened in the case of cholera. Scientists had different explanations. They formulated experiments and collected data.

Exploration (20 minutes)

1. Have students read Student Reproducible 1: *Finding the Real Cause of Cholera*. Tell them that they are going to become "disease detectives." One group is going to portray the scientists of the time. The other group will portray a scientist, John Snow, whose methods were not widely accepted. Both groups will try to figure out a way to prove what is causing the spread of cholera.

2. Divide students into two groups. Give Group A Student Reproducible 2. Group A will try to figure out what they would do to prove the theory of John Snow (that contaminated water was the cause of the cholera).

3. Give Group B Student Reproducible 3. Group B will try to find a way to prove the generally accepted wisdom of the time, that contaminated air caused the disease to spread. Point out that this is how real scientists work. They don't just say something is true. They must find an experiment and collect data to support that opinion.

4. Give students about 10 minutes to develop their answers. Have them present their findings in front of the class.

Explanation (10 minutes)

1. Now give students Student Reproducible 4: *John Snow's Methods*. Discuss how Snow used data to prove his idea.

2. Explain that once John Snow understood the environment in which cholera spread, he could control the outbreak of the disease by controlling the environment (cutting off access to water from the contaminated well).

Elaboration/Evaluation (30 minutes)

1. Student Reproducible 5 includes a chart of some common disease-causing microbes, along with the environment in which they thrive. Have students list at least one way they could break the environmental chain and thus help control the spread of this disease. See the *Teacher's Answer Guide* for examples of correct responses.

Extension

1. For more information on John Snow, advanced students may want to explore the John Snow Web site created by the UCLA Department of Epidemiology at www.ph.ucla.edu/epi/snow.html.

2. Have students visit the *BAM!* Web site to read about real life "disease detectives" at www.bam.gov/sub_diseases/diseases_detectives.html, www.bam.gov/sub_diseases/diseases_sars_who.html, www.bam.gov/sub_diseases/diseases_wnv.html, and www.bam.gov/sub_yourbody/yourbody_smoking.html. Using the information on *BAM!*, plus the information they have learned about John Snow, have students write a short paragraph on whether they would be a good disease detective or not, and why.

Text Correlations

Glencoe, *Teen Health, Level 1,* Chapter 12: Understanding Communicable Diseases
Glencoe, *Teen Health, Level 2,* Chapter 7: Preventing Diseases
Glencoe, *Teen Health, Level 3,* Chapter 17: Communicable Diseases

Web Resources

CDC *BAM! Body and Mind*™: www.cdc.gov/bam or www.bam.gov

BAM! Body and Mind is brought to you by the Centers for Disease Control and Prevention (CDC), an agency of the U.S. Department of Health and Human Services (DHHS). *BAM!* was created to answer kids' questions on health issues and recommend ways to make their bodies and minds healthier, stronger, and safer. *BAM!* also serves as an aid to teachers, providing them with interactive activities to support their health and science curriculums that are educational and fun.

Centers for Disease Control and Prevention (CDC): www.cdc.gov

The CDC Web site provides a comprehensive overview of the latest research on infectious diseases. From research studies on infectious diseases to information for travelers, this site provides a wealth of information. Some is written for medical professionals, but much of the information is written for health care consumers.

University of California Los Angeles School of Public Health: www.ph.ucla.edu

John Snow: www.ph.ucla.edu/epi/snow.html

A Web site devoted to the life and work of John Snow, considered the father of epidemiology. The site includes both articles about John Snow as well as some of his primary source documents, including some of the maps he made of the cholera epidemic in London.

Relevant Standards

National Science Education Standards

Content Standard C, Grades 5-8: Life Science
Disease is a breakdown in structures or functions of an organism. Some diseases are the result of intrinsic failures of the system. Others are the result of damage by infection by other organisms.

Content Standard F, Grades 9-12: Science in Personal and Social Perspectives
The severity of disease symptoms is dependent on many factors such as human resistance and the virulence of the disease-producing organism. Many diseases can be prevented, controlled or cured. Some diseases such as cancer, result from specific body dysfunctions and cannot be transmitted.

Content Standard G, Grades 5-8: History and Nature of Science
Scientists formulate and test their explanations of nature using observation, experiments, and theoretical and mathematical models. Although all scientific ideas are tentative and subject to change and improvement in principle, for most major ideas in science, there is much experimental and observational confirmation. Those ideas are not likely to change greatly in the future. Scientists do and have changed their ideas about nature when they encounter new experimental evidence that does not match their existing explanations.

In areas where active research is being pursued and in which there is not a great deal of experimental or observational evidence and understanding, it is normal for scientists to differ with one another about the interpretation of the evidence or theory being considered. Different scientists might publish conflicting experimental results or might draw different conclusions from the same data. Ideally, scientists acknowledge such conflict and work towards finding evidence that will resolve their disagreement.

Many individuals have contributed to the traditions of science. Studying some of these individuals provides further understanding of scientific inquiry, science as a human endeavor, the nature of science, and the relationships between science and society.

Benchmarks for Science Literacy

Chapter 6, Benchmark E, Grades 3-5: Physical Health
By the end of grade 5, students should understand that:

If germs are able to get inside one's body, they may keep it from working properly. For defense against germs, the human body has tears, saliva, skin, some blood cells, and stomach secretions. A healthy body can fight most germs that do get inside. However, there are some germs that interfere with the body's defenses.

Chapter 6, Benchmark E, Grades 6-8: Physical Health
By the end of grade 8, students should understand that:

The environment may contain dangerous levels of substances that are harmful to human beings. Therefore, the good health of individuals requires monitoring the soil, air, and water and taking steps to keep them safe.

National Health Education Standards

Standard 1
Students will comprehend concepts related to health promotion and disease prevention.

- Explain the relationship between positive health behaviors and the prevention of injury, illness, disease and premature death.

- Analyze how environment and personal health are interrelated.

- Describe how lifestyle, pathogens, family history and other risk factors are related to the cause or prevention of disease and other health problems.

Lesson 4, Activity 2, Student Reproducible 1:

Finding the Real Cause of Cholera

Cholera (KOLL-er-uh) is a terrible disease. People who have been infected with cholera have diarrhea so badly that they get **dehydrated**. Within a short time—two or three days—nearly half the patients will die.

On the night of the 31st of August, 1854, cholera broke out in the Soho section of London. It was, according to a local doctor, "the most terrible outbreak of cholera which ever occurred in the kingdom." In a single night, doctors reported 56 new cases of cholera—all within a few blocks of each other. Before the outbreak was over, nearly 500 people had lost their lives.

In those days, people did not have running water in their homes. They carried in water from pumps located around the neighborhood.

At the time, most people—even the best scientists—thought that cholera was spread through the air. But one local doctor did not agree. His name was John Snow. He believed that cholera was caused by a microbe and was spread by **contaminated** water.

But at the time, no one knew how this terrible disease was spread. That's what you are going to do. In this activity, you will become "disease detectives," trying to figure out how cholera is spread so you can prevent infection in more people.

Glossary

Contaminated (cun-TAM-in-ay-tud): Polluted, poisoned.

Dehydrated (dee-HY-dray-tud): What happens when there's not enough water in your body. If people lose too much water, then can even die!

Lesson 4, Activity 2, Student Reproducible 2:

Assignment for Group A

Pretend you are John Snow or a doctor who agrees with him. You want to prove that the cholera in your neighborhood is being caused by contaminated water. How would you prove that?

What are some things you would want to know about the people who got sick and died in the neighborhood?

1.

2.

3.

What would you want to know about people who lived in the neighborhood who did not die?

1.

2.

3.

What would you want to know about people who died and lived away from the neighborhood?

1.

2.

Figure out the information you might need to prove your case. Later, you will present your ideas before the class.

Lesson 4, Activity 2, Student Reproducible 3:

Assignment for Group B

Pretend you are a person who believes that the cholera in your neighborhood is being caused by a *miasma* (infected air). You know that Dr. Snow is gathering information to prove a different theory. How could you prove that cholera is spread through the air?

What are some things you would want to know about the people who got sick and died in the neighborhood?

1.

2.

3.

What would you want to know about people who lived in the neighborhood who did not die?

1.

2.

3.

What would you want to know about people who died and lived away from the neighborhood?

1.

2.

Figure out the information you might need to prove your case. Later, you will present your ideas before the class.

Lesson 4, Activity 2, Student Reproducible 4:

John Snow's Methods

Snow carefully mapped the location of each death. Nearly all lived close to the pump at the corner of Cambridge and Broad Streets. Two women who had died lived many miles away. But Snow learned they had drunk water from the pump.

Some people who lived in the area had not gotten sick. Snow learned that most of them drank water from other wells.

Snow presented the map to local authorities. This time, they paid attention. He asked them to take the handle off the pump, and eventually, they did. The number of new cases of cholera went down (although it had been declining already since so many people had left the area).

Later, people learned that the well below the pump was about 28 feet deep. But close by ran a sewer that was only 22 feet below ground level. A few days before people got sick, some people remembered a bad smell near the pump. The raw sewage had seeped through the ground and into the well. As more people got sick, the sewage contained more of the microbes that caused cholera. That made the water even more contaminated.

Today, John Snow is recognized as one of the first "disease detectives." His methods of gathering information are still used by epidemiologists. One of the first things epidemiologists do when they get to the site of an outbreak of a new disease is to map it. They figure out in detail where all the sick people live, work, and play. They also keep track of anyone with whom a sick person has had contact.

For more information on disease detectives, visit the *BAM!* Web site at
www.bam.gov/sub_diseases/diseases_detectives.html,
www.bam.gov/sub_diseases/diseases_sars_who.html,
www.bam.gov/sub_diseases/diseases_wnv.html, and
www.bam.gov/sub_yourbody/yourbody_smoking.html.

Lesson 4, Activity 2, Student Reproducible 5:

Disease-Causing Microbes

Microbe that Causes Disease	Environment in which the Microbe Thrives	How to Break the Environmental Chain and Control the Spread of the Disease
Salmonella—bacterium that causes salmonellosis	Intestines of people and animals—lives in raw eggs, poultry, and meat.	
Borrelia burgdorferi—bacterium that causes Lyme disease	Lives in deer ticks.	
Group A Streptococcus—bacterium that causes "strep" infections	Lives in the mucus from the nose or throat of an infected person.	
Giardia—protozoan that causes giardiasis	Lives in feces of infected people and animals. Spread by contact with contaminated water.	
Rabies virus	Lives in the saliva of infected animals. Spread when an infected animal bites another animal or person.	
Vibrio cholerae—bacteria that cause cholera	Lives in the feces of infected people. Transmitted by drinking contaminated water. Usually found in areas with inadequate treatment of sewage and drinking water.	

Teacher's Answer Guide, *Disease-Causing Microbes*

Microbe that Causes Disease	Environment in which the Microbe Thrives	How to Break the Environmental Chain and Control the Spread of the Disease
Salmonella—bacterium that causes salmonellosis	Intestines of people and animals—lives in raw eggs, poultry, and meat.	*Do not eat undercooked meat or poultry— make sure it is not pink in the middle. Do not eat raw eggs or foods containing raw eggs.*
Borrelia burgdorferi—bacterium that causes Lyme disease	Lives in deer ticks.	*Wear long sleeves and long pants in wooded areas. Check carefully for tick bites after returning from being in the woods.*
Group A Streptococcus—bacterium that causes "strep" infections	Lives in the mucus from the nose or throat of an infected person.	*Wash hands thoroughly, especially after coughing or sneezing. Treating infected people with antibiotics will stop the spread of the disease.*
Giardia—protozoan that causes giardiasis	Lives in feces of infected people and animals. Spread by contact with contaminated water.	*Do not swim in water that has been contaminated by feces. Keep children in diapers out of swimming pools.*
Rabies virus	Lives in the saliva of infected animals. Spread when an infected animal bites another animal or person.	*Vaccinate animals against rabies. Do not handle wild animals or stray animals.*
Vibrio cholerae—bacteria that cause cholera	Lives in the feces of infected people. Transmitted by drinking contaminated water. Usually found in areas with inadequate treatment of sewage and drinking water.	*Treat all water before people drink it. Set up sanitary methods to dispose of human waste.*