Investigations in Infectious Disease:
Outbreak on the Hospital Ship USNS *Relief*

Mobile Lab Experiences and TRIPs
(Teacher-Research Institute Partnerships)
to Inspire Middle School Students

Learning Objectives and NGSS

SEPA SCIENCE EDUCATION PARTNERSHIP AWARD
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Seattle Children's HOSPITAL · RESEARCH · FOUNDATION | Science Education Department

Lesson 1
Infection Strikes the Hospital Ship USNS *Relief*

Description
In this lesson, students will learn about how an outbreak of infectious disease is investigated to identify the source and prevent further spread.

Lesson Overview
Students share their prior knowledge about how infectious diseases spread and discuss recent outbreaks they may have heard about. They will listen to a simulated scenario about an infection that occurred on a hospital ship and learn about how cases of infectious diseases are classified including outbreak, epidemic, or pandemic. *This lesson should take between 55-60 minutes of classroom time, which includes 20 minutes for students to complete the pre-assessment survey.*

Guiding Question
How is an outbreak of infectious disease investigated in order to identify the source and prevent further spread?

Outcomes and Objectives
Specific Learning Outcomes
Students will be able to:

1. Identify the four types of infectious microorganisms: bacteria, viruses, fungi, and parasites.
2. Differentiate between whether microorganisms are single or multicellular: bacteria (single), viruses (exception, not cells), fungi (single and multicellular), or parasites (single and multicellular).
3. Identify the common routes of infection, including but not limited to direct contact, indirect contact, insect bites, food contamination, airborne infection, and from animals.
4. Differentiate between outbreak, epidemic, and pandemic and explain how an outbreak progresses to an epidemic and pandemic.

Learning Targets:

1. I can identify the four types of infectious microorganisms and state if they are single cellular and/or multicellular or neither.
2. I can identify at least one common route of infection.
3. I can explain how an outbreak can progress to an epidemic and possibly a pandemic.

Assumptions of Prior Student Knowledge:

- Students will be familiar with the concept of outbreaks and some examples of recent foodborne illnesses.
- Students will have a basic understanding of the symptoms of foodborne illnesses.

Lesson 2
Phases of an Epidemiological Investigation

Description
In this lesson, students will be introduced to the phases of an epidemiological investigation, which are: 1) Gathering information and preparing case reports, 2) Defining the route of spread and identifying the source and 3) Implement control and prevention measures.

Lesson Overview
This lesson begins with a card sorting activity that serves as a vocabulary review. Students are led through the three phases of an epidemiological investigation, described in more detail below. Students will learn about the different types of epidemic curves and plot an epidemic curve that helps to identify how the simulated infection on the USNS *Relief* is spreading. Students will use elements of the Claim, Evidence, Reasoning framework including generating a hypothesis (Claim), compiling data (Evidence), and interpreting data to reach a conclusion (Reasoning). *This lesson should take between 55-60 minutes of classroom time.*

Guiding Question
What are the phases of an epidemiological investigation?

Outcomes and Objectives
Specific Learning Outcomes
Students will be able to:

1. List the three phases of an epidemiological investigation.
2. Explain two main routes of how infectious diseases spread.
3. Analyze evidence to create a graphical representation of the number of cases of an infectious disease over time by plotting an epidemic curve.

Learning Targets:

1. I can list the three phases of an epidemiological investigation.
2. I can identify two different routes of how infectious diseases spread.
3. I can plot an epidemic curve in order to create a graphical representation of the number of cases of an infectious disease over time.

Assumptions of Prior Student Knowledge:

- Students will be familiar with creating a graphical representation of data.
- Students may be familiar with some widely-known outbreaks of foodborne illness and foods that were linked to the illness.

Lesson 3
Review of Case Reports and Introduction to DNA Fingerprinting

Description
Students will review case reports from some of the passengers and crew who were affected by the outbreak on the ship and create a list of foods that are potential sources of the infection. In preparation for the laboratory activity on the Science Adventure Lab, they will be introduced to the principles of gel electrophoresis and DNA fingerprinting.

Lesson Overview
Students extract information from case reports of the infected people and work with classmates to narrow down the source of infection. They will examine possible explanations on how foods are at risk for contamination. Students will be introduced to gel electrophoresis and DNA fingerprinting which are laboratory techniques that are commonly used to identify the source of an infection. Finally, students will review laboratory safety and how to use a micropipette. *This lesson should take between 55-60 minutes of classroom time.*

Guiding Questions
How can investigators use case reports to identify commonalities between infected patients?
What laboratory techniques are used to compare DNA samples from bacteria?

Outcomes and Objectives
Specific Learning Outcomes
Students will be able to:

1. Identify potential sources for the outbreak by reviewing case reports and extracting relevant information.
2. Identify gel electrophoresis as a laboratory technique that separates DNA fragments according to their size.
3. Identify DNA fingerprinting as a laboratory technique used to compare patterns in DNA.

Learning Targets:

1. I can identify potential sources for the outbreak using data.
2. I can identify gel electrophoresis as a laboratory technique that can be used to separate DNA fragments according to their size.
3. I can identify DNA fingerprinting as a laboratory technique that can be used to find the source of infection based on patterns in DNA.

Assumptions of Prior Student Knowledge:

- Students will be familiar with DNA and how it determines traits expressed by an organism.
- Students will be familiar with basic concepts of electricity.

Lesson 4
Science Adventure Lab: DNA Fingerprinting Experiment

Description
In this laboratory activity, students use a DNA-based approach, known as DNA fingerprinting, to identify the contaminated food that is the source of the outbreak. DNA samples will be visualized using a technique called gel electrophoresis. This lesson takes place onboard the Science Adventure Lab and is taught by scientists from Seattle Children's Research Institute.

Lesson Overview
Students learn how to use micropipettes to manipulate small volumes. They will learn about the sequence of steps in the process of identifying a bacterial contaminant: isolating DNA, generating fragments, and separating them using gel electrophoresis. They will perform gel electrophoresis to separate fragments of DNA from a sick patient and suspected foods in order to compare the patterns, or DNA fingerprints, and identify the source. *This lesson requires 55 minutes onboard the mobile lab.*

Guiding Question
What laboratory techniques are used to analyze and compare DNA samples from bacteria?

Outcomes and Objectives
Specific Learning Outcomes
Students will be able to:

1. Explain how gel electrophoresis separates DNA fragments.
2. Explain how DNA fingerprinting can be used to identify the source of an outbreak.

Learning Targets:

1. I can explain how gel electrophoresis separates DNA fragments.
2. I can explain how DNA fingerprinting can be used to identify the source of an outbreak.

Assumptions of Prior Student Knowledge:

- Students will be familiar with DNA.
- Students will understand that the sequence of the base pairs in DNA determines the relatedness of organisms.

Lesson 5
Analysis of Bacterial DNA Specimens to Identify the Source

Description
In this lesson, students will interpret the results of the DNA fingerprinting experiment. They will state a final claim, compile all the evidence for the claim, and interpret the data to reach their final reasoning about the source of the outbreak that occurred on the hospital ship.

Lesson Overview
Students will compare the DNA fingerprints from the five candidate foods to the DNA fingerprint from the first sick patient in order to identify the contaminated food. Students will share their prior knowledge about why outbreaks do not spread indefinitely and what factors may limit their spread. *This lesson should take between 55-60 minutes of classroom time, which includes 20 minutes for students to complete the post-assessment survey.*

Guiding Question
How are the results of a DNA fingerprinting experiment interpreted?

Outcomes and Objectives
Specific Learning Outcomes
Students will be able to:

1. Learn how to interpret results of a DNA fingerprinting experiment and draw conclusions.
2. Discuss reasons why outbreaks do not continue indefinitely.

Learning Targets:

1. I can interpret results of a DNA fingerprinting experiment and draw conclusions.
2. I can list at least two reasons why outbreaks do not continue indefinitely.

Assumptions of Prior Student Knowledge:

- Students will be familiar with the concept that people can become immune to infectious diseases either by natural resistance, developing immunity after being infected, or through vaccination.

Overview and Standards

Lesson	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Vocabulary
Lesson 1: Infection Strikes the Hospital Ship USNS *Relief* **Guiding Question: How is an outbreak of infectious disease investigated in order to identify the source and prevent further spread?**	**LS1.A: Structure and Function** All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular).	**Planning and Carrying out Investigations**: Conduct an investigation to produce data to serve as the basis for evidence that meet the goals of an investigation. **Analyze and Interpret Data**: Analyze displays of data to identify linear and nonlinear relationships. **Using Mathematics and Computational Thinking**: Use mathematical representations to support scientific conclusions and design solutions. **Communicating Information**: Communicate scientific and/or technical information in writing and/or through oral presentations. Integrate qualitative scientific and technical information in written text with that contained in media and visual displays to clarify claims and findings.	**Patterns** can be used to identify cause and effect relationships. **Cause and Effect** relationships may be used to predict phenomena in natural or designed systems.	Microorganism Infectious disease Pathogen Epidemiology Epidemiologist Outbreak Epidemic Pandemic
Lesson 2: Phases of an Epidemiological Investigation **Guiding Question: What are the phases of an epidemiological investigation?**	**LS1.A: Structure and Function**	**Developing and Using Models**: Use a model to describe a phenomenon. **Analyze and Interpret Data** **Asking Questions and Defining Problems**: Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and when appropriate, frame a hypothesis based on observations and scientific principles. Ask questions to identify and/or clarify evidence and/or the premise(s) of an argument. **Constructing Explanations**: Construct an explanation using models or representations. **Communicating Information**	**Patterns** **Cause and Effect**	Epidemic curve Point source outbreak Person-to-person spread outbreak
Lesson 3: Review of Case Reports and Introduction to DNA Fingerprinting **Guiding Questions: How can investigators use case reports to identify commonalities between**	**LS1.A: Structure and Function**	**Analyze and Interpret Data** **Constructing Explanations**: Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. **Communicating Information**	**Patterns** **Cause and Effect**	Gel electrophoresis DNA fingerprinting DNA fingerprint Micropipette

infected patients? **What laboratory techniques are used to compare DNA samples from bacteria?**				
Lesson 4: Science Adventure Lab: DNA Fingerprinting Experiment **Guiding Question: What laboratory techniques are used to analyze and match DNA samples from bacteria?**	**LS1.A: Structure and Function**	**Analyze and Interpret Data** **Constructing Explanations**: Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. **Communicating Information**	**Patterns** **Cause and Effect**	Gel electrophoresis DNA fingerprinting DNA fingerprint Enzyme
Lesson 5: Analysis of Bacterial DNA Specimens to Identify the Source **Guiding Question: How are the results of a DNA fingerprinting experiments interpreted?**	**LS1.A: Structure and Function**	**Analyze and Interpret Data** **Communicating Information**	**Patterns** **Cause and Effect**	Immunity

Performance Expectations

MS-LS1-1: Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.

Overview and Standards (continued)
Nature of Science

	Understandings about the Nature of Science: Themes closely associated with Scientific and Engineering Practices	
Lessons	**Categories**	**Middle School**
Lessons 1-5	Scientific Investigations Use a Variety of Methods	Science investigations use a variety of methods and tools to make measurements and observations.
Lessons 2, 3, and 5	Scientific Knowledge is Based on Empirical Evidence	Science knowledge is based upon logical and conceptual connections between evidence and explanations.
Lessons 2-5	Scientific Knowledge is Open to Revision in Light of New Evidence	Science findings are frequently revised and/or reinterpreted based on new evidence.

	Understandings about the Nature of Science: Themes closely associated with Crosscutting Concepts	
Lessons	**Categories**	**Middle School**
Lesson 4	Science is a Way of Knowing	Science knowledge is cumulative and many people, from many generations and nations, have contributed to science knowledge.
Lesson 2	Scientific Knowledge Assumes an Order and Consistency in Natural Systems	Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation.
Lesson 4	Science is a Human Endeavor	Advances in technology influence the progress of science and science has influenced advances in technology.

Source: Appendix H – Understanding the Scientific Enterprise: The Nature of Science in the Next Generation Science Standards
www.nextgenscience.org/resources/ngss-appendices