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

This is a **PREVIEW** of Investigations in Infectious Disease: Outbreak on the Hospital Ship USNS Relief, Mobile Lab Version (5 Lessons).

The full curriculum includes four classroom lessons and one lesson onboard the mobile lab where students perform of a DNA fingerprinting experiment.

Teachers requesting the mobile lab version must be located in Western Washington.

To request the full version of this curriculum at no cost, go to https://www.adventurelab.org/nih-sepa-grant-project.aspx and fill out the request form.

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How to decide which version is best for your classroom:

Where are you located?	How much time is available?	How many classes are participating?	Version	Description
Western Washington	5 lessons, including a 1-hour mobile lab visit	3-5 (30 students max per class)	Investigations in Infectious Disease Mobile Lab Version	5 days, includes a mobile Science Adventure Lab visit to your school
Puget Sound area	5 lessons, including a 3-hour field trip	1 (32 students max)	Investigations in Infectious Disease Field Trip Version	5 days, includes a field trip to the Science Discovery Lab in downtown Seattle; transportation assistance is available
Any location	4 lessons	Not limited	Investigations in Infectious Disease Classroom Version	Classroom activities (4 days)
Any location	2 lessons	Not limited	Investigations in Infectious Disease Using the Claim, Evidence, Reasoning Framework	Classroom activities (2 days)
Any location	1 lesson	Not limited	Introduction to Epidemiology of the COVID-19 Pandemic: Featuring Infectious Disease Researchers	Video and reading
Any location	20 minutes	Not limited	Epidemiological Investigation of the COVID-19 Pandemic Student Reading	Reading

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

General Description

This unit includes classroom activities and a laboratory experience on the Science Adventure Lab, which are anticipated to have a positive, sustained impact on students' content knowledge, perceived self-efficacy in science, and interest in a biomedical career. This unit is aligned to the Next Generation Science Standards (NGSS).

During this five-lesson unit, students will learn about:

- The fields of epidemiology and infectious diseases.
- The steps in an epidemiological investigation.
- How scientists can use DNA to identify the source of an infection.

Four of the lessons will take place in the classroom and one will take place onboard Seattle Children's mobile science laboratory, the Science Adventure Lab. In Lessons 1 through 3, students will use standard epidemiological techniques to investigate a simulated outbreak of infectious disease onboard a hospital ship. In Lesson 4, students will use research-grade equipment onboard the mobile laboratory to perform a DNA fingerprinting experiment to identify the source of the infection. In Lesson 5, students will learn how to interpret the results of the DNA fingerprinting experiment and discuss some of the common misconceptions about infectious diseases. Students will use the evidence collected throughout the lessons answer the essential question *"What caused the crew and passengers to become ill on the USNS Relief in August of 2018?"* and complete a Claim, Evidence, Reasoning framework.

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The Science Adventure Lab

Lesson 4 takes place onboard the Science Adventure Lab and is taught by scientists from Seattle Children's Research Institute. The Science Adventure Lab is a custom-built, 45-foot, wheelchair-accessible, mobile laboratory equipped with research-grade equipment and space for up to 30 students. The mobile lab travels to schools across Washington state providing innovative, hands-on science curriculum to students in grades 4-8.

Please visit www.seattlechildrens.org/research/centers-programs/science-education-department/science-adventure-lab for more information about the mobile lab.

Overview and Standards

Lesson	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Vocabulary
Lesson 1: Introduction to Epidemiology Guiding Questions: 1. What background knowledge and terminology does an epidemiologist need to know in order to be able to successfully launch an investigation? 2. 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
Lesson 2: Outbreak on the USNS Relief Guiding Question: 1. How can we use this background knowledge to begin our investigation of the infections on the USNS Relief?	**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**	Outbreak Epidemic Pandemic Epidemic curve Point source outbreak Person-to-person spread outbreak

Lesson 1
Introduction to Epidemiology

Description
In this lesson, students will learn the background knowledge and terminology that an epidemiologist needs to know in order to be able to successfully launch an investigation.

Lesson Overview
Students will learn the background knowledge about infectious disease that an epidemiologist needs to know in order to be able to successfully launch an investigation and will share their prior knowledge about how infectious diseases spread. Students will be introduced to the steps in an epidemiological investigation using the COVID-19 pandemic as an example. Students will then apply the same principles to begin to investigate the infections on the USNS Relief. The steps are condensed into three phases for this unit. The three phases are: 1) Gathering information and preparing case reports, 2) Defining how the infection is spreading and identifying the source, and 3) Implementing control and prevention measures. *This lesson should take between 55-60 minutes of classroom time.*

Guiding Questions
1. What background knowledge and terminology does an epidemiologist need to know in order to be able to successfully launch an investigation?
2. How is an outbreak of infectious disease investigated in order to identify the source and prevent further spread?

Outcomes and Learning Targets
Specific Learning Outcomes
Students will be able to:
1. Identify the four types of infectious microorganisms, also called pathogens: bacteria, fungi, parasites, and viruses.
2. Determine whether a microorganism is unicellular, multicellular, or neither: bacteria (unicellular), fungi (unicellular and multicellular), parasites (unicellular and multicellular) and viruses (neither; they are an exception to this classification as they are not composed of cells).
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. Identify the phases in an epidemiological investigation.

Key Vocabulary
- Microorganism
- Infectious disease
- Pathogen
- Epidemiology
- Epidemiologist

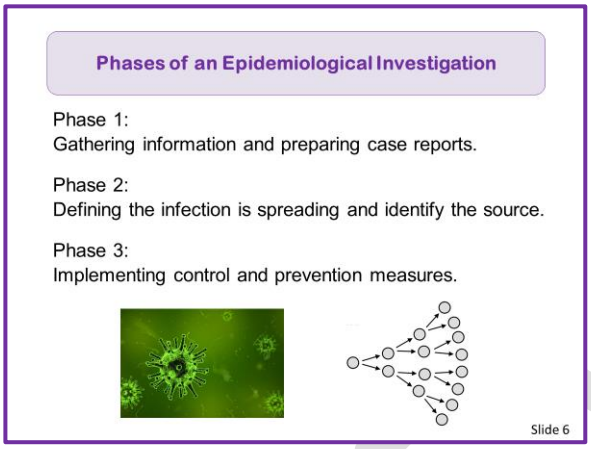
Materials Needed

- If students have an existing science lab notebook or composition book, it is recommended they use that to show their work. Loose paper could be used as an alternative.
- PowerPoint presentation with videos for Lesson 1.
- Teacher manual.
- Copies of pages 2-6 of the Student Manual if needed.
- Provided copies of *Information for Parents/Guardians* and *Permission to Participate in Seattle Children's Science Adventure Lab* slip for each student if needed (Resource pages 85-86).
- Optional: Key Vocabulary words for a word wall (Resource pages 144-165).

SAMPLE

Slide 6 — Lesson 1 — *12 minutes*

Slide 6



Phases of an Epidemiological Investigation

6A. Direct students to page 3 of the Student Manual.

6B. Introduce the *Phases of an Epidemiological Investigation* by reading the first paragraph on page 3 of the Student Manual.

6C. Instruct a student to read *Phase 1 – Gathering information and preparing case reports* to the class.

6D. Repeat with *Phase 2 – Defining how the infection is spreading and identifying the source*, and *Phase 3 – Implementing control and prevention measures*.

Background: Students will be provided with case reports from infected and non-infected people on the USNS Relief at the time of the outbreak in Lesson 3. Students will explore each part of Phase 2 throughout Lessons 2-4.

Lesson 2
Outbreak on the USNS Relief

Description
Students will use the knowledge gained in Lesson 1 to launch an epidemiological investigation. Students will learn about how clusters of infections are classified as an outbreak, epidemic, or pandemic and determine which category the infections on the hospital ship fall into.

Lesson Overview
Students will review the simulated scenario about the infection that occurred on a hospital ship and learn about how cases of infectious diseases are classified including outbreak, epidemic, or pandemic. Students are led through the three general phases of an epidemiological investigation, which are: 1) Gathering information and preparing case reports, 2) Defining how the infection is spreading and identifying the source and 3) Implementing control and prevention measures, described in more detail below. Students will learn about the different types of epidemic curves and use data to plot an epidemic curve that helps to identify how the simulated infection on the USNS Relief is spreading. *This lesson should take between 55-60 minutes of classroom time.*

Guiding Question
1. How can we use this background knowledge to begin our investigation of the infections on the USNS Relief?

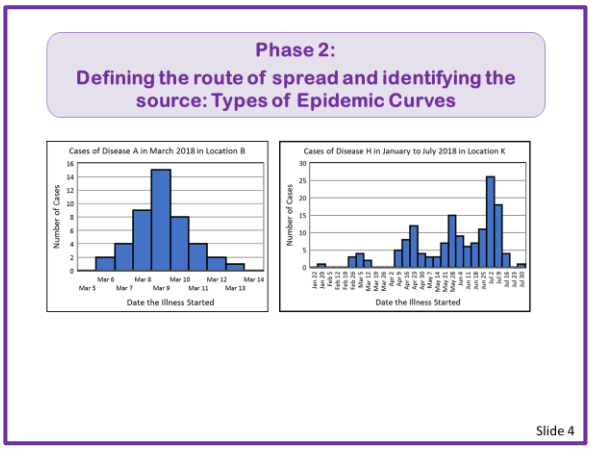
Outcomes and Learning Targets
Specific Learning Outcomes
Students will be able to:
1. Explain two main ways that infectious diseases spread.
2. Analyze evidence to create a graphical representation of the number of cases of an infectious disease over time by plotting an epidemic curve.
3. Differentiate between outbreak, epidemic, and pandemic and explain how an outbreak progresses to an epidemic and pandemic.

Key Vocabulary
- Outbreak
- Epidemic
- Pandemic
- Epidemic curve
- Point source outbreak
- Person-to-person spread outbreak

SAMPLE

Slide 4 | Lesson 2 | *8 minutes*

Slide 4



Phase 2: Types of Epidemic Curves

4A. Direct students to page 8 of the Student Manual.

4B. Moving to Phase 2, introduce the *Types of Epidemic Curves* by reading the first paragraph on page 8 of the Student Manual to the class.

4C. Point out the labels on the examples of epidemic curves.

- **Title**: Cases of (*disease*) in (*month year*) in (*location*).
  - Example: Case of Disease A in March 2018 in Location B.
- **Horizontal x-axis** represents **time**.
  - This could be on the scale of days, months, or even years.
- **Vertical y-axis** represents **number of cases**.
  - The height of each bar represents the number of cases in that time frame. A taller bar represents more cases.

4D. Instruct students to read about examples of epidemic curves that show how different infections spread. Students could take notes or highlight the unique characteristics for each type of curve.

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 a bacterial infection. Finally, students will review laboratory safety while on the Science Adventure Lab. *This lesson should take between 55-60 minutes of classroom time.*

Guiding Questions

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

Outcomes and Learning Targets

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.

Key Vocabulary

- Gel electrophoresis
- DNA fingerprinting
- DNA fingerprint
- Micropipette

Background: Gel electrophoresis and DNA fingerprinting are typically used when the illness is

Case Reports for Each Group

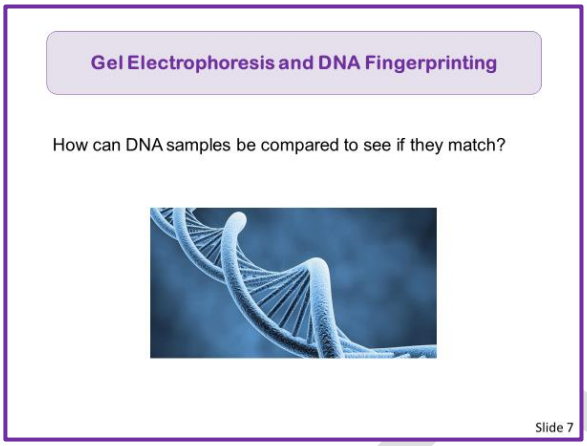
Background: Epidemiological investigations of outbreaks begin with field investigators gathering information from people in the community that are exhibiting symptoms of the disease and those who appear to be symptom-free. That information is summarized into case reports. Reviewing these reports of infected and non-infected people is a key part of any epidemiological investigation and can

help narrow down possible sources of the infection. Information collected often includes basic medical information (age and gender), vital signs (temperature, blood pressure, and respiratory rate), list of symptoms, and recent activities (what they have done and where they have been). The investigation of these recent activities can be expanded to include people they have been in contact with or foods they recall consuming. Please note that in an actual investigation, epidemiologists would review many more case reports, information about what locations and events infected people had visited, and many other factors. While this scenario has been simplified to allow students to complete it in the allotted time, it does model the process used during an authentic investigation.

SAMPLE

Slide 7 — Lesson 3 — *7 minutes*

Slide 7



Introducing Gel Electrophoresis and DNA Fingerprinting

7A. Involve the class in a discussion about their prior knowledge of how DNA samples could be compared to see if they match. If needed, supplement their ideas with the examples from the list below.

- Companies such as Ancestry.com and 23-and-me offer genetic sequencing of a DNA sample isolated from person's cheek cells. Genetic information from the sequence can be used to determine who a person is related to, information about where a person came from, their ancestry, and about genes associated with medical conditions. Information about how the sequencing and interpretation is done is on each company's website.
- Matching DNA samples is also used in the field of science called forensics. Forensic scientists use DNA to solve crimes by comparing DNA samples to identify victims or criminals.

7B. Direct students to page 12 of the Student Manual.

7C. Instruct students to read page 12 of the Student Manual and tell them they will be doing these techniques during their visit on the Science Adventure lab.

CER Tip #9: The laboratory technique, DNA fingerprinting, will need to be performed to match the DNA sample from the patient with the samples from the foods. This will tell us which of the five foods is the culprit.

Lesson 4

Science Adventure Lab: DNA Fingerprinting Experiment

Description

In this laboratory activity, students use a laboratory technique called 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, which separates DNA according to size. 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 Questions

1. What laboratory techniques are used to compare DNA samples from bacteria? *(continued)*

Outcomes and Learning Targets

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.

Protocol for Science Adventure Lab Team (Information for Teachers)

During the lesson on the Science Adventure Lab, the Seattle Children's instructors will complete the following:

1. Review objective of DNA fingerprinting experiment.
2. Review use of micropipettes including stops on plunger and avoiding cross-contamination.
3. Lead students through practice activity with dye. Students will pipet into Petri dish, then into practice gels.
4. Instruct students to load DNA samples into gels and run for 20 minutes.
5. Explain the following techniques and concepts during gel electrophoresis:
    a) Preparation of DNA from bacteria found on suspect foods.
    b) Use of enzymes to cut DNA into fragments.
    c) Relationship of fragment size to position on gel.
    d) Use of UV light to visualize the fragments so that a picture can be taken.
6. Print gel images for students to analyze when they return to the classroom. The students will analyze the gel images and interpret the results in Lesson 5.

Lesson 5
Analysis of Bacterial DNA Samples to Identify the Source

Description
In this lesson, students will interpret the results of the DNA fingerprinting experiment. They will state a claim, compile all the evidence for the claim, and interpret the data to form their 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. There is a unit assessment with suggested questions found on Resource page 131-132. Teachers may administer this assessment at their discretion. *This lesson should take between 55-60 minutes of classroom time. (Optional unit assessment not included in the time frame.)*

Guiding Questions
1. How are the results of a DNA fingerprinting experiment interpreted?
2. Why do outbreaks stop at some point?

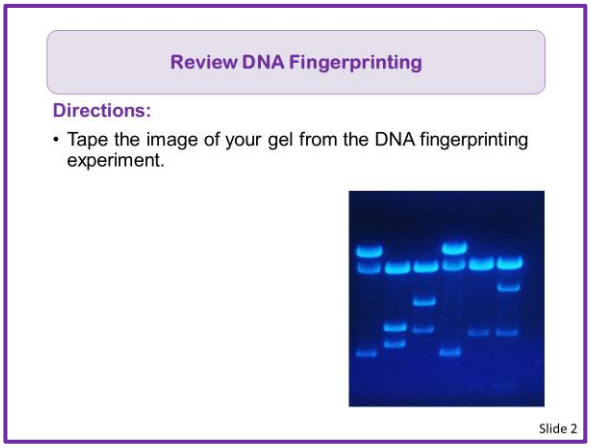
Outcomes and Learning Targets
Specific Learning Outcomes
Students will be able to:
1. Learn how to interpret results of a DNA fingerprinting experiment and draw conclusions.
2. Discuss reasons why outbreaks do not continue indefinitely.

Key Vocabulary
- **Immunity**
  - Definition: The ability of an organism to **resist, or recover from, a particular infection**.
  - For example, a child may get chickenpox, recover, and develop immunity to the chickenpox virus (varicella; vair-eh-cell-a) such that they can't get chickenpox again. A child may also get vaccinated to develop immunity to the chickenpox virus without getting sick first. Some people seem to have natural immunity to certain diseases and don't get sick even if they are exposed. This has been demonstrated for some viral infections like Influenza, Ebola, and HIV.

SAMPLE

Slide 2 — Lesson 5 — 3 minutes

Slide 2



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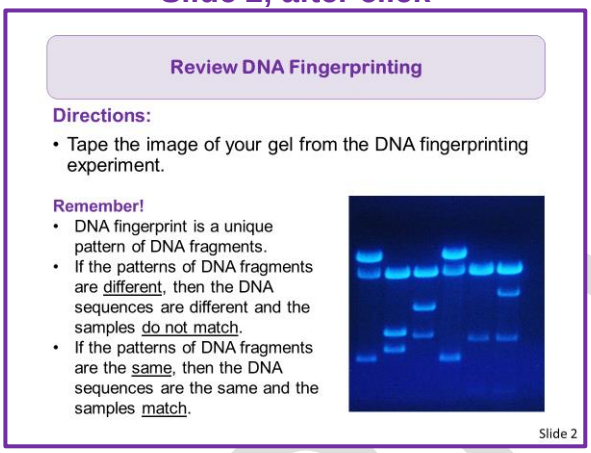


Review DNA Fingerprinting

2A. Distribute an image of the DNA fingerprinting experiment performed on the Science Adventure Lab to each student and instruct them to tape in their lab notebook.

Click on Slide 2

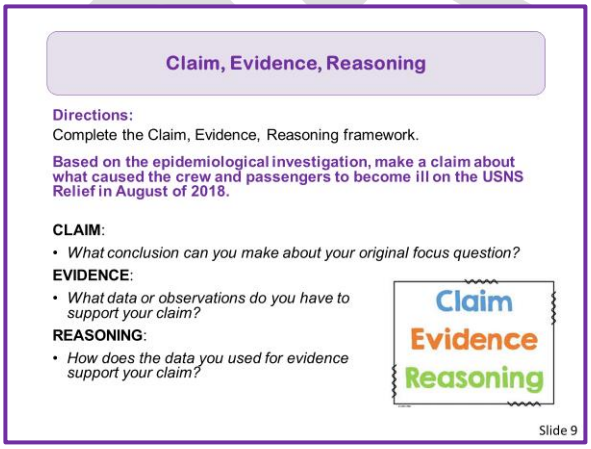
2B. Remind students that identifying the source of the infection is part of Phase 2 of an epidemiological investigation.

2C. Review the principles of DNA fingerprinting:

- A DNA fingerprint is a unique pattern of DNA fragments.
- If the pattern (both position and number) of DNA fragments from samples seen in the gel are different, then the DNA sequences are different, and the samples do not match.
- If the patterns of DNA fragments seen in the gel are the same, then the DNA sequences are the same and the samples match.

Slide 9 — Lesson 5 — 20 minutes

Slide 9



Claim, Evidence, Reasoning

9A. *Say This:*
Now that we have progressed through the phases of an epidemiological investigation and gathered evidence in the form of data from case reports and laboratory experimentation, you will use this evidence to answer the essential question, "What caused the crew and passengers to become ill on the USNS Relief in August of 2018?" and complete a Claim, Evidence, Reasoning framework.

9B. Direct students to page 14 of the Student Manual. Students may use their lab notebooks or page 15 to complete this task.

TRIPs
Teacher-Research Institute Partnerships

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