



Lesson 5: Outbreak! Investigating Epidemics

Overview Students explore how diseases can spread between humans and/or other organisms, as well as how medical professionals track what diseases may be spreading and try to prevent more people from getting sick. The concept of epidemics is discussed, then students engage in a real-world simulation to determine the cause of an actual disease outbreak and respond to it. Students then reflect on the activity as it relates to the Centers for Disease Control and Prevention (CDC)'s "Steps of an Outbreak Investigation" in discussion and writing.

Adaptations / extensions are listed at the end of the lesson, including research projects, the creation of comparison diagrams, a class game to help teach the concepts of epidemiology, and videos which can be shared with the students—or produced by them.

Subjects: Science, Health, Reading, Writing, Speaking & Listening, Social Studies

Grades: Adaptable for 4–12

Time: 45–60 min. or more

Vocabulary

- Disease
- Epidemic, epidemiology, and epidemiologist
- Host
- Infection
- Investigation
- Outbreak
- Symptom
- Vector
- Transmission

Lesson Goals

- Increase students' understanding of:
 - How diseases can spread, including the role of vectors such as mosquitoes, flies, ticks, and fleas
 - How epidemic investigations are carried out
 - The scientific steps used to answer questions reliably
 - Factors that can influence data quality
- Provide students with the opportunity to play the roles of epidemiologists and community health professionals as they work to solve real-world mysteries involving the outbreak of diseases
- Explore cause and effect through the process of studying disease outbreaks and their impacts on communities



A screenshot of the "Solve the Outbreak" app from the CDC

Objectives

- Students will brainstorm with a partner about ways diseases spread and how medical professionals track what diseases may be spreading and record their ideas in words and pictures.
- Students will play the role of epidemiologists to solve the mysteries of real-world disease outbreaks and plan the best ways to address them.
- Students will reflect on disease outbreak scenario(s) orally and in writing as they relate to the CDC’s “Steps of an Outbreak Investigation.”

Standards		Middle School (Grades 6-8)
Next Generation Science Standards (NGSS)	Crosscutting Concepts	<ul style="list-style-type: none"> • Patterns • Cause and Effect • Stability and Change
	Science & Engineering Practices	<ul style="list-style-type: none"> • Planning and Carrying Out Investigations • Asking Questions and Defining Problems • Analyzing and Interpreting Data • Constructing Explanations and Designing Solutions • Obtaining, Evaluating, and Communicating Information • Engaging in Argument from Evidence
	Disciplinary Core Ideas	LS2: Ecosystems: Interactions, Energy, and Dynamics LS4: Biological Evolution: Unity and Diversity
Common Core State Standards ELA	Speaking & Listening	1, 2, 4, 6
	Language Standards	1, 2, 3, 6
	Writing Standards Science & Technical Subjects	4, 7, 10

Materials + Preparation

1. Prepare to demonstrate the “Solve the Outbreak” simulation game, either the app available for free download from the CDC at cdc.gov/mobile/applications/sto or the Web-based version at cdc.gov/mobile/applications/sto/web-app.html.
2. Data projector to display the simulation and links for students
3. Review the additional resources listed in the More Resources / References section at the end of the lesson.

Suggested Procedure

1. Engage students with a quick brainstorming session in pairs about one or more questions designed to activate prior knowledge and prime them for the lesson, such as:
 - a. How can diseases spread between humans and/or other organisms?
 - b. How do medical professionals track what diseases may be spreading and try to prevent more people from getting sick?

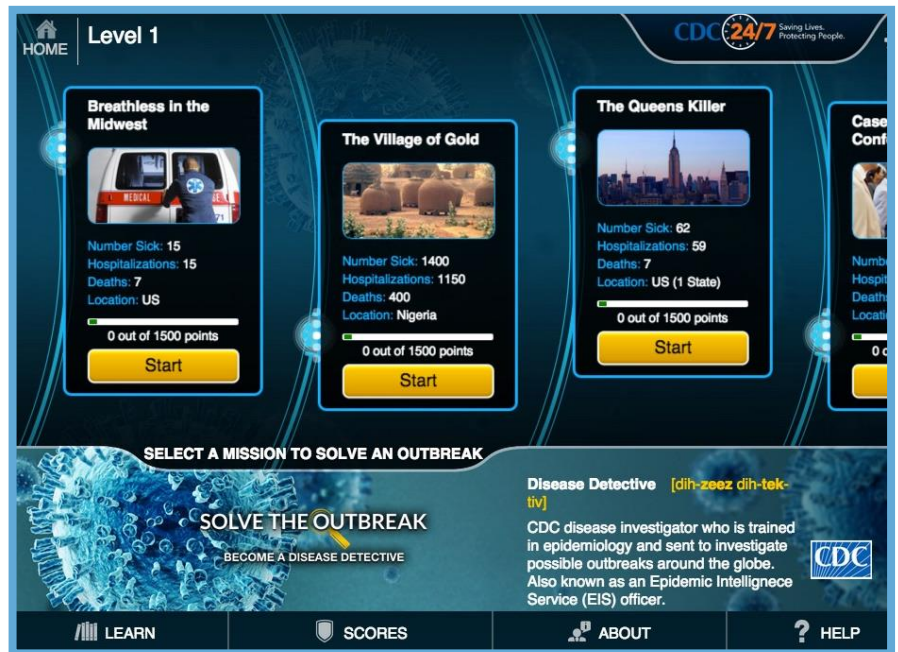
2. Ask students to record their ideas in words and/or pictures on paper or with an electronic device. Circulate through the room, answering any questions. After 1-2 minutes, tell students they have one more minute to brainstorm and that they should be prepared to share one or more of their best ideas with the class.
3. Ask the pairs to share their best ideas and discuss them briefly. Include a review of important vocabulary from earlier lessons in the discussion, such as vector, pathogens, disease, host, and transmission.
4. Write **“EPIDEMIC”** on the board in big, dramatic letters and ask students to raise their hands if they think they know what the word means. After a few moments, call on one of the last students to raise her/his hand and share their ideas. Call on another student or two to share their ideas, as well, and then ask students to think about ways they can try to decode words if they aren’t sure what they mean. Someone should suggest looking to see if there is a prefix, suffix, and/or root word they are familiar with and trying to use those as clues to solve the mystery of what the word means. Ask students to each take a moment to break the word down into parts on a piece of paper. Then ask a volunteer to go to the board and break it down there, such as in syllables and/or as “epi-demic.”

Discuss how the word, like many others we use, especially those in science, has its origins in Greek (and Latin that was influenced by Greek). Circle “epi-” and explain that in Greek it meant “upon,” “on,” “over,” “at,” or “before.” Then circle “-demic” and explain that it comes from the Greek “dēmos” meaning “the people.” Discuss how putting the two main parts of the word together to get “upon the people” could help the students know what it means.

Optional: If the students are engaged and you have time, talk about other words that begin or end in similar ways, such as “epicenter,” “epidermis,” “epitome,” and “epic,” as well as “democracy,” “demography,” “academic,” “Democrat,” etc.

5. Ask one or more students to look up the definition using respected sources such as the American Heritage Dictionary, available online without distracting ads at ahdictionary.com. Then they can share the authoritative definition(s) with the class, as well.
6. Discuss how one definition of an epidemic is “an outbreak of a contagious disease that spreads rapidly and widely,” in the words of the American Heritage Dictionary.
7. Then ask the students if anyone knows what we call a scientist who specializes in the study of epidemics, including the interesting detective work of solving the mysteries about why and how diseases are spreading. Discuss how the suffix “-ologist” is added to make “epidemiologist,” the name of the scientist who specializes in the study of epidemics. Ask the students if they know the name of any other professions that end that way, and some should be able to share “biologist,” “dermatologist,” “entomologist,” etc. Then ask students how the suffix changes a little for the name of the field that scientists specialize in; some should share “-ology,” like biology or epidemiology, the focus of today’s lesson.
8. Tell students they will be playing the role of epidemiologists in simulation games, trying to solve mysteries about how diseases are spreading. They will be using an app on computers or tablets called “Solve the Outbreak,” and working with a partner to try to diagnose why sicknesses are spreading and stop them before many more people can get sick.
9. Demonstrate for students how to play the “Solve the Outbreak” simulations via the app available for free download from the Centers for Disease Control (CDC) at cdc.gov/mobile/applications/sto. It can also be played online through any modern web browser at cdc.gov/mobile/applications/sto/web-app.html.

10. We recommend beginning with “Level 1,” then choosing “The Queens Killer” simulation; it presents the fascinating true story of how West Nile Virus was first discovered in the United States at the Bronx Zoo and the area surrounding it. There is a text version of the simulation if you’d like to read through the scenario and/or the others in the series before trying the game: cdc.gov/mobile/applications/sto/508STO.html#outbreak9.



A screenshot of the “Solve the Outbreak” app from the CDC

11. Offer suggestions about ways students can get more information and be successful in their new roles as epidemiologists, including exploring the resources in the “Learn” section, accessed by clicking the tab in the lower-left of the game.
12. Tell students that at the end of the exercise they will be reflecting on it in discussion and writing. They should be able to explain how the scenario related to and helped them learn more about the CDC’s “Steps of an Outbreak Investigation” explained here: cdc.gov/ophss/csels/dsepd/ss1978/lesson6/section2.html
13. Share the link with students and ask them to take turns reading the steps aloud as a class. Briefly discuss the concepts at each step, which are similar to the steps in any scientific investigation:
1. Prepare for field work
 2. Establish the existence of an outbreak
 3. Verify the diagnosis
 4. Construct a working case definition
 5. Find cases systematically and record information
 6. Perform descriptive epidemiology
 7. Develop hypotheses
 8. Evaluate hypotheses epidemiologically
 9. As necessary, reconsider, refine, and re-evaluate hypotheses
 10. Compare and reconcile with laboratory and/or environmental studies
 11. Implement control and prevention measures
 12. Initiate or maintain surveillance
 13. Communicate findings
14. When the students complete the exercise, ask them to talk about the scenario with their partner and how it connected with the investigation steps listed above. If there are steps that were not taken in the scenario, ask students what could have been done to help in the

investigation, communicate findings, etc. They can record their ideas for each step in writing, which can be used for evaluation.

15. Discuss the activity as a class, asking the pairs of students to share their best ideas about how it helped them to understand each step of an epidemic outbreak investigation. Include a discussion of the ways data was collected and presented in the scenario(s), as well as factors which may have affected the quality of the data. For example, when people are interviewed they do not always remember events clearly, and data collected in a lab may be less accurate due to improper collection techniques, transport, or storage of specimens, so you could ask students how the data quality might have been improved in the scenario(s).

Adaptations / Extensions

- **Students can explore additional mysteries** in “Solve the Outbreak,” such as “Sugar Plantation Blues,” “Deadlier than War,” and the “Case of the Conference Blues”:
cdc.gov/mobile/applications/sto/web-app.html
- **Show and discuss one or more short videos about epidemiology and public health**, such as:
 - “John Snow: Pioneer of Epidemiology” from PBS:
opb.pbslearningmedia.org/resource/envh10.sci.life.nathis.johnsnow/john-snow-pioneer-of-epidemiology
 - “Mystery Illness in New York City” from PBS:
opb.pbslearningmedia.org/asset/midlit11_vid_splwnilea
 - “Mystery Solved! West Nile Virus” from PBS:
opb.pbslearningmedia.org/asset/midlit11_vid_splwnileb
 - “Epidemiological Studies - made easy!” [youtube.com/watch?v=Jd3gFT0-C4s](https://www.youtube.com/watch?v=Jd3gFT0-C4s)
 - “What is Epidemiology” (first 53 seconds):
<https://www.youtube.com/watch?v=mH0Bx92SjE4>
 - “What is Public Health??” [youtube.com/watch?v=t_eWESXTnic](https://www.youtube.com/watch?v=t_eWESXTnic)
 - “Global Disease Detectives in Kibera” (5:35):
cdc.gov/cdctv/diseaseandconditions/outbreaks/kiberia-disease-detectives.html
- **Read the start of “The Queens Killer” scenario aloud with students.** The text of it and the other scenarios is available here: cdc.gov/mobile/applications/sto/508STO.html#outbreak9.
- **Have students research the history of disease outbreaks** such as malaria, bubonic plague, Lyme disease, cholera, and dysentery, and ways the science has been used to control them. Findings could be shared with the rest of the class through oral presentations, research papers, student-created videos, etc.
- **Ask students to compare two vector-borne diseases** and how they are spread using a Venn diagram or another type of diagram. If desired, they can write more detailed explanations of their diagrams in paragraph form. A list of vector-borne diseases with the type of organism that spreads them is available from the World Health Organization: who.int/news-room/fact-sheets/detail/vector-borne-diseases.
- **Students can work in pairs or small groups to create public service announcement videos** about how to stay safe from vector-borne illnesses, such as those they researched.
- **Do a complete simulation in “Solve the Outbreak” as a class** using a data projector to demonstrate the complete process, including how to complete the analysis of

the scenario as it relates to the “Steps of an Outbreak Investigation.” Then students can repeat the process using another simulation of their choice on their own.

- **Play the game “What's Lurking in Lunch?”** to teach kids more about epidemiology: askbiologist.asu.edu/whats-lurking-lunch-teachers
- **Student can research careers in public health** and record the required qualifications, daily activities, and organizations that hire individuals in the fields.

More Resources / References

- Centers for Disease Control (CDC) resources:
 - “Solve the Outbreak” lesson plan and supporting resources:
 - Middle grades: cdc.gov/mobile/applications/sto/Lesson_Plan_Middle_School_Level.pdf
 - High school level: cdc.gov/mobile/applications/sto/Lesson_Plan_High_School_Level.pdf
 - Standards alignment for the different scenarios, etc.: docs.google.com/viewer?url=https://www.cdc.gov/mobile/applications/sto/WebVersion_core_curriculum.pdf
 - “Steps of an Outbreak Investigation”: cdc.gov/ophss/csels/dsepd/ss1978/lesson6/section2.html
 - Epidemiology in the Classroom: cdc.gov/careerpaths/k12teacherroadmap/classroom/index.html
 - Epidemiology Lesson Plans: cdc.gov/careerpaths/scienceambassador/lesson-plans/epidemiology.html
 - “Teacher Roadmap” website: cdc.gov/careerpaths/k12teacherroadmap/index.html
 - Science Ambassador program: cdc.gov/careerpaths/scienceambassador/lesson-plans/index.html
 - “What is Epidemiology?” definition: cdc.gov/careerpaths/k12teacherroadmap/epidemiology.html
 - “Introduction to Epidemiology.” A longer explanation with examples: youtube.com/watch?v=4oaQUAnA6nY
- Lessons from PBS and WGBH:
 - “Epidemiologists: Disease Detectives” opb.pbslearningmedia.org/resource/envh10.health.lp912/epidemiologists-disease-detectives/#.W2wzSMLavgf
 - “Solving a Public Health Problem”: opb.pbslearningmedia.org/resource/midlit11.sci.splwnile/solving-a-public-health-problem
Student site: lsintspl3.wgbh.org/en-us/lesson/midlit11-sci-splwnile
- More resources from Clackamas County Vector Control District: fightthebites.com/education.
- Learn more about West Nile Virus and its transmission from the Mayo Clinic: mayoclinic.org/diseases-conditions/west-nile-virus/symptoms-causes/syc-20350320