Simulating the spread of an infectious disease

How are infectious diseases spread?

It can be difficult to determine the origin of and identify an outbreak of an infectious disease. Epidemiology is the study of disease and disease transmission. Cases of a disease outbreak are usually reported to public health outlets (county or state departments of health). An inquiry begins with field work by investigating the cases reported and looking for connections. Public health officials trained to collect samples from infected people or from doctors/clinicians in areas where the disease is spreading would document cases, collect samples then deliver them to a lab to determine if people are infected by the same pathogen. DNA from the pathogen would be extracted, amplified by PCR, then genetically sequenced to compare to other known pathogens. In the meantime a case definition would be created with a list of the major symptoms and as more cases are discovered, the case definition would be further refined. Those symptoms might be shared with doctors, and /or described in the media and folks would be encouraged to report cases to their doctors.

In this lesson, students will model the spread of a contagious/infectious disease. At the end of this simulation, students take on the role of an epidemiologist to discover the origin of the disease that has spread through the classroom.

Ohio Standards

- Anatomy and Physiology Transport (AP.T.3: Lymphatic and immune systems)

Student prior knowledge

Students should have familiarity with the immune system, with common diseases, and with various ways infections may be transmitted. Follow this lesson with a review of the immune system, investigating the organs and cellular components.

Suggested timeline

One class period for simulation and discussion

Materials

- Test tube for each student (or small paper cup)
- Dropper for each student
- 0.1 molar NaOH solution
- Distilled H_20 (as the native body fluid)
- Phenolphthalein solution testing solution

Teacher preparation

1. Fill all but one test tube halfway with clear liquid (distilled H2O) to represent “body fluid”.
2. Fill one test tube halfway with 0.1M NaOH (infected individual).
3. Copy student documents.

Procedure

1. Let participants know they are going to model the transmission of a disease by exchanging some of their test tube's contents with that of other participants. Mention that one of the test tubes is "infected" with an imaginary infectious disease.
2. Distribute the student document, prepared test tubes, and droppers randomly to the class. Make a mental note of who receives the test tube containing NaOH (the infection).
3. Have participants walk around the room with their test tubes. When you say "stop!", each participant should use a dropper to trade a drop of fluid with the person nearest them.
4. Have students record the names of the others they exchange fluid with on a notecard in the order they encountered them.
5. Repeat until at least three trades have occurred.
6. It is now time to test for the imaginary infection. Add a drop of phenolphthalein to each test tube. If the fluid turns pink, the tube is "infected" with NaOH (the imaginary infection). How many participants are now "infected"?
7. List names on the board and make connections as to who exchanged with whom using student records with whom they interacted.

Suggested wrap-up

Lead a class discussion exploring these topics:

- Why might it be important to locate the source of infection?
- What difficulties arise in trying to collect and interpret data?

Note that the simulated disease has a 100% rate of infection that appears immediately under testing. Some infections, such as AIDS and chicken pox, can remain dormant in the body for a long time. Others, such as Ebola, kill the host rapidly.

- How might each of these factors affect the spread of disease and the ability to identify carriers?

Rapid and constant evolution challenges our main defenses against infectious diseases, which include:

- Public health measures that minimize exposure to disease-causing organisms
- Immunity, whether gained by infection or vaccination
- Therapeutic drugs used to treat infections

Differentiation

- Consider having lab assistants prepare the test tubes.
- Students with disabilities may need to be partnered with another student to exchange drops.
- Extension: read this case write-up of SARS-CoV2: ***theconversation.com/how-virus-detectives-trace-the-origins-of-an-outbreak-and-why-its-so-tricky-161387***
- Further activities may be found here: ***archive.cdc.gov/www_cdc_gov/csels/dsepd/ss1978/lesson6/section2.html***

Extensions

Have students investigate current and past outbreaks.

- Current:
  - Covid, world-wide
  - *Salmonella* outbreak tied to onions; over 900 people sick
  - Ebola virus disease in the Democratic Republic of the Congo
  - Pet store puppies; *Campylobacter* infections
  - Bird flu
- Past:
  - Pig ear dog treats; *Salmonella* outbreak
  - Pet turtles; *Salmonella*
  - Beef; *E. coli* (Jack-in-the-Box)
  - Bubonic plague

Support information

- Disease can be spread by direct or indirect contact.
- This lesson simulates direct contact.
- The immune system will react to disease in a variety of ways.

Career connections

- **Epidemiologists** search for the cause of disease, identify people who are at risk, and determine how to control or stop the spread or prevent it from happening again.
- **Physicians, veterinarians, scientists, lab technicians** and other health professionals all contribute to epidemiology by collecting data and testing for an infectious agent and reporting to local boards of health.
- **Pathologists** are involved in diagnosing illnesses. They study body fluids, tissues, or organs.
- **Immunologists** study the immune system and analyze the responses to disease in order to help treat or reduce the effects of a disease.
- Similar occupations:
  bls.gov/ooh/life-physical-and-social-science/epidemiologists.htm#tab-8