ACTIVITY 8

Investigating a Pathogen

CARD-BASED INVESTIGATION


Various
microorganisms
grown in a lab

8: INVESTIGATING A PATHOGEN

GUIDING QUESTION

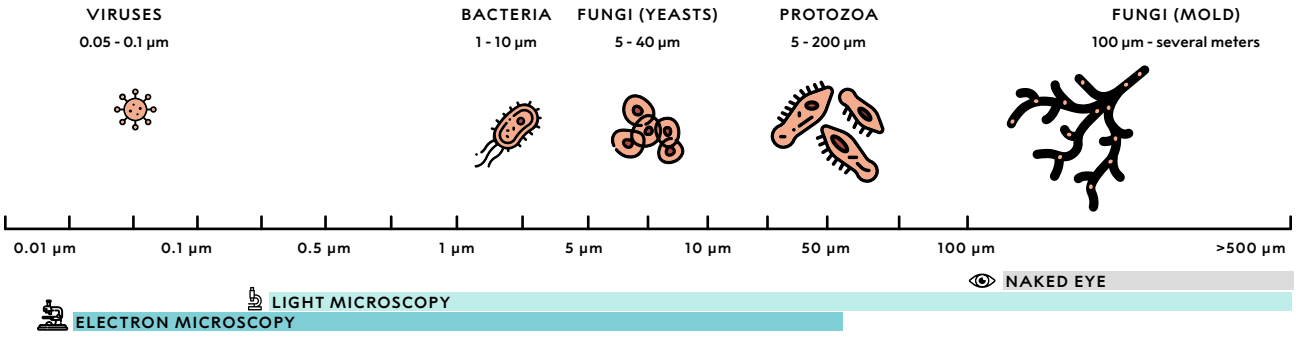
How do epidemiologists use an actively open mindset?

INTRODUCTION

Researchers in Wuhan, China, identified the virus that causes COVID-19. This virus was the pathogen—an organism or biological agent that causes infectious disease. Viruses, bacteria, fungi, and even parasites can be pathogens. Identifying the cause of an infectious disease involves detecting a harmful pathogen in a medical, food, or environmental sample. This kind of scientific work serves as an example of how scientific progress depends on slow thinking and an actively open mindset. In this activity, you will evaluate information related to Southsand fever to identify the pathogen responsible for the infection.

FIGURE 8.1
Pathogen Size

The sizes of various pathogens on a scale that uses factors of 10. These images show just a few examples—there are many types of each pathogen. NOTE: Images not shown to scale.



CONCEPTUAL TOOLS

If you need to review concepts related to microbes, you will find a Science Review at the end of this activity.

MATERIALS LIST

FOR EACH GROUP OF FOUR STUDENTS

- SET OF 4 PATHOGEN TYPE CARDS

PROCEDURE

1 With your class, read the following fictional scenario.

> *In order to find effective solutions to treat and prevent Southsand fever, the Southsand Fever Investigation Team needs to identify the pathogen responsible for the illness. They know that Southsand fever causes respiratory symptoms that affect the lungs, though the infection can spread to the skin and other parts of the body. In the lab, scientists on the Investigation Team isolated a Southsand fever microbe that might be the pathogen from the diseased lung tissue of a Southsand fever patient.*

2 With your group, carefully read each Pathogen Type card. With the class, clarify any questions you have about the information.

3 With your group, make one or more guesses about which pathogen type might be the cause of Southsand fever. Discuss whether your guesses involved any cognitive shortcuts or cognitive biases.

4 Compare the images on the Pathogen Type cards to the following image of the Southsand fever microbe in the lung of an infected patient. The patient is a contractor working at one of the new construction sites in Southsand City. As a group, use the comparison to identify the most likely pathogen. Record your claim, evidence, and reasoning in your science notebook.

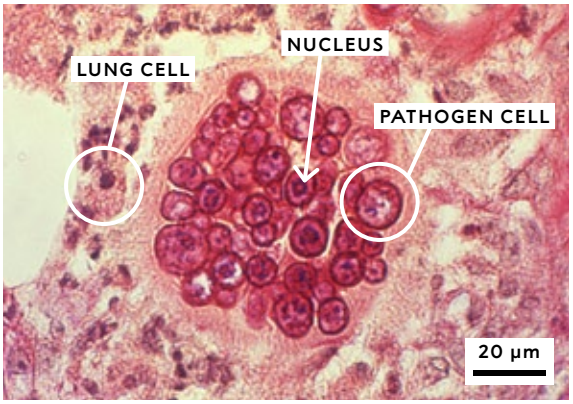


FIGURE 8.2
Pathogen Cell

A microscope image of pathogen cells from a Southsand Fever patient. It shows a spore consisting of many pathogen cells.

5 Share with the class your ideas and evidence about which types of pathogens are likely to be the Southsand fever pathogen.

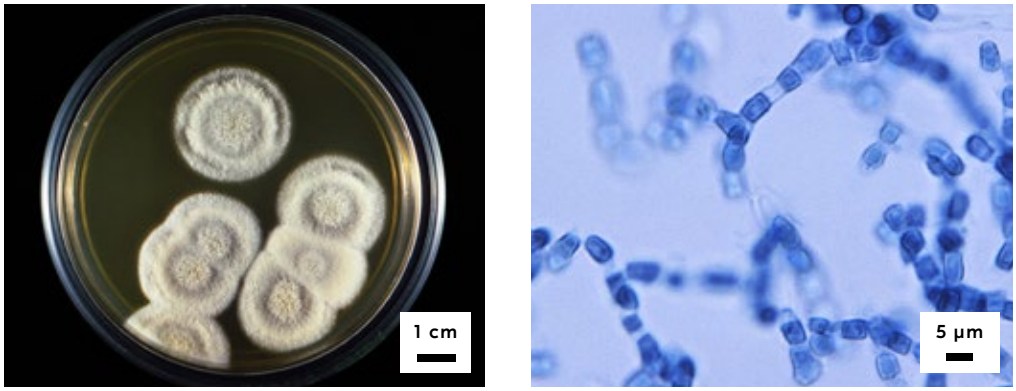
6 Read the following continuation of the fictional scenario.

> *The scientists formed an initial hypothesis that the pathogen is a protozoa. To confirm this finding, they took a lung sample from the Southsand fever patient and tried to grow the pathogen in a few petri dishes. Then they looked at the organism growing on the petri dish under a microscope.*

7 The following images show the petri dish and the microscope slide from the scenario. Compare the images, including the scale of the organism, to the Pathogen Type cards. In your group, determine whether or not this evidence supports the scientists' hypothesis.

FIGURE 8.3
Petri dish and microscope slide

View of the organism growing in the petri dish (left) and a microscope image of the organism from the same petri dish (right).



8 Read the following continuation of the fictional scenario.

> *After looking at the images, one scientist said, "This must be a mistake because the pathogen is a protozoa. I think that our patient sample must have been contaminated with mold." Later, the scientist returned to the petri dishes and found that the mold had dried up. When he opened one of the petri dishes, he accidentally inhaled some of the particles from the dried-out dish. Less than a week later, he developed symptoms of Southsand fever! The scientist was sure that he was not infected from something else. He realized that he contracted the disease from what he inhaled from the dried-up petri dish.*

9 With your group, consider the evidence thus far about the pathogen. Decide if you would like to keep your claim from Step 4 about the pathogen type or revise it. Record your claim, evidence, and reasoning in your science notebook.

10 In real life, scientists have to confirm that the microbe collected from an infected patient is the same as the ones that are present in the location where the person got the disease. In the Southsand fever scenario, scientists need to confirm that the microbe found in the infected patient is the same as the one found in the soil where the patient was infected. They sampled a mold found in the soil near where an infected patient worked. Your teacher will show you an image of the microscope image of the mold. Use the image to evaluate your claim from Step 9.

11 As a class, discuss the evidence from this activity and other activities. Revisit your predictions and then come to consensus on

- how the pathogen appears inside the body and in the soil. Specifically,
  - in Step 4, the image shows the pathogen inside an infected patient.
  - in Step 7, the image shows the pathogen cultured from the infected patient.
  - in Step 10, the image shows the pathogen from the soil.
- the pathogen type causing Southsand fever.
- how infection most likely occurs in Southsand.

12 Think about what you just read about the mold in the petri dish. Identify places in the scenario where cognitive biases affected the scientist's thinking and how he overcame the bias. Discuss your ideas with the class.

BUILD UNDERSTANDING

1. What is the pathogen of Southsand fever? Use the evidence from this activity to make a claim about the pathogen type and how it appears inside the body and in the soil. Include your reasoning.

2. How did confirmation bias appear in the investigation to identify the pathogen?

CONNECTIONS TO EVERYDAY LIFE

3. What were the most important aspects of an actively open mind-set you used to identify the pathogen in this activity? Explain.

KEY SCIENTIFIC TERMS

pathogen

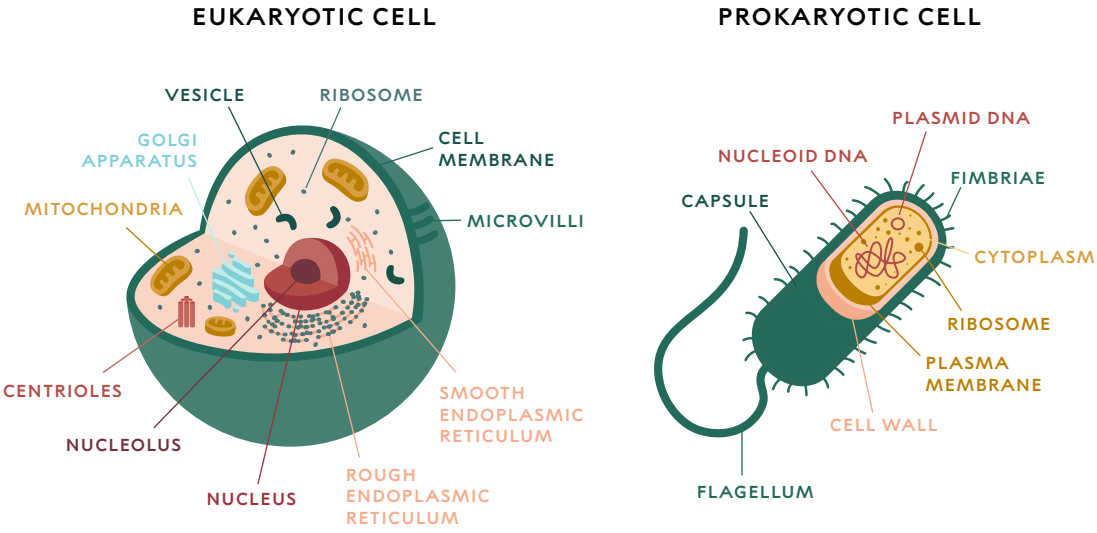
SCIENCE REVIEW

Types of Organisms

All living organisms can be classified into two broad categories based on the location of their genetic material (DNA) and cell structure. *Eukaryotes* are organisms whose cells contain a nucleus. The nucleus is a large organelle surrounded by a double membrane where the DNA is stored. Eukaryotes can be one cell or many cells. Examples of unicellular eukaryotes include some fungi—such as yeasts—and amoebas, paramecium, and protozoa. Multicellular eukaryotes are made of multiple cells that work together to form tissues, organs, and organ systems. Examples of multicellular eukaryotes include animals and plants.

Prokaryotes are cells that do not have a nucleus, and their DNA is located in the cytoplasm of the cell. They are simpler in structure than eukaryotes. All prokaryotes are unicellular organisms and consist of a single cell that performs all life functions. An example of prokaryotes are bacteria. The relatively simple prokaryotes were the first forms of life on Earth.

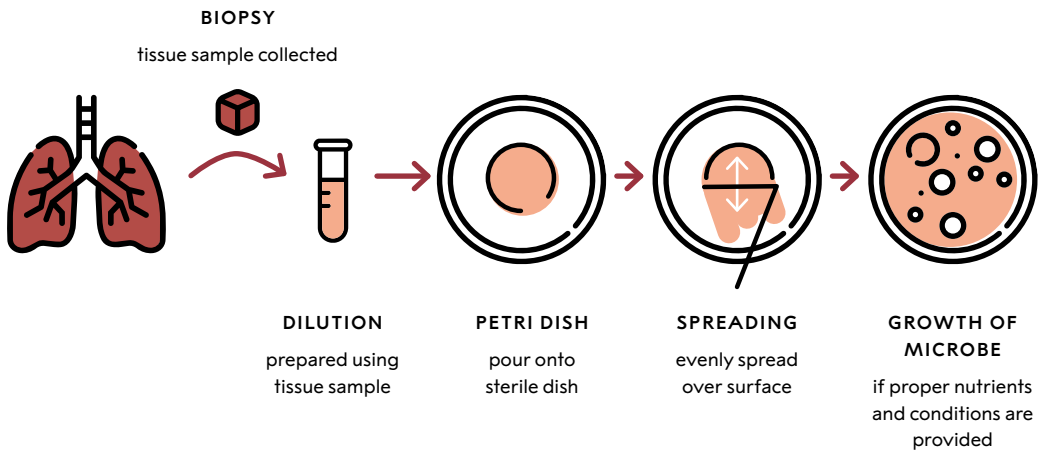
FIGURE 8.4
Two Types of Cells



Culturing Microorganisms

Cell culture is the process of growing cells under controlled conditions outside of their natural environment. Culturing microorganisms is one way in which scientists investigate disease-causing organisms. In a lab setting, scientists grow microorganisms from samples on solid agar in petri dishes or in liquid broth in tubes. The agar or the broth provide nutrients that support the growth of bacteria or fungi. Sterile techniques prevent contamination, with samples incubated at specific temperatures to create pure cultures for diagnosis. A pure culture is one that only contains the species being investigated. For optimal growth, conditions are adjusted to suit the target species. For example, species found in atmospheric conditions, such as on the skin's surface or in the upper respiratory tract, will typically grow well in the presence of oxygen. Species that are naturally found in low oxygen environments, such as in deep wounds, will typically grow best in the absence of oxygen. Selecting appropriate nutrients and restricting growth conditions can encourage the growth of the target species and help to eliminate the growth of non-target species.

FIGURE 8.5
Cell Culture



The steps of cell culture when testing for a microorganism in a patient. Tissue samples are collected, diluted, and spread on petri dishes.