

- **Protozoa** are single-celled organisms that prey on other cells. Like viruses, protozoa need healthy cells to complete their life cycles. Malaria is a blood disease that is caused by a protozoan. The chapter on protists and fungi includes a description of how the protozoan that causes malaria uses red blood cells to complete its life cycle.
- **Parasites** are organisms that grow and feed on a host. Some parasites kill the host, while others drain the body's resources without killing the host. **FIGURE 1.3** shows a filaria, a parasitic worm found in tropical climates. Filaria will rarely kill its host, although some forms, such as heartworm, can be fatal in mammals. You can read more about parasitic worms in the chapter on invertebrate diversity.

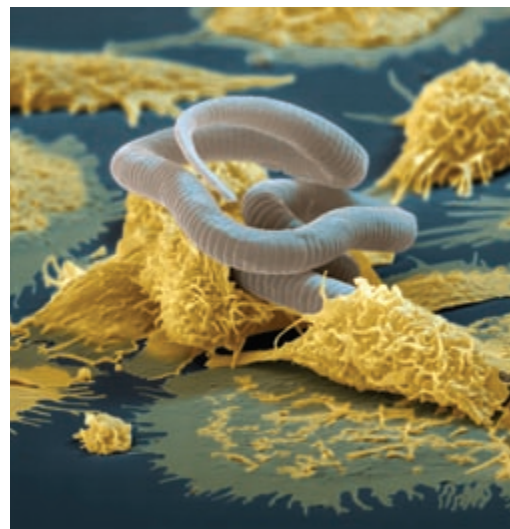
Although each of these pathogens is different, they all cause disease by attacking healthy cells. However, the way by which they attack varies.

**Summarize** What do all of these pathogens do that makes a person sick?

### ▶ MAIN IDEA

## Pathogens can enter the body in different ways.

Before a pathogen can make a person sick, it must get inside the body. Some pathogens can be transferred by **direct** or **indirect** contact. Pathogens that spread by direct contact are those that require an infected person or animal to physically touch a healthy person. Rabies, for example, is transferred when an infected animal bites a healthy animal. HIV is transmitted through an exchange of bodily fluids, such as during sexual intercourse or sharing of infected needles. It can also be transmitted from a mother to her child through the placenta or breast milk.



**FIGURE 1.3** Filaria, such as this one, enter the body through contaminated food and can grow to be a meter long. (colored SEM; magnification 2500×)

## QUICK LAB MODELING

### How Pathogens Spread

Pathogens are disease-causing particles. In this lab, you will model how a pathogen spreads through a population.

**PROBLEM** From whom did the pathogen originate?

#### PROCEDURE

1. Obtain a cup filled with an unknown solution. Pour half your solution into a classmate's cup. Then pour the same amount from your classmate's cup back into your cup. Now your cup contains a mixture of the two solutions.
2. Repeat step 1 two more times with different classmates. Keep a record of with whom you exchanged solutions and in which order.
3. After you have exchanged solutions with three classmates, add three drops of "pathogen"-detecting solution to your cup. If your solution becomes pink, your cup contains the pathogen.

#### ANALYZE AND CONCLUDE

1. **Analyze** If your cup contained the pathogen, can you identify its origin? If your cup did not contain the pathogen, is it possible that any of the other solutions poured into your cup contained the pathogen?
2. **Analyze** Only one person in your class began with the pathogen in his or her cup. How can you determine whose cup had it?

#### MATERIALS

- 8-oz cup
- 100 mL unknown solution
- eyedropper
- 3 drops "pathogen"-detecting solution





**FIGURE 1.4** Sometimes even surfaces that we think are clean are covered with pathogens. Here you can see different types of pathogens clinging to a kitchen sponge. (colored SEM; magnification 6000×)

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Spread of Infectious Disease

Pathogens that are spread by **indirect contact** can survive on nonliving surfaces, such as tables, door knobs, or kitchen sponges—as shown in **FIGURE 1.4**. Some parasitic worm larvae live in the soil and can burrow through the skin of a victim's bare foot. Once inside the body, the larvae travel into the victim's intestines. Species that remain in the intestines throughout their life cycle can cause discomfort, nausea, and diarrhea.

Other pathogens are spread **through the air**. When you cough or sneeze, you release droplets into the air around you. When you are sick, these droplets might contain pathogens. Other airborne pathogens are lightweight and hearty enough that they can survive in the air on dry particles. Respiratory diseases such as tuberculosis and SARS are examples of airborne diseases.

Still other pathogens are spread **by vectors**. A **vector** is anything that carries a pathogen and transmits it into healthy cells. Insects are examples of vectors. Insects can transmit bacteria, viruses, and protozoa. The Black Death, which killed millions of people in the 1300s, is caused by a bacterium that lives in the stomach of a rat's flea. People got sick with the Black Death when they were bitten by a contaminated flea. Mosquitoes can also pass diseases between animals. The protozoan that causes malaria, for example, completes a part of its life cycle in the gut of a mosquito. Mosquitoes can also transmit diseases between species. West Nile virus originally affected birds, but when an infected mosquito bites a person with a weak immune system, the virus can cause the person's brain to swell. However, insects cannot transmit pathogens, such as HIV, that die when the insect digests the infected human blood cells.

Pathogens can also be transmitted **through food**. Some diseases are caused by pathogens that were alive when the food-animal lived. Mad cow disease, which causes neurological problems in humans, is caused by an abnormal protein that is found in some beef cattle. Salmonella, which causes vomiting, is found in the intestines of some pigs and other animals. Most parasitic worm eggs enter the body through the mouth, as when a person eats contaminated food. Other diseases, such as various types of food poisoning, are caused by bacteria or fungi that decompose food.

**Infer** Why are some diseases only spread by insect bites?

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## 31.1 Formative Assessment

### REVIEWING MAIN IDEAS

1. What conditions must be met before a specific **pathogen** is proved to cause a disease?
2. Name five general types of pathogens.
3. What are some ways in which pathogens spread?

### CRITICAL THINKING

4. **Contrast** How do bacteria and viruses differ in the ways they affect cells in the body?
5. **Synthesize** How did the work of Lister and Koch support Pasteur's **germ theory** of disease?

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### CONNECT TO

#### VIRUSES

6. Viruses infect healthy cells by injecting their genetic material into them. How are viruses similar to **vectors**? If the virus is the vector, what is the pathogen?