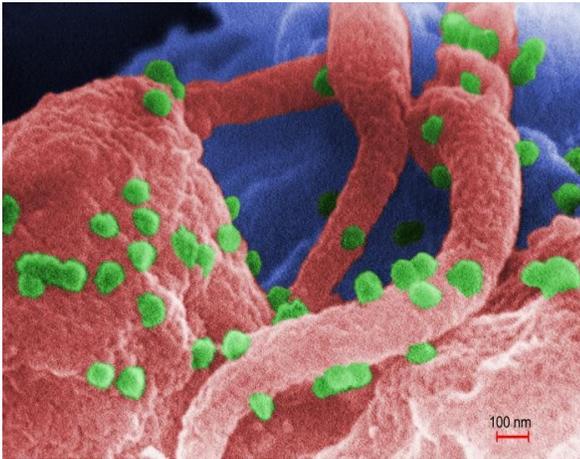




How Microorganisms Cause Disease



Many infections and diseases are caused by **microorganisms**—organisms that cannot be seen without the aid of a microscope. But, not all microorganisms cause disease. There are many bacteria in the environment that don't make you sick.

A scanning electron image of an HIV virus (spherical green shapes) on a human lymphocyte (white blood cell).
Image Credit: CDC/ C. Goldsmith, P. Feorino, E. L. Palmer, W. R. McManus

How do the pathogens—disease-causing agents—produce infection and disease in the body?

Objectives

To understand how microorganisms cause disease, you should be able to:

- Compare and contrast the states of infection and disease.
- Identify ways to avoid infection by pathogens that use direct and indirect transmission methods.
- Explain three different methods of indirect transmission of pathogens.
- Describe how bacteria cause disease.
- Describe how viruses cause disease.
- Explain how exotoxins and endotoxins cause disease.

Vocabulary

bacteria—one-celled, prokaryotic organisms which are involved in fermentation, nitrogen fixation, and infectious disease.



disease—a condition in which the body cannot function normally due to infection by a pathogenic agent, genetic condition, nutritional deficiency, or an illness of an affected body organ.

endotoxin—poisons that are part of the bacterial cell wall that are released when the bacteria adheres to a host cell.

exotoxin—a poison excreted by a microorganism.

immune system—a body system that protects against disease and foreign substances, destroys infected cells, and removes cellular debris.

infection—a condition in which an infectious agent invades the body and begins to multiply.

inflammation—redness, swelling, pain and tenderness around an area of the body due to an infection or injury.

microorganism—an organism too small to be seen without a microscope.

pathogen—any disease-causing agent.

phagocytosis—the process of engulfing a smaller cell, microorganism, or foreign particle.

transmission—any mechanism by which an infectious agent is spread to a host.

virus—an infectious agent that multiplies only within the cells of living hosts; composed of RNA or DNA and a protein coat; more complex viruses also have a surrounding envelope.

Infection and Disease

Have you ever gone to the doctor for a sinus infection, the flu, or a bad cold? Depending on your illness, the doctor may have told you the infection was caused by a bacteria or a virus. Have you ever thought about the difference between the two? You may be used to hearing about bacterial or viral infections, but have you ever thought about how these **microorganisms**—organisms too small to be seen without a microscope—can actually make you sick?

There are plenty of microorganisms that you are in contact with every day that do not make you sick. Millions of bacteria live in your body and





help you digest food, destroy harmful bacteria, and protect you by creating environments in which disease-causing organisms cannot survive. Other microorganisms infect you and cause you to become sick. You may get a fever, have swollen lymph glands, cough a lot, and have a runny nose or high fever.

Why do only some microorganisms make you ill?

How Microbes Are Transmitted

The first step in infection is the microbe entering the body. This can happen in a number of different ways and each is specific to the pathogen. **Transmission** is the process by which an infectious agent leaves its reservoir or host, travels by some mode, and enters and infects a susceptible host.

There are direct and indirect transmission methods. **Direct transmission** methods include contact with soil, plants, or people infected with a pathogen. **Indirect transmission** methods are methods by which a pathogen travels to a host. These methods include those that are:

- **airborne**—an infectious agent is carried from a source to a host while suspended in air particles.
- **vector borne**—an infectious agent is carried by a live carrier, such as a mosquito, flea, rat, or tick.
- **vehicle-borne**—an agent is carried by an inanimate object, such as food, water, blood or items such as surgical instruments.

Knowing how an infectious agent is transmitted allows you to take actions to avoid infection. For example, if a pathogen is airborne, avoid being in an environment of someone who is coughing without covering his mouth. If the infectious agent is vector-borne, avoid the carriers, such as mosquitos or fleas by using an insect repellent.

Once inside the body, **pathogens** (disease-causing organisms) attack specific cells or travel to specific tissues, depending on the pathogen.

Infections and disease are not the same. An **infection** occurs when bacteria, viruses, or other pathogens invade the body and begin to multiply. This is the first step to a disease condition. **Disease** occurs when the cells of your body are damaged from the invading



Streptococcal infection. Note the whitish areas of pus.

Image Source: [Wikipedia](#)



pathogens and regular cell processes are disrupted. The disruption of cell processes causes symptoms that are specific to the pathogen.

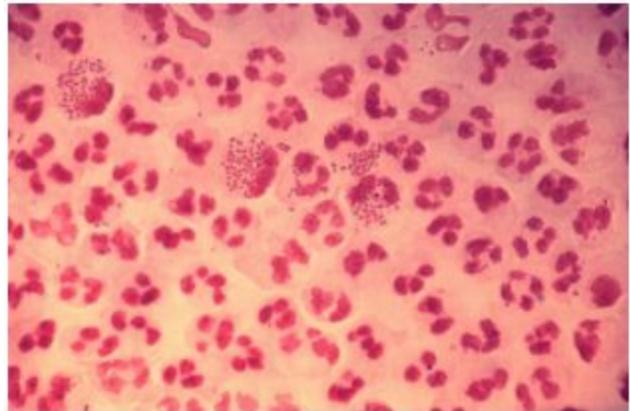
This is why you develop a rash from the measles virus (a single stranded RNA virus of *Morbillivirus* genus) or why your throat hurts so much when you have strep throat (*Streptococcus pyogenes*). Each pathogen attacks specific cells that disrupt processes which then produce specific symptoms.

Soon after the initial time of infection, many pathogens are destroyed through natural immune responses by the body. The pathogen may be engulfed (**phagocytized**) by specialized white blood cells or made inactive by antibodies in the blood. **Inflammation** of tissues is triggered by the presence of a pathogen and may keep the infection localized. Keeping the infection contained allows more specific immune responses time to develop and fight the infection.

What happens if it is NOT contained?

If a pathogen invades host body cells, multiplies, and is not contained, it can cause the host cell to burst and release even more pathogens into the body. These then move to susceptible body cells and continue to multiply. Enzymes help some pathogens invade the cells and help with the spread from the initial site of infection to other areas of the body. Other enzymes kill white blood cells that would have destroyed the pathogen. These processes result in the infection spreading throughout the body causing disease.

The image of the microscopic slide at the right shows a gonococcal infection (the small pink round-shaped bacteria) cultured from a urethra. The bacteria on this slide are both inside and outside the white blood cells shown.



A microscopic slide of a gonococcal infection, pink round-shaped bacteria.

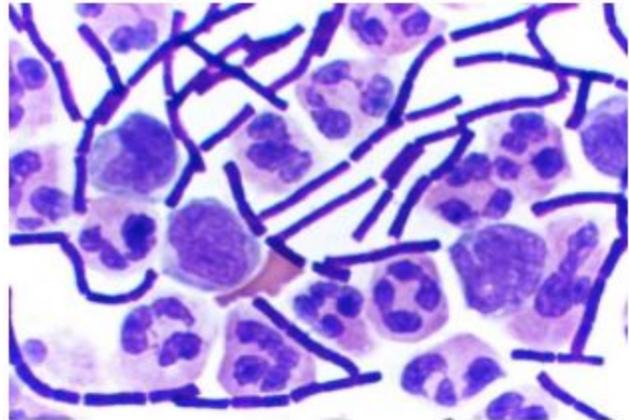
Image Source: [Wikimedia](#)

Once pathogens are inside body cells, they cause disease by destroying cells and disrupting tissue and body functions. Some bacteria produce **exotoxins**—a poisonous substance that is released into cells. Examples of bacteria that produce exotoxins include *Clostridium botulinum* that produces botulism, *Corynebacterium diphtheria* which produces diphtheria, and *Clostridium tetani* which produces tetanus.



These bacteria can be fought by a variety of immune system factors, but sometimes the exotoxin is so poisonous that it is deadly to the host before the immune system can destroy it.

Other bacteria produce **endotoxins**—poisons that are part of the bacterial cell wall. Unlike endotoxins, endotoxins are not released from the bacteria until the bacteria adhere to the surface of a body cell. Bacteria that secrete endotoxins include *E. coli* (severe diarrhea), *Pseudomonas* (infections of the lungs, urinary tract, burn, and wounds), *Neisseria* (meningitis and gonorrhea), and *B. pertussis* (whooping cough).



This image shows the Gram-positive, rod-shaped *Bacillus anthracis*, the bacterium that causes anthrax. The round, nucleated cells on the slide are white blood cells.

Image: [Wikimedia](#)

Viruses

Viruses also cause infectious disease. Their structure consists of a protein coat wrapped around a nucleic acid core—its genetic material. They cannot replicate outside a living host cell.



Digitally-colored scanning electron micrograph showing filamentous Ebola virus particles.

Image Source: National Institute of Allergy and Infectious Diseases (NIAID)

Each type of virus can only reproduce inside certain hosts. For example, some viruses infect only humans, while others infect only dogs. You don't worry about getting a cold from your dog.

In order to infect a body cell, viruses chemically attach to the host cell. The entire virus or its genetic component penetrates the cell's cytoplasm. Viral DNA or RNA interferes with host genetic material and redirects the cell to produce copies and form new virus particles. The reproduced viruses are released from the cell, usually when the cell ruptures and is destroyed.



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The new virus particles spread to other cells, the process is repeated, and infection and disease result.

Clearly, pathogens are not without their defenses and specialized ways of managing their spread throughout the body. Their structure may be simple, but they are not simple in their response mechanisms and the consequences to their invasion of the body can be lethal.

Note: It is possible that a virus that did not previously infect a human suddenly seems to have that capability. We say the virus “jumps” to other species. The “bird flu” came to us through waterfowl and HIV affected chimpanzees before humans. Scientists think that the likelihood of a virus jumping species is a combination of exposure factors and how closely related the species are.

Check Your Understanding

1. Describe transmission methods that allow pathogenic microorganisms to enter the body?
2. How do microbes cause disease?
3. What are exotoxins and endotoxins and how do they cause disease?
4. Describe how knowing the transmission method of specific pathogens could allow you to avoid disease?
5. Why are diseases produced by pathogens so different?