# 35 Immune System and Disease

## Big idea

How does the body fight against invading organisms that may disrupt homeostasis?

<table>
<thead>
<tr>
<th>WHAT I KNOW</th>
<th>WHAT I LEARNED</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>35.1 How do people catch infectious diseases?</strong></td>
<td><strong>SAMPLE ANSWER:</strong> People catch infectious diseases from other people who are sick.</td>
</tr>
<tr>
<td><strong>35.2 How does the body defend against infection?</strong></td>
<td><strong>SAMPLE ANSWER:</strong> The body’s immune system defends it against infection.</td>
</tr>
<tr>
<td><strong>35.3 How do humans fight and prevent disease by keeping things clean and by going to the doctor and taking medicine?</strong></td>
<td><strong>SAMPLE ANSWER:</strong> Humans fight and prevent disease by keeping things clean and by going to the doctor and taking medicine.</td>
</tr>
<tr>
<td><strong>35.4 What happens when the immune system does not function properly?</strong></td>
<td><strong>SAMPLE ANSWER:</strong> A person will get sick often if his or her immune system does not function properly.</td>
</tr>
</tbody>
</table>
35.1 Infectious Disease

Lesson Objectives

- Identify the causes of infectious disease.
- Explain how infectious diseases are spread.

Lesson Summary

Causes of Infectious Disease  Changes to body physiology that disrupt normal body functions and are caused by microorganisms are called infectious diseases. This explanation, established by Louis Pasteur and Robert Koch, is called the germ theory of disease.

- Infectious diseases are caused by viruses, bacteria, fungi, protists, and parasitic worms. Disease-causing microorganisms are also called pathogens.
- Koch also developed a series of rules that help scientists identify which organism causes a specific disease. These rules are called Koch's postulates.
- Many microorganisms are symbionts that are either harmless or beneficial. Pathogens cause disease by destroying cells, disrupting body functions, or releasing toxins that kill cells or interfere with their normal functions.

How Diseases Spread  Infectious diseases can be spread in several ways.

- Some infectious diseases are spread from person to person through coughing, sneezing, physical contact, or exchange of body fluids. Most infectious diseases are spread through indirect contact, such as pathogens that are carried through the air. These pathogens can be inhaled, or they can be picked up from surfaces.
- Some pathogens are spread by specific kinds of direct contact, such as sexual contact or drug use that involves shared syringes.
- Other infectious diseases are spread through contaminated water or food.
- Some infectious diseases spread from animals to humans. Such a disease is called a zoonosis. Often, the spread of zoonoses involves vectors, which are disease carriers that usually do not get sick from the pathogen.

Causes of Infectious Disease

1. What are infectious diseases, and what causes them?

   Infectious diseases are changes to body physiology that disrupt normal body functions. They are caused by microorganisms.

2. How did the germ theory of disease get its name?

   Microorganisms were once called germs; today the word “germ” has no scientific meaning.

3. What is another name that scientists use for a disease-causing agent?

   pathogen
For Questions 4–12, match each type of disease with the type of disease-causing agent that causes it. Some types of disease-causing agents may be used more than once.

<table>
<thead>
<tr>
<th>Disease</th>
<th>Type of Disease-Causing Agent</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. African sleeping sickness</td>
<td>A. virus</td>
</tr>
<tr>
<td>5. athlete’s foot</td>
<td>B. bacterium</td>
</tr>
<tr>
<td>6. botulism</td>
<td>C. protist</td>
</tr>
<tr>
<td>7. chicken pox</td>
<td>D. parasitic worm</td>
</tr>
<tr>
<td>8. hookworm</td>
<td>E. fungus</td>
</tr>
<tr>
<td>9. influenza</td>
<td></td>
</tr>
<tr>
<td>10. malaria</td>
<td></td>
</tr>
<tr>
<td>11. trichinosis</td>
<td></td>
</tr>
<tr>
<td>12. tuberculosis</td>
<td></td>
</tr>
</tbody>
</table>

13. What are Koch’s postulates used for?
   *They are used to scientifically identify the microorganism that causes a specific disease.*

14. Complete the flowchart by numbering the steps to show the order in which a researcher applies Koch’s postulates.

   - Same pathogen recovered from sick mouse
   - Pathogen injected into a healthy lab mouse
   - Pathogen grown in a pure culture
   - Healthy mouse becomes sick
   - Pathogen isolated from a dead mouse

   5 3 2 4 1

15. Are microorganisms always harmful to the human body? Explain your answer, and give an example.
   *No. Most microorganisms that live in the human body are symbionts, which are either harmless or even beneficial. For example, bacteria that live in the large intestine help with digestion and also produce vitamins.*

16. List two ways that bacteria can produce illness.
   A. *by destroying cells*
   B. *by producing poisons that kill cells or interfere with their normal functions*
17. List three ways that parasitic worms cause disease.
   A. by blocking blood flow in blood vessels and organs
   B. by taking up nutrients
   C. by disrupting body functions

How Diseases Spread

For Questions 18–26, complete each statement by writing the correct word or words.

18. Natural selection favors pathogens with adaptations that help them spread from host to host.

19. Symptoms of disease that can spread pathogens include coughing and sneezing.

20. The best ways to prevent infections of the nose, throat, and respiratory tract are frequent and thorough hand washing and avoiding touching your mouth and nose.

21. Drug-resistant staphylococci that cause skin infections can be transmitted by any body contact or by contact with contaminated towels or equipment.

22. \text{SAMPLE ANSWER: Chlamydia} is spread from one host to another in body fluids exchanged during sexual activity.

23. Blood on shared syringes can spread certain forms of hepatitis, as well as AIDS.

24. A symptom of diseases spread by contaminated water or food is diarrhea.

25. Lyme disease, mad cow disease, and SARS are all examples of zoonoses.

26. The vector that carries the West Nile virus between birds and humans is a mosquito.

27. Explain how coughing and sneezing can not only spread infection, but also help protect against invading organisms.

\text{SAMPLE ANSWER: Coughing and sneezing release thousands of droplets that could contain pathogens. Other people can breathe them in or touch where they land, thereby contracting the infection. However, coughing and sneezing also expel unwanted pathogens out of the body with great force. The fewer pathogens that are in the body, the easier it will be for the immune system to fight the infection.}
35.2 Defenses Against Infection

Lesson Objectives

- Describe the body’s nonspecific defenses against invading pathogens.
- Describe the function of the immune system’s specific defenses.
- List the body’s specific defenses against pathogens.

Lesson Summary

Nonspecific Defenses  The body has many nonspecific defenses, which defend against a wide range of pathogens.

- The first line of defense is skin. Skin keeps pathogens out of the body by forming a barrier that few pathogens can get through. Mucus, saliva, and tears contain an enzyme that can kill bacteria. Mucus can also trap pathogens.

- When pathogens do enter the body, the second line of defense goes to work. These nonspecific defenses include:
  - the inflammatory response, in which chemicals called histamines cause blood vessels near a wound to expand and phagocytes to move into the tissue to fight infection.
  - the production of proteins called interferons, which help block the replication of viruses.
  - the release of chemicals that produce a fever, an increase in normal body temperature, which may slow the growth of pathogens and speed up immune response.

Specific Defenses: The Immune System  The function of the immune system is to fight infection by inactivating foreign substances or cells that have entered the body. The specific immune response works in several ways, including:

- recognizing “self,” including cells and proteins that belong to the body.
- recognizing “nonself”, or antigens, molecules found on foreign substances. Antigens stimulate the immune system to produce cells called lymphocytes that recognize, attack, destroy, and “remember” specific pathogens.
- producing specific lymphocytes that recognize specific antigens. They work by attacking infected cells or producing antibodies, proteins which tag antigens for destruction by immune cells.

The Immune System in Action  The immune response works in two ways.

- In humoral immunity, white blood cells, called B lymphocytes (B cells), make antibodies that attack pathogens in the blood.
- In cell-mediated immunity, white blood cells, called T lymphocytes (T cells), find and destroy abnormal or infected cells.

- After a pathogen is destroyed, memory B cells and memory T cells stay in the body. These cells help create a faster immune response if the same pathogen enters the body again.
Nonspecific Defenses

For Questions 1–8, write the letter of the definition that best matches each term.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. skin</td>
<td>A. An increase in body temperature, which slows or stops pathogens</td>
</tr>
<tr>
<td>2. lysozyme</td>
<td>B. A secretion of the nose and throat that traps pathogens</td>
</tr>
<tr>
<td>3. inflammatory response</td>
<td>C. An enzyme found in tears and saliva that breaks down bacterial cell walls</td>
</tr>
<tr>
<td>4. histamines</td>
<td>D. Chemicals that increase blood flow to tissues</td>
</tr>
<tr>
<td>5. interferons</td>
<td>E. Combination of physical and chemical barriers that defend against pathogens</td>
</tr>
<tr>
<td>6. fever</td>
<td>F. Redness, pain, and swelling at the site of an injury</td>
</tr>
<tr>
<td>7. mucus</td>
<td>G. Proteins that fight viral growth</td>
</tr>
<tr>
<td>8. nonspecific defenses</td>
<td>H. The body’s most important nonspecific defense</td>
</tr>
</tbody>
</table>

Specific Defenses: The Immune System

For Questions 9–14, complete each statement by writing the correct word or words.

9. The __________ response is the body’s response to specific invaders.

10. A substance that triggers the immune response is known as a (n) __________.

11. The main role of __________ is to tag __________ for destruction by immune-system cells.

12. The main working cells of the immune system are two types of __________. Their specific types are determined by a person’s __________.

13. __________ discover antigens in body fluids.

14. __________ defend the body against pathogens that have infected body cells.

15. **THINK VISUALLY** In the space provided, draw an example of each type of lymphocyte indicated to show a basic difference between the two types of cells.

<table>
<thead>
<tr>
<th>B Cell</th>
<th>T Cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>See the textbook for what this drawing should look like.</td>
<td>See the textbook for what this drawing should look like.</td>
</tr>
</tbody>
</table>
The Immune System in Action

For Questions 16–22, write True or False on the line provided.

16. Humoral immunity is a response to pathogens in blood and lymph.  
   True

17. The first response of humoral immunity to infection is much faster than the second response.  
   True

18. Plasma cells are specialized B cells.  
   False

   False

20. Cell-mediated immunity causes infected body cells to die.  
   True

21. Cell-mediated immunity only works on viral diseases.  
   False

22. Cytotoxic T cells are a cause of rejection of transplanted organs.  
   True

23. Complete the table to compare how humoral and cell-mediated immunity work after a virus invades the body for the first and second times.

<table>
<thead>
<tr>
<th>Humoral Immunity vs. Cell-Mediated Immunity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Action of Humoral Immunity</strong></td>
</tr>
<tr>
<td><strong>Primary response:</strong></td>
</tr>
<tr>
<td>Antigens bind to antibodies.</td>
</tr>
<tr>
<td>Activated B cells grow and divide rapidly.</td>
</tr>
<tr>
<td>B cells produce plasma cells and memory B cells.</td>
</tr>
<tr>
<td>Plasma cells release antibodies that capture antigens and mark them for destruction.</td>
</tr>
<tr>
<td><strong>Secondary response:</strong></td>
</tr>
<tr>
<td>Memory B cells respond faster than B cells in the primary response.</td>
</tr>
</tbody>
</table>

24. A runny nose is a symptom of a cold. How is this evidence that the body’s immune defenses are working?

SAMPLE ANSWER: Mucus is one of the body’s nonspecific defenses. It traps pathogens and removes them from the body. An increase in mucus would prove the body’s defenses were working to fight pathogens.