

The History of Vaccines Lesson Plan: How Vaccines Work

Overview and Purpose: The purpose of this lesson is to relate the action of vaccines to the human immune system. In this lesson, students will explore infectious disease and immunity and learn how vaccines help the body defend itself against infectious diseases. This lesson plan gives you two one-period class options (Part 1 or Part 2) and a two-period class option (Parts 1 and 2). All three options give students opportunities to explore information and graphics that describe the parts of the immune system and how vaccines build immunity against infectious diseases.

Grade Level: Grades 9-12

Estimated Time Allotment

Part 1: One 50-minute class period

Part 2: One 50-minute class period

Curriculum Focus: Biology, Health

Learning Objectives

After completing Part 1 of this lesson, students will be able to:

- explain that an **infectious disease** is caused by a **pathogen** that invades an organism
- recognize **viruses** and **bacteria** as common pathogens that cause infectious disease
- explain that **immunity** is a state of resistance to, or protection from, a pathogen
- identify the **immune system** as the group of physical and chemical defenses that produce immunity
- distinguish **specific immunity** from **non-specific (innate) immunity**

After completing Part 2 of this lesson, students will be able to:

- distinguish **antigens** and **antibodies**
- identify the functions **phagocytes**, **T cells**, and **B cells** in protecting the body from invaders
- describe the nature and purpose of a **vaccine**
- summarize the steps of the **immune response** following vaccination and subsequent infection by a pathogen

Standards Addressed

National Science Education Standards

Unifying Concepts and Processes: Systems, order, and organization; Evidence, models, and explanation; Form and function

CONTENT STANDARD A Science as Inquiry: Abilities necessary to do scientific inquiry; Understandings about scientific inquiry

A.1.f Communicate and defend a scientific argument.

A.2.a Scientists usually inquire about how physical, living, or designed systems function.

CONTENT STANDARD C Life Science: The cell

C.1.a Cells have particular structures that underlie their functions.

C.1.f Cells can differentiate, and complex multicellular organisms are formed as a highly organized arrangement of differentiated cells.

CONTENT STANDARD E Science and Technology: Understandings about science and technology

CONTENT STANDARD F Science in Personal and Social Perspectives: Personal and community health; Science and technology in local, national, and global challenges

CONTENT STANDARD G History and Nature of Science: Science as a human endeavor

Health Standards

National Health Education Standards

Health Education Standard 1: Students will comprehend concepts related to health promotion and disease prevention. Students will:

1. analyze how behavior can impact health maintenance and disease prevention

4. analyze how the family, peers, and community influence the health of individuals
7. analyze how public health policies and government regulations influence health promotion and disease prevention
8. analyze how the prevention and control of health problems are influenced by research and medical advances

Health Education Standard 2: Students will demonstrate the ability to access valid information, products, and services to enhance health. Students will:

2. demonstrate the ability to evaluate resources from home, school, and community that provide valid health information.
3. evaluate factors that influence personal selection of health products and services.
6. analyze situations requiring professional health services.

Health Education Standard 3: Students will demonstrate the ability to practice health-enhancing behaviors and reduce health risks. Students will:

1. analyze the role of individual responsibility for enhancing health.
3. analyze the short-term and long-term consequences of safe, risky and harmful behaviors.
4. develop strategies to improve or maintain personal, family and community health.

Health Education Standard 4: Students will analyze the influence of culture, media, technology, and other factors on health. Students will:

3. evaluate the impact of technology on personal, family, and community health.
4. analyze how information from the community influences health.

Health Education Standard 6: Students will demonstrate the ability to use goal-setting and decision-making skills to enhance health. Students will:

3. predict immediate and long-term impact of health decisions on the individual, family, and community.
4. formulate an effective plan for lifelong health.

Lesson Procedures

Teacher Background: Familiarize yourself with the different sections of the History of Vaccines Website so that you can provide support to students as they work. All of the different sections are available from the main navigation bar. To access the How Vaccines Work resources, click *Educators*. Explore the information and links on the page. Additional information about infectious diseases, viruses, and immunity can be found at Kimball's Biology Pages, an online biology textbook by John W. Kimball @ <http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/>.

Teacher Preparation:

- Plan to have the students use the Internet during class.
- Locate the resources for How Vaccines Work (see below for specifics).
- Email vaccines@collegeofphysicians.org to receive answers to questions on recording sheets. Type **Worksheet Answers** in the subject line. If you do not email from a school district address, then provide a school phone number.
- Make enough copies of the recording sheets, one per student. The reproducibles are found at the end of this document.

Part 1: Opening Activity – Introduce Infectious Disease and Immunity

Time: 10 minutes

1. Introduce the topic of infectious disease. Ask students, *What is a disease?* (A disease is a sickness.) Ask, *What are some examples of diseases?* (Students should name the common diseases they may have had or that they know about, such as colds, flu, chickenpox, AIDS, and strep throat.) Write the names of the diseases they name on the board or an overhead projector. Urge them to think of other examples of diseases they may have heard of, such as measles, mumps, polio, and malaria. Tell students that diseases such as the ones they just named are called infectious diseases because they are caused by pathogens that enter, or infect, the human body. Ask, *What type of pathogen causes each disease?* (Strep throat is caused by a bacterium. Malaria is caused by a protozoan. Viruses cause all the others named above.)
2. Some students may mention diseases such as hay fever, asthma, diabetes, hemophilia, multiple sclerosis, muscular dystrophy, cystic fibrosis, or lupus. If not, mention these diseases and write their names on the

board. Ask, *Are these also infectious diseases?* (Students may know that these diseases are not caused by an infectious agent but are caused by genetic factors or are autoimmune responses.) Explain that such diseases can be referred to as noninfectious diseases.

3. Explain that the human body has several natural ways of protecting itself from infectious diseases. Ask, *What do we call the condition of being protected from getting an infectious disease?* (Students should know the terms *immune* and *immunity*.) Tell students they will be using Internet resources to learn about vaccination, an artificial means of making people immune to certain infectious disease.

Read About and Discuss the Human Immune System

Time: 30 minutes

1. Divide the class into groups of three or four. Tell the students that they will begin by reading and discussing an article that introduces the human immune system.
2. Direct students to the article [The Human Immune System and Infectious Disease](#). Explain that immunity is complex and that they may encounter many new terms as they read. Urge students to write important terms and their definitions in their notebooks as they read and discuss the article.
3. Give each group the appropriate recording sheet(s) to complete as they read and discuss the article. Let students know that they are responsible for gathering information and reporting to the class what they have learned. Circulate among the groups as they work, ensuring that they stay on task and are finding the resources they need.

Closing Activity

Time: 10 minutes

1. Have groups of students summarize what they learned about immunity. Tell them they may use their recording sheets as a guide. Encourage other groups to add to or clarify information given by each group.
2. Tell students that next they will be using a web-based simulation to explore the development of specific immunity and how vaccines help individuals develop specific immunity to infectious diseases. Then, have each student write a question about immunity or vaccines that they hope the simulation will help answer.

Part 2: Opening Activity--Introduce the Simulation

Time: 5 minutes

Invite volunteers to read the question he or she wrote about immunity or vaccines. Have students record questions posed by other students in their notebooks. Also invite volunteers to suggest answers to students' questions. Encourage students to record any answers that make sense under the corresponding questions.

Exploring the Responses to a Vaccine and a Pathogen

Time: 25 minutes

1. Divide the class into groups of two or three. Tell students they will be using a simulation to explore the how vaccines help humans develop immunity to infectious diseases.
2. Give each student a copy of the recording sheets to complete as they work through each part of the simulation. Let students know that they will be using the information they learn about how vaccines work to test themselves by completing an online activity.

Vaccine Response Activity

Time: 10 minutes

1. Have students complete the activity individually or in pairs. Be sure to pair struggling students with a strong partner.
2. Hold a brief class discussion about what students liked or did not like about the activity after everyone has finished.

Closing Activity

Time: 10 minutes

Have each group of students report on what they learned, using their recording sheets as a guide.

Parts 1 and 2: Assessment

- Anecdotally observe students during whole group discussions and independent work.
- Assess content knowledge by evaluating students' recording sheets and oral contributions. Email vaccines@collegeofphysicians.org to receive answers for recording sheets.
- Part 2 only: Have groups of three or four students compete to correctly complete the Vaccine Response Activity in the shortest amount of time. Groups could be awarded points based on the order in which they complete the activity. Individuals in each group could earn points by correctly completing a step on the first try.

Extensions

- Have students view the miniactivity *Different Types of Vaccines* and write a few paragraphs summarizing the types of vaccines.
- Have students view the miniactivity *How Vaccines Are Made* and write a report that summarizes the general process of vaccine manufacturing.

The Human Immune System and Infectious Disease

1. What is the name for the body's multiple layers of protection that target dangerous invaders?

2. List the two levels of defense that humans have against pathogens. What do their names mean?
 - a.

 - b.

3. What are two types of outer barriers that serve as the first line of defense against pathogens?

4. How are pathogens able to get past the body's first line of defense?

5. What is a phagocyte?

6. What are the two classes of white blood cells that cause the body to develop immunity to certain pathogens, and where do they form?
 - a.

 - b.

Student Name: _____
Student Recording Sheet 2

How Vaccines Work

Overview

1. How do vaccines work?

Response to Vaccine

2. A vaccine is described as a pathogen-imposter. Why is this?
3. What is an antigen?
4. Where in the body do immune-system cells cluster?
5. What are the immune system's antibody factories?
6. What does the analogy "lock and key" describe?
7. How does the immune system's response to an infection by a pathogen after vaccination differ from the response to vaccination?

Response to Pathogen

8. What is the name for the immune system’s response to a vaccine?

9. What is the name for the immune system’s response to an infection by a pathogen against which an individual has been vaccinated?

10. What is the name for the immune system cells that protect the body from future infections by a specific pathogen?

11. Describe the role of each element in the immune response listed below. Use your own words to be sure that you truly understand what each element does.
 - a. **Vaccine antigen**

 - b. **Antigen-presenting cell**

 - c. **Antibodies**

 - d. **Naïve killer T cell**

- e. **Active killer T cell**

- f. **Memory killer T cell**

- g. **Naïve B cell**

- h. **Plasma B cell**

- i. **Memory B cell**

- j. **Memory T helper cell**

- k. **T helper cell**