

Lesson Content Outlines

UNIT 1: The Human Immune System

Learning opportunity and knowledge gap

The learning opportunity for students is to understand the basics of the human immune system including:

- Organs and tissues of the immune system (Lesson 1)
- The differences between the innate and adaptive immune systems (Lessons 2 and 3)

The knowledge gap is that students may not know which organs and tissues are involved the immune system. They may also be unaware of the two modes of immune defense: innate and adaptive.

Instructional goal

The goal is for the student to be able to identify organs and tissues of the immune system and to describe the difference between the innate and adaptive immune systems.

Lesson 1 - Organs and Tissues of the Immune System

Condition: Learner is given a diagram of the human body and necessary glossary terms

Behavior: Learner identifies parts of the body associated with glossary terms related to organs and tissues of the immune system

Criteria: Learner correctly identifies ten parts of the body associated with the immune system

Text: Brief description of organs and tissues of the immune system

Interactives: Pop-up glossary of terms related to organs and tissues of the immune system. Diagram of human body with blanks as labels for organs and tissues of the immune system. User must drag and drop the correct terms, completing the diagram.

Assessment: Learner drags and drops correct term into field (labeled A through F)

Lesson objectives: Identify organs and tissues of the body associated with the immune system.

Lesson questions: What parts of the body are associated with the immune system?

5Es Lesson structure

- Engage — Teacher highlights illnesses commonly experienced by students. Students describe their experiences with everyday illnesses such as the common cold and influenza.

- Explore — Students explore online resources to learn about organs and tissues of the immune system, including the interactive glossary.
- Explain — Students label a hard-copy diagram of the human body with terms referring to organs and tissues of the immune system. Students identify the organs and role of the lymph system. Students define key features to differentiate between innate (non-specific) and adaptive (specific) immunity.
- Elaborate — Students choose a particular condition (illness, injury, etc.) and investigate which organs and tissues of the immune system are involved in defenses against that condition.
- Evaluate — Students use the drag and drop interactive to self-evaluate their ability to identify parts of the body associated with the immune system.

Lesson 2 - The Innate Immune System

Condition: Learner is given glossary terms and a flow chart that describe features of the innate immune system. Learner has materials and instructions to participate in an activity that models the innate immune system.

Behavior: Learner defines cells and processes involved in innate immune system. Learner understands the analogy between a castle and moat and the innate immune system.

Criteria: Learner characterizes the innate immune system in terms of responses to immune system challenges (scenarios with given symptoms).

Text: Brief introduction to the innate immune system. Instructions for activity.

Interactives: Pop-up glossary of terms used to describe the innate immune system. Data table for entering data for the “Castle of the Body” activity. Data table for calculating statistics of data for the “Castle of the Body” activity. Table for entering data related to symptoms of potential infection, and innate immune responses.

Assessment: Learner uses innate immune system glossary terms in written responses. Learner completes data table with data collected during activity, and calculates statistics. Learner answers questions about the castle and moat model of the innate immune system. Learner completes a table to characterize innate immune system responses to immune system challenges (scenarios with given symptoms).

Lesson objectives: Define glossary terms related to the innate immune system. Collect data during an activity that models the innate immune system. Calculate statistics of data collected during the castle and moat activity. Analyze the castle and moat model as an analogy for the innate immune system. Identify features of the innate immune system involved in responses to immune system challenges.

Lesson questions: What are the key features and processes of the innate immune system?

5Es Lesson structure

- Engage — Students list fun games they have played and stories they have read about castles and defenses.
- Explore — Students explore glossary terms and flowcharts describing the innate immune response, and then conduct the “Castle of the Body” activity.
- Explain — Students describe how the castle and moat model is analogous to the innate immune system, explaining how the model differs from the real system.
- Elaborate — Students repeat the activity using different materials to represent various kinds of pathogens. Students calculate statistics from the data collected during the activity. Students complete an interactive table showing how the innate immune system responds to immune system challenges.
- Evaluate — Students work in pairs or small groups to create a multimedia resource that demonstrates understanding of the innate immune system.

Lesson 3 - The Adaptive Immune System

Condition: Learner is given glossary terms and components of a concept map that describes features of the adaptive immune system

Behavior: Learner defines cells, molecules and processes involved in the adaptive immune system. Learner creates a concept map of the adaptive immune system. Learner creates analogies to illustrate the features and function of the adaptive immune system.

Criteria: Learner characterizes the adaptive immune system in terms of the roles of its various components and processes.

Text: Brief introduction to the adaptive immune system.

Interactives: Pop-up glossary of terms related to terms used to describe the adaptive immune system. Concept map of the adaptive immune system into which the user must drag and drop the correct terms, completing the diagram. Multiple choice questions for assessment.

Assessment: Learner drags and drops correct terms into fields in the concept map of the adaptive immune system. Student responds to multiple choice questions.

Lesson objectives: Define glossary terms related to the adaptive immune system. Creates a concept map of the adaptive immune system. Create analogies to illustrate features and processes of the adaptive immune system.

Lesson questions: What are the key features and processes of the adaptive immune system?

5Es Lesson structure

- Engage — Teacher asks students about serious illnesses they have heard about, and to describe how doctors help prevent those diseases.
- Explore — Students explore glossary terms and concept maps that illustrate the features and functioning of the adaptive immune system.
- Explain — Students drag and drop correct terms from a list into a concept map of the immune system.
- Elaborate — Students choose one aspect of the adaptive immune system to explore in more detail, and write a short passage describing its role in the adaptive immune system.
- Evaluate — Students create a multimedia resource (story, skit, webpage, video script, etc.) to explain the features and functioning of the adaptive immune system.

UNIT 2: Understanding Disease and Vaccination

Learning opportunity and knowledge gap

The learning opportunity is for students is to understand the relationship between the human immune system, disease and vaccination by investigating:

- How diseases affect the immune system (Lesson 1)
- Approaches used by pathogens, with influenza and human immunodeficiency virus (HIV) case studies (Lesson 2)
- How vaccines work, how they are made and how they contribute to public health, including the concept known as herd immunity (Lesson 3)
- Scientific innovation and human interest stories using mumps and hepatitis B vaccines (Lesson 4)
- Popular vaccine safety concerns and their scientific basis (Lesson 5)

The knowledge gap is that students may not know how diseases affect the immune system. They may also be unaware how pathogens overcome immune defenses. Students may not know how vaccines work, about their manufacture or how they have contributed to public health. Students may not know the scientific innovations underlying the history of vaccines, particularly during the 20th century, nor how vaccines have involved human interest stories, such

as the mumps and hepatitis B vaccines. Students may be unaware of scientific evidence for the safety of vaccines.

Instructional goal

The goal is for the student to be able to describe relationship between the human immune system, disease and vaccination, including the effects of disease on the immune system, pathogens' strategies to overcome immune defenses, the function, manufacture and benefits of vaccines, and innovations and history of widely used vaccines. The student should also be able to analyze scientific evidence for the safety of vaccines.

Lesson 1 - Development of Infection and Disease

Condition: Learner is given glossary terms and a reading passage about the causes and development of infection and disease. Learner has materials and instructions to participate in an activity to simulate the immune response to pathogens. Learner has a diagram showing steps of the infection process.

Behavior: Learner defines glossary terms and summarizes key concepts related to the causes and development of infection and disease.

Criteria: Learner can define glossary terms and show understanding of the causes and development of infection and disease.

Text: Reading passage (to be rewritten from existing informational outline). Instructions for activity.

Interactives: Pop-up glossary of terms related to the causes and development of infection and disease. Diagram of steps of the infection process with blanks labelling where the pathogen can overcome immune system, onto which the user must drag and drop the correct step, completing the diagram.

Assessment: Students write a brief passage to relate the activity to processes in the development of infection and disease. Learner drags and drops correct terms into fields in the infection process steps. Student completes Constructed Response questions.

Lesson objectives: Define glossary terms related to the causes and development of infection and disease. Explain the role of antigen and of the immune system in the development of infection and disease. Describe key steps in the process of the development of infection and disease.

Lesson questions: What aspects of the antigen and of the immune system cause the development of infection and disease? What are key steps in the process of the development of infection and disease?

5Es Lesson structure

- Engage — Teacher shows a clip or animation describing how infection and disease develop (influenza).

- Explore — Students read the reading passage, then work in small groups to create a concept map of how infection and disease develop and the associated immune response.
- Explain — Students write a simulated blog post or pop science magazine article explaining how infection and disease develop despite an immune response.
- Elaborate — Students choose a disease to research in more detail, and create a presentation to describe the development of the disease and the immune response.
- Evaluate — Students answer multiple choice and short answer questions.

Lesson 2 - Development of Disease Case Studies: Influenza and HIV

Condition: Learner is given glossary terms and a reading passage about the causes and development of influenza and HIV. Learner has materials and instructions to participate in an activity to model the molecular process of viral replication. Learner is given an interactive diagram of the HIV replication process.

Behavior: Learner describes influenza and HIV in the context of antigenic variation and resistance. Learner shows how antigenic shift and drift enable the influenza virus uses antigenic variation to overcome the immune defenses. Learner describes key steps and concepts in the process of HIV infection, including the role of the immune system.

Criteria: Learner can describe the role of antigenic variation and resistance in influenza and HIV pandemics. Learner can describe how antigenic shift and drift enable the influenza virus to use antigenic variation to overcome immune defenses. Learner correctly describes key steps and concepts in the process of HIV infection, including the role of the immune system.

Text: Reading passage (to be rewritten from existing informational outline). Instructions for activity.

Interactives: Pop-up glossary of terms related to the causes and development of influenza and HIV. Diagram of the HIV replication process, in which the learner can drag and drop terms into the correct field.

Assessment: Student completes the activity and Constructed Response questions. Learner drags and drops correct terms into fields in the diagram of the HIV replication process.

Lesson objectives: Describe and model the processes of antigenic shift and drift. Describe key features of influenza and HIV that lead to antigenic shift and drift. Describe the main steps in the HIV infection cycle. Explain how the influenza virus reinfects the same person.

Lesson questions: What are antigenic shift and drift? What are the key features of influenza and HIV that lead to antigenic shift and drift? What are the main steps in the HIV infection cycle? How does the influenza virus reinfect the same person?

5Es Lesson structure

- Engage — Students write in their notebooks how many times they have had viral illness including cold, flu, measles, mumps and so on.
- Explore — Students read the reading passage and then participate in the activity to model the molecular process of viral replication, and antigenic shift and drift.
- Explain — Students explain why some viral diseases can infect someone once but influenza can reinfect the same person.
- Elaborate — Students explore the history of the 1918 flu epidemic and the steps in HIV replication.
- Evaluate — Students answer multiple choice and short answer questions.

Lesson 3 - Discovery and Development of Vaccines

Condition: Learner is given glossary terms. Learner is given worksheets and Internet access to explore online resources, including videos and a simulation.

Behavior: Learner answers questions based on their online research. Student creates a multimedia presentation explaining how different kinds of vaccines work, and how they are made. Students complete a simulation of herd immunity and show understanding of the concept of herd immunity, compared with passive immunity and vaccination.

Criteria: Learner can explain the principle of how vaccines work and how vaccines are made. Learner describes the advantages and disadvantages of the various approaches to making vaccines. Learner explains the concept of herd immunity.

Text: Instructions for activities.

Interactives: Herd immunity simulator (third party)

Assessment: Students complete activities and worksheets. Students' presentations explain (a) how different kinds of vaccines work (b) how they are made. Students create graphs of data from herd immunity simulation. Student completes Constructed Response questions about herd immunity.

Lesson objectives: Explain how different kinds of vaccines work, and how they are made. Analyze and graph data from a computer simulation of herd immunity and describe the concept of herd immunity.

Lesson questions: What are the different kinds of vaccines, how do they work and how are they made? What is herd immunity?

5Es Lesson structure

- Engage — Students list in their notebooks the vaccines they have been given, and then whether or not they were effective. Students list diseases that do not have vaccines.

- Explore — Students explore different kinds of vaccines and how they work by researching online and viewing videos.
- Explain — Students complete worksheets to show learning.
- Elaborate — Students complete a simulation activity on herd immunity, and graph their results.
- Evaluate — Students create a presentation to explain how different kinds of vaccines work, and how they are made.

Lesson 4 - Development of Vaccines Case Studies: Mumps and Hepatitis B Vaccines

Condition: Learner watches a segment of *The Memory Maker* documentary related to the mumps and hepatitis B vaccines. Learner reads Chapters 3 and 8 of *Vaccinated: One Man's Quest to Defeat the World's Deadliest Diseases*. Learner explores additional online resources. Learner is given worksheets and suggested essay topics.

Behavior: Learner answers questions and completes worksheets based on their online research and book reading. Learner describes sequence events leading to development of mumps and hepatitis B vaccines and of events leading to modern vaccine technology.

Criteria: Learner correctly answers questions and completes worksheets to show knowledge and understanding of vents leading to development of mumps and hepatitis B vaccines and of events leading to modern vaccine technology.

Text: Instructions for activities.

Interactives: None

Assessment: Student completes activities and worksheets.

Lesson objectives: Describe basic outline of events leading to development of mumps and hepatitis B vaccines. Explain how modern vaccine technology depends on a series of eight main preceding events.

Lesson questions: What events led to development of mumps and hepatitis B vaccines? What prior events led to development of modern vaccine technology?

5Es Lesson structure

- Engage — Students list their prior knowledge of mumps and hepatitis B.
- Explore — Students watch segments of The Memory Maker documentary and read book chapters.
- Explain — They complete worksheets on mumps and hepatitis B vaccines and on development of modern vaccine technology.
- Elaborate — Students create a timeline describing development of modern vaccine technology, showing how mumps and hepatitis B vaccines relied on prior discoveries.
- Evaluate — Students complete Constructed Response questions.

Lesson 5 - Understanding Vaccine Safety

Condition: Learner is given worksheets and Internet access to explore online resources.

Behavior: Learner describes key vaccine safety concerns and analyzes the scientific basis for such concerns.

Criteria: Learner is able to accurately describe key vaccine safety concerns and to use scientific criteria to analyze the basis for such concerns.

Text: Instructions for activities.

Interactives: None

Assessment: Student completes activities and worksheets. Student works in a group to create a media resource that illustrates a vaccine safety concern and its scientific basis.

Lesson objectives: Describe the main concerns regarding vaccine safety. Analyze the scientific basis for popular concerns regarding vaccine safety.

Lesson questions: What are the main concerns regarding vaccine safety? What is the scientific basis for popular concerns regarding vaccine safety?

5Es Lesson structure

- Engage — Students list news items and other negative things they have heard about vaccines.
- Explore — Students work in small groups to research online various topics related to vaccine safety concerns. Students complete worksheets to evaluate the scientific basis for concerns about vaccine safety.
- Explain — Students create a media resource that illustrates a vaccine safety concern and its scientific basis.
- Elaborate — Students debate a motion: On balance, vaccines are a benefit to society, citing their media resource and findings as evidence for their debate position.
- Evaluate — Students complete Constructed Response questions.