

The Immune System



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Noninfectious Disorders

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The Immune System: Infectious Diseases

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LESSON 2

THE IMMUNE SYSTEM

11 EoT3 Questions Covered: 5, 6, 7, 8, 19, 20, 21, 22, 23, 24, 29

21	BIO.3.1.01.088 Differentiate between specific and nonspecific immune responses	Information from text	12-13-14
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Nonspecific Immunity

At the time of birth, the body has a number of defenses in the immune system that fight off pathogens. These defenses are nonspecific because they are not aimed at a specific pathogen. They protect the body from any pathogen that the body encounters.

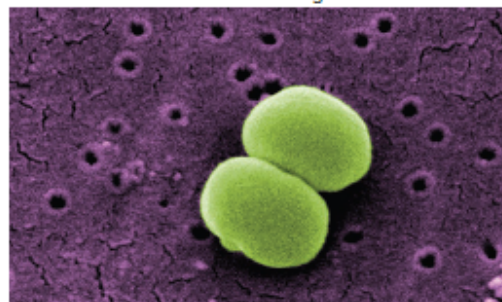
The nonspecific immunity provided by the body helps to prevent disease. Nonspecific immunity also helps to slow the progression of the disease while the specific immunity begins to develop its defenses. Specific immunity is the most effective immune response, but nonspecific immunity is the first line of defense.

Barriers

Like the strong walls of a fort, barriers are used by the body to protect against pathogens. These barriers are found in areas of the body where pathogens might enter.

Skin barrier The first major line of defense is the unbroken skin and its secretions. Skin contains layers of living cells covered by many layers of dead skin cells. By forming a barrier, the layers of dead skin cells help protect against invasion by microorganisms. Of the many different types of bacteria that normally live on the skin, most have little or no effect on our health. Many of the bacteria that live symbiotically on the skin digest skin oils to produce acids that inhibit many pathogens. Figure 8 shows bacteria that are normally found on the skin and protect the skin from attack.

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Staphylococcus epidermidis

Figure 8 These bacteria are found on human skin and provide protection from pathogens.



Q1: Which of the following describes the primary functional difference between nonspecific and specific immunity during a disease invasion?

- a. Specific immunity acts as the first line of defense to destroy any general pathogen.
- b. Nonspecific helps slow the disease progression while specific develops targeted defenses.**
- c. Nonspecific immunity provides the most effective response for long-term memory.
- d. Specific immunity is present at birth and targets any microorganism encountered.

Q2: Based on Figure 8, how do symbiotic bacteria like *Staphylococcus epidermidis* contribute to the body's nonspecific defenses?

- a. They activate helper T cells in the lymph nodes to produce antibodies.
- b. They secrete interferon to help neighboring cells produce antiviral proteins.
- c. They digest skin oils to produce acids that inhibit the growth of pathogens.**
- d. They act as a physical barrier of dead cells that prevents microbial invasion.

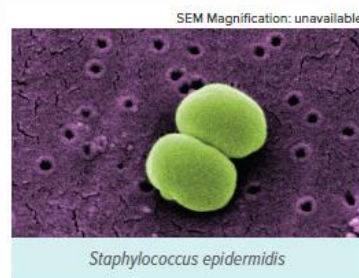


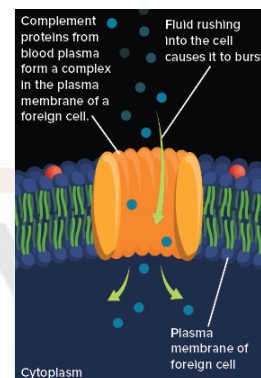
Figure 8 These bacteria are found on human skin and provide protection from pathogens.

Q3: Which of the following is NOT categorized as an aspect of nonspecific immunity?

- a. Physical barriers like the skin and chemical barriers like mucus.
- b. Cellular defenses such as phagocytosis by neutrophils and macrophages.
- c. Targeted responses involving B cells and T cells to kill specific pathogens.**
- d. The inflammatory response that increases blood flow and vessel permeability.

Q4: According to Figure 9, how do complement proteins in the blood plasma specifically enhance the body's nonspecific immune response?

- a. They produce mucus to trap bacteria before they reach the airway epithelial cells.
- b. They trigger infected cells to secrete proteins that prevent viral replication.
- c. They form a complex in a pathogen's membrane to create a pore, leads to burst.**
- d. They move bacteria away from the lungs through the beating motion of cilia.

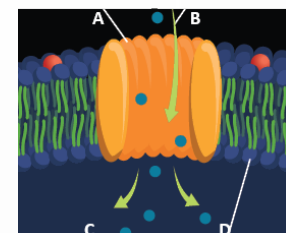


Q5: When a virus enters the body, which cellular defense is secreted by infected cells to stimulate neighbors to produce antiviral proteins?

- a. Lysozyme
- b. Hydrochloric acid
- c. Interferon**
- d. Cytokine

Q6: In the figure below, complement proteins can form a pore in the plasma membrane of the invading cell. Which letter of the following indicates the formation of a complex in the plasma membrane of a foreign cell?

- A. A**
- B. B
- C. C
- D. D



7. How do the layers of dead skin cells specifically assist in nonspecific immunity?

- A. They secrete lysozyme to break down viral cell walls.
- B. They provide nutrients for the production of lymphocytes.
- C. They form a physical barrier that helps protect against invasion by microorganisms.**
- D. They act as receptors for the inflammatory response

8. Which statement correctly compares nonspecific and specific immunity?

- A. Specific immunity acts first against pathogens
- B. Nonspecific immunity is more effective than specific immunity
- C. Nonspecific immunity is the first line of defense, while specific immunity is more effective**
- D. Both immune responses function identically

9. The table below shows the differences between specific and nonspecific immunity. What do the letters (A) and (B) in the table present?

- a. (A): Memory and (B): Rapid response
- b. (A): Rapid response and (B): Memory**
- c. (A): Active immunity and (B): Passive immunity
- d. (A): No response and (B): Memory

(Nonspecific)	Specific
Reacts to any pathogen (A)	Reaction is tailored to individual pathogens
No memory	Slow-developing response (B)
Involves skin, chemicals, and phagocytes	Involves lymphocytes

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(Nonspecific)	Specific
(A)	Reaction is tailored to individual pathogens
Rapid response	Slow-developing response
No memory	Memory
Involves skin, chemicals, and phagocytes	(B)



19	BIO.3.1.01.088 Discuss the bodies nonspecific defenses to include first line of defense (barriers) and second line of defense (cellular defense, interferons and inflammatory response)	Information from text 'Get it' question	13
20	BIO.3.1.01.088 Discuss the bodies nonspecific defenses to include first line of defense (barriers) and second line of defense (cellular defense, interferons and inflammatory response)	Information from text	13

Chemical barriers Saliva, tears, and nasal secretions contain the enzyme lysozyme. Lysozyme breaks down bacterial cell walls, which kills pathogens.

Another chemical defense is mucus, which is secreted by many inner surfaces of the body. It acts as a protective barrier, blocking bacteria from sticking to the inner epithelial cells. Cilia also line the airway. Their beating motion sends any bacteria caught in the mucus away from the lungs. When the airway becomes infected, extra mucus is secreted, which triggers coughing and sneezing to help move the infected mucus out of the body.

A third chemical defense is the hydrochloric acid secreted in your stomach. In addition to digestion, stomach acid kills many microorganisms found in food that could cause disease.



Get It?

Compare and contrast the different types of barriers of the immune system.

Nonspecific responses to invasion

Even if an enemy gets through the walls of a town's fort, defense doesn't end. Similarly, the body has nonspecific immune responses to pathogens that get beyond its barriers.

Cellular defense If foreign microorganisms enter the body, the cells of the immune system, shown in Table 2, on the next page, defend the body. One method of defense is phagocytosis. White blood cells, especially neutrophils and macrophages, are phagocytic. Recall that phagocytosis is the process by which phagocytic cells surround and internalize the foreign microorganisms. The phagocytes then release digestive enzymes and other harmful chemicals from their lysosomes, destroying the microorganism.

A series of about 20 proteins that are found in the blood plasma are called complement proteins. **Complement proteins** enhance phagocytosis by helping the phagocytic cells bind better to pathogens and activating the phagocytes. Some complement proteins can form a complex in the plasma membrane of a pathogen. This complex forms a pore, which aids in the destruction of the pathogen, as shown in Figure 9.

Interferon When a virus enters the body, another cellular defense helps prevent the virus from spreading. Virus-infected cells secrete a protein called **interferon**. Interferon binds to neighboring cells and stimulates these cells to produce antiviral proteins which can prevent viral replication in these cells.

Inflammatory response Another nonspecific response, the inflammatory response, is a complex series of events that involves many chemicals and immune cells that help enhance the overall immune response. When pathogens damage tissue, chemicals are released by both the invader and cells of the body. These chemicals attract phagocytes to the area, increase blood flow to the infected area, and make blood vessels more permeable to allow white blood cells to escape into the infected area.

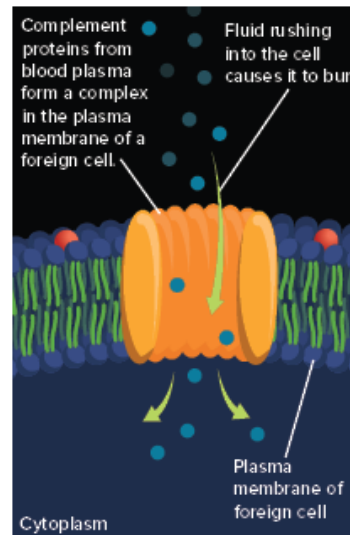
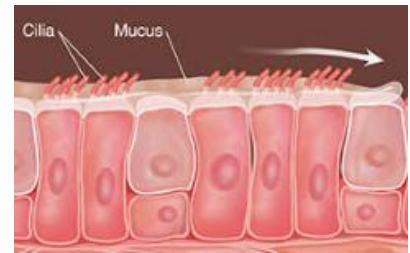


Figure 9 For some pathogens, complement proteins can form a pore in the plasma membrane of the invading cell.



Q1: In comparing different types of nonspecific barriers, which of the following describes a functional difference between mucus and cilia in the respiratory tract?

- a. Mucus moves bacteria away from the lungs, while cilia act as a physical wall to block entry.
- b. Mucus traps bacteria to prevent them from sticking to cells, while the beating motion of cilia moves the trapped bacteria away from the lungs.**
- c. Cilia secrete lysozyme to kill pathogens, while mucus provides nutrients needed for symbiotic bacteria.
- d. Mucus is considered a physical barrier of dead cells, while cilia are considered a chemical defense of the stomach.



Q2: How do lysozyme and hydrochloric acid (HCl) differ in their defensive locations?

- a. Lysozyme is found only in the stomach, while HCl is found in saliva and tears.
- b. Lysozyme acts in saliva, tears, and nasal secretions, while HCl acts within the stomach to kill microorganisms in food.**
- c. Lysozyme blocks pathogens from sticking to epithelial cells, while HCl uses a beating motion to remove mucus.
- d. HCl is a physical barrier of living cells, while lysozyme is a protein secreted only by virus-infected cells.

Q3: While both are chemical barriers, what is the primary defensive mechanism of lysozyme compared to mucus?

- a. Lysozyme kills pathogens by breaking down bacterial cell walls, whereas mucus acts as a protective barrier that prevents bacteria from sticking to inner cells.**
- b. Mucus triggers the production of antiviral proteins, while lysozyme increases blood flow to infected areas.
- c. Lysozyme forms pores in the plasma membrane of pathogens, while mucus internalizes pathogens through phagocytosis.
- d. Mucus is only active when the airway is infected, while lysozyme is only active in the digestive tract.

Q4: Which of the following is a characteristic shared by all first-line nonspecific barriers, such as the skin, mucus, and stomach acid?

- a. They are developed only after a specific immune response has failed.
- b. They rely on memory B cells to identify specific viral strains.
- c. They provide a general defense against any pathogen and are present at birth.**
- d. They use cytokines to recruit specialized lymphocytes to sites of infection.

Q5: What is the most likely result if a person's body lost the ability to produce the chemical defenses, such as lysozyme and mucus?

- a. The body would rely solely on red blood cells to transport oxygen to infected tissues.
- b. Pathogens would more easily infect the body through the mouth, nose, and inner epithelial surfaces.**
- c. The inflammatory response would immediately clear all pathogens from the bloodstream.
- d. The body would automatically develop active immunity against all common bacteria.

Q 6: What occurs during the process of phagocytosis when white blood cells, such as neutrophils and macrophages, encounter a foreign microorganism?

- The cells produce antibodies that bind to the pathogen's processed antigen.
- The cells surround and internalize the microorganism, then use digestive enzymes from lysosomes to destroy it.**
- The cells secrete interferon to signal neighboring cells to produce antiviral proteins.
- The cells form a complex in the blood plasma that creates pores in the pathogen's membrane.

Q7: According to Figure 9, what is the specific function of the complement proteins?

- They act as a physical barrier of dead skin cells to prevent invasion.
- They are secreted by virus-infected cells to prevent viral replication in neighboring cells.
- They enhance phagocytosis and can form a complex that creates pores in a pathogen's membrane, causing it to burst.**
- They are produced by B lymphocytes to specifically react with a foreign antigen.

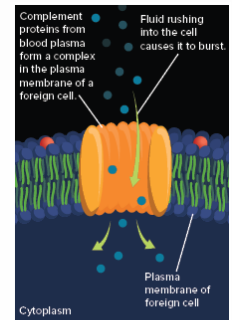


Figure 9 For some pathogens, complement proteins can form a pore in the plasma membrane of the invading cell.

Q8: How does the protein interferon provide a second-line defense against viral infections?

- It attracts macrophages to the area to remove dead neutrophils and debris.
- It is secreted by virus-infected cells and stimulates neighboring cells to produce antiviral proteins that prevent viral replication.**
- It increases the permeability of blood vessels to allow white blood cells to escape.
- It coats the skin in a layer of oil to inhibit the growth of pathogens.

Q9: Which of the following describes the sequence of events during a nonspecific inflammatory response?

- Lysozyme breaks down cell walls, which immediately signals the thymus to mature T cells.
- Pathogens damage tissue, causing the release of chemicals that attract phagocytes, increase blood flow, and make blood vessels more permeable.**
- Cilia move infected mucus to the stomach where it is neutralized by complement proteins.
- Interferon binds to B cells, signaling them to divide and manufacture antibodies.

Q10: Why is the inflammatory response characterized by symptoms such as pain, heat, and redness?

- These symptoms indicate the failure of the nonspecific immune system.
- The skin is shedding its dead layers to form a new barrier.
- The symptoms result from increased blood flow and the accumulation of white blood cells in the infected area.**
- These signs are only present during a primary response to the chicken pox virus.

Q11: All of the following is considered as a chemical barrier **except:**

- Tears
- Saliva
- Skin cells**
- Mucus



Q12: When a virus enters a host cell, the infected cell secretes a protein called interferon. How does this protein assist in the body's nonspecific defense?

- A. It forms a physical complex that creates a pore in the virus's membrane.
- B. It acts as a phagocytic agent that surrounds and internalizes the virus.
- C. It stimulates neighboring cells to produce antiviral proteins that prevent viral replication.**
- D. It increases the acidity of the stomach to kill microorganisms found in food.

Q13: What is the primary role of the chemicals released by both the invader and body cells during an inflammatory response?

- A. To signal the bone marrow to produce more red blood cells.
- B. To stop the beating motion of cilia in the respiratory tract.
- C. To attract phagocytes to the area and increase blood flow to the infected tissue.**
- D. To specifically target and destroy only one type of pathogen.

Q14: A patient is suffering from an infectious disease and experiences local pain, heat, and redness. these symptoms are a direct result of?

- A. Lysozyme secretion
- B. Inflammatory response**
- C. Interferon production
- D. Passive immunity

Q15: What is the functional significance of increased blood vessel permeability during the inflammatory response?

- A. It allows white blood cells to escape the vessels and reach the infected area.**
- B. It prevents phagocytes from binding better to specific pathogens.
- C. It decreases blood flow to minimize the spread of the virus.
- D. It triggers the immediate secretion of lysozyme into the saliva.

Q16: Which of the following correctly identifies the trigger for a cell to produce and secrete interferon?

- A. The presence of hydrochloric acid in the stomach.
- B. Pathogens damaging tissue and releasing histamines.
- C. The formation of a pore by complement proteins.
- D. A virus entering and infecting a host cell.**

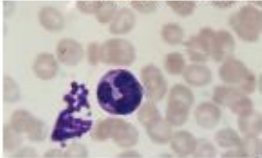
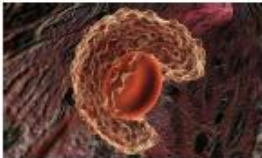
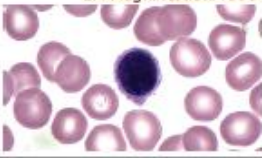
Q17: Unlike specific immunity, the inflammatory response and the secretion of interferons are considered nonspecific because they:

- A. Are developed only after a person receives a vaccination.
- B. Provide a general defense against any pathogen the body encounters.**
- C. Involve the production of targeted B and T lymphocytes.
- D. Only activate once a specific pathogen has been identified by a macrophage.

5	BIO. 3.1.01.089 Differentiate between the various types of immune cells, to include WBC (neutrophils (macrophages, phagocytes, lymphocytes	Information from text Table 2	14
6	BIO.3.1.01.089 Identify the function and structures of lymphatic system	Information from text Figure 10	14

This response aids in the accumulation of white blood cells in the area. Some of the pain, heat, and redness experienced during an infectious disease are the result of the inflammatory response.

Table 2 Cells of the Immune System

Type of Cell	Example	Function
Neutrophils	LM Magnification: 800x 	Phagocytosis: blood cells that ingest bacteria
Macrophages		Phagocytosis: blood cells that ingest bacteria and remove dead neutrophils and other debris
Lymphocytes	LM Magnification: 1600x 	Specific immunity (antibodies and killing of pathogens): blood cells that produce antibodies and other chemicals

Specific Immunity

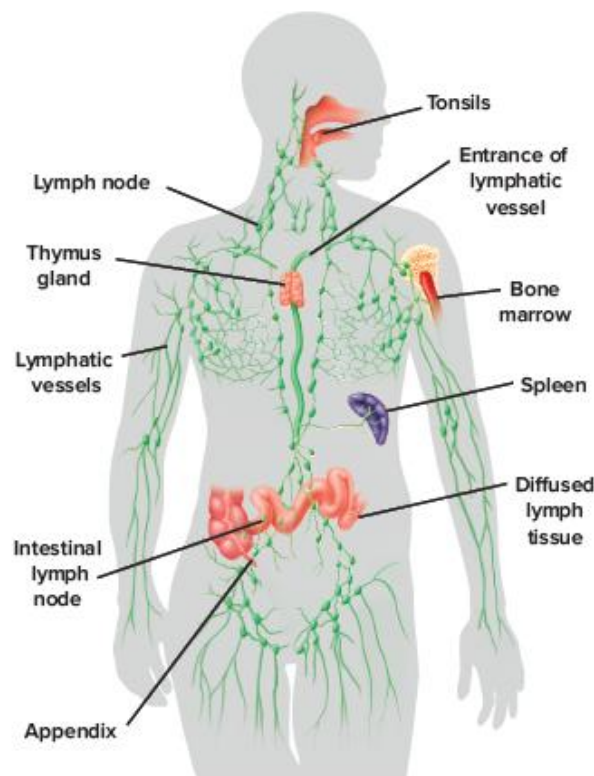
Pathogens sometimes get past the nonspecific defense mechanisms. In this event, the body has a second line of defense that attacks the pathogens. Specific immunity is more effective and involves the tissues and organs found in the lymphatic system.

Lymphatic system

The lymphatic system, shown in **Figure 10**, includes organs and cells that filter lymph and blood, destroy foreign microorganisms, and absorb fat. Lymph is the watery part of the blood (the plasma) that leaks out of capillaries to bathe all the cells in the body. This clear fluid, containing oxygen, nutrients, and white blood cells, circulates among the tissue cells, is collected by lymphatic vessels, and is returned to the circulatory system via the veins near the heart.

Figure 10 The lymphatic system contains the organs involved in the specific immune response.

Identify the lymphatic organ where T cells mature.

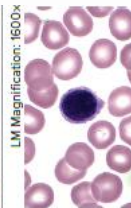
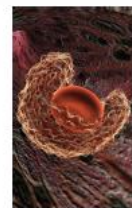
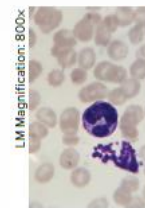


Q1: According to Table 2, what is the primary functional difference between a neutrophil and a macrophage?

- a. Neutrophils produce antibodies, while macrophages only ingest bacteria.
- b. Neutrophils are specific immune cells, while macrophages are nonspecific.
- c. **Macrophages ingest bacteria and remove dead neutrophils and debris, while neutrophils primarily ingest bacteria.**
- d. Neutrophils mature in the thymus gland, while macrophages mature in the red bone marrow.

Q2: Which type of white blood cell is specifically involved in specific immunity by producing antibodies and other chemicals?

- a. Phagocytes
- b. Macrophages
- c. **Lymphocytes**
- d. Neutrophils



Q3: What allows phagocytic cells like macrophages to destroy microorganisms after internalizing them?

- a. They release hydrochloric acid into the bloodstream.
- b. They trap the pathogen in mucus within the lymph node.
- c. **They release digestive enzymes and harmful chemicals from their lysosomes.**
- d. They use cilia to move the pathogen to the spleen for destruction.

Q4: Which of the following cells are correctly categorized as phagocytic white blood cells?

- a. B cells and T cells
- b. Red blood cells and lymphocytes
- c. **Neutrophils and macrophages**
- d. Complement proteins and interferons

Q5: Use Table 2 to identify which cell type serves as a bridge to specific immunity by producing chemicals that react with foreign antigens?

- a. Phagocytes
- b. **Lymphocytes**
- c. Dead skin cells
- d. Symbiotic bacteria

Q6: What is "lymph"?

- a. Watery plasma that carries hydrochloric acid to the stomach.
- b. A series of 20 proteins found only in the blood plasma.
- c. **Watery blood plasma that leaks out of capillaries to bathe cells and contains nutrients.**
- d. A chemical secreted by virus-infected cells to protect neighboring cells.

Q7: Identify the lymphatic organ in the side Figure which is the site where T cells mature.

- a. Spleen
- b. Tonsils
- c. **Thymus gland**
- d. Lymph node

Q8: What is the primary function of lymph nodes?

- a. To produce red blood cells and store oxygen.
- b. **To filter lymph and remove foreign materials.**
- c. To secrete lysozyme into the nasal and oral cavities.
- d. To return oxygen-rich blood directly to the arteries.

Q9: Which organ of the lymphatic system is responsible for destroying damaged red blood cells?

- a. Thymus
- b. **Spleen**
- c. Appendix
- d. Intestinal lymph node

Q10: Where is diffuse lymphatic tissue typically found in the body?

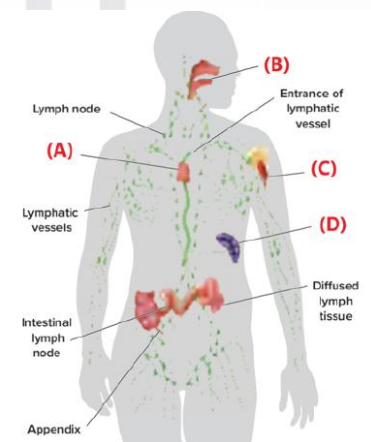
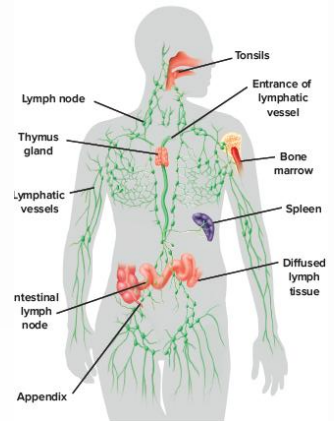
- a. Only in the red bone marrow.
- b. On the outer layers of the skin.
- c. **In the mucous membranes of the intestinal and respiratory tracts.**
- d. Surrounding the heart and lungs to produce interferon.

Q11. All of the following is a component of the Lymphatic system except.....

- a. **The heart**
- b. The spleen
- c. The tonsils
- d. The thymus gland

Q12. The figure below shows the lymphatic system organs involved in the specific immune response. Which of the following letters indicates the organ that stores blood and destroys damaged red blood cells?

- a. A
- b. B
- c. C
- d. **D**





7	BIO. 3.1.01.089 Sequence the steps of the antibody-mediated response and the cytotoxic T cell response as a part of the specific immune system	Information from text	15
22	BIO. 3.1.01.089 Explain how immune cells communicate and interact with one another during immune responses	Information from text	15

Lymphatic organs

The organs of the lymphatic system contain lymphatic tissue, lymphocytes, a few other cell types, and connective tissue. **Lymphocytes** are a type of white blood cell that is produced in red bone marrow. The lymphatic organs include the lymph nodes, tonsils, spleen, thymus (THI mus) gland, and diffused lymphatic tissue found in mucous membranes of the intestinal, respiratory, urinary, and genital tracts.

The lymph nodes filter the lymph and remove foreign materials from the lymph. The tonsils form a protective ring of lymphatic tissue between the nasal and oral cavities. This helps protect against bacteria and other harmful materials in the nose and mouth.

The spleen stores blood and destroys damaged red blood cells. It also contains lymphatic tissue that responds to foreign substances in the blood. The thymus gland, which is located above the heart, plays a role in activating a special kind of lymphocyte called T cells. T cells are produced in the bone marrow, but they mature in the thymus gland.

B Cell Response

B lymphocytes, often called **B cells**, are located in all lymphatic tissues and can be thought of as antibody factories. **Antibodies** are proteins produced by B lymphocytes that specifically react with a foreign antigen. An antigen is a substance foreign to the body that causes an immune response; it can bind to an antibody or T cell. When a portion of a pathogen is presented by a macrophage, B cells produce antibodies. Follow along in **Figure 11** on the next page as you learn about how B cells are activated to produce antibodies.

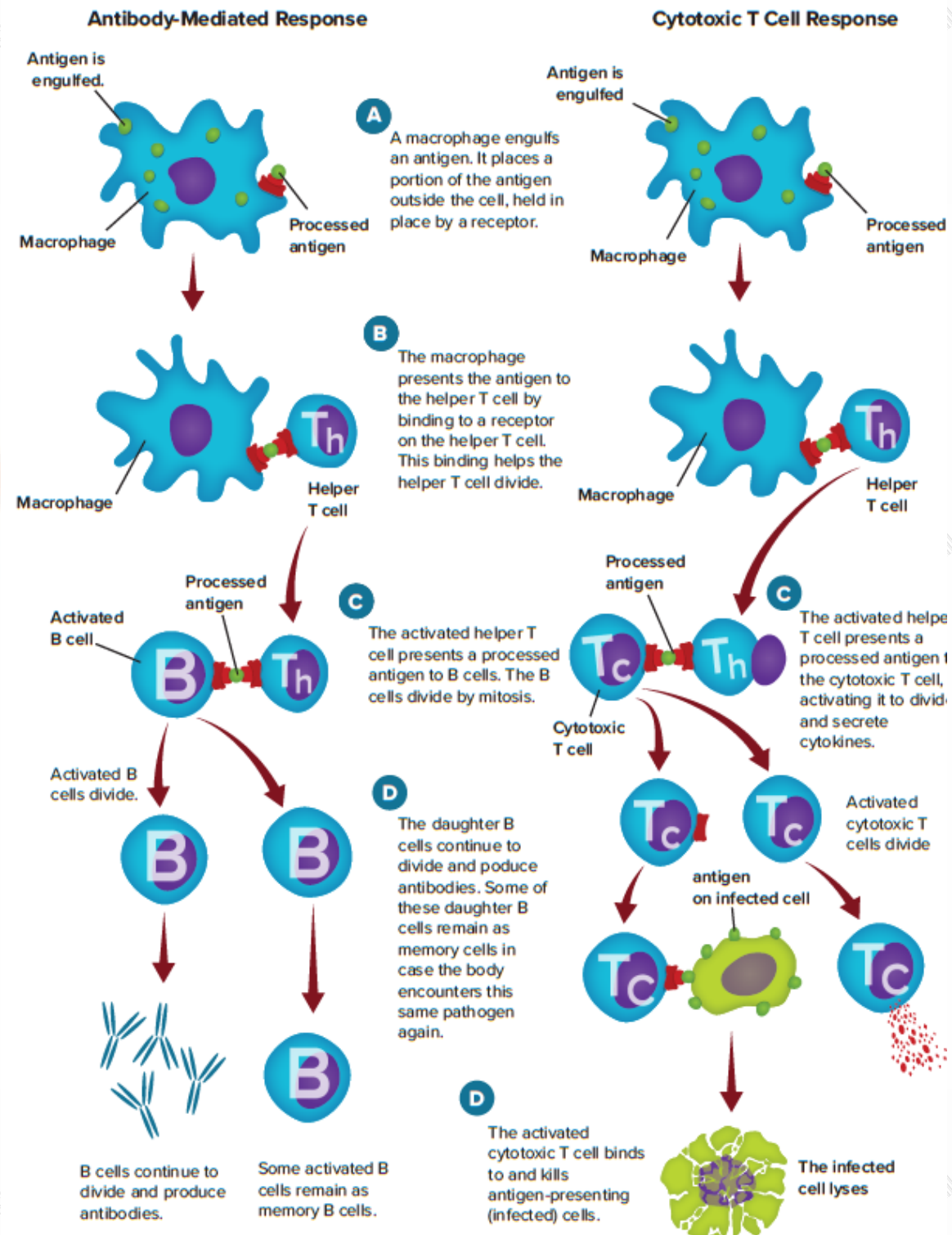
When a macrophage surrounds, internalizes, and digests a pathogen, it takes a piece of the pathogen, which is called a processed antigen, and displays it on its membrane, as illustrated in **Figure 11**. In the lymphatic tissues, such as the lymph nodes, the macrophage, with the processed antigen on its surface, binds to a type of lymphocyte called a **helper T cell**. This process activates the helper T cell. This lymphocyte is called a "helper" because it activates antibody secretion in B cells and another type of T cell, which will be discussed later, that aids in killing microorganisms:

- The activated helper T cell reproduces, binds processed antigens, and attaches to a B cell.
- The new helper T cells continue the process of binding antigens, attaching to B cells, and reproducing.
- Once an activated helper T cell binds to a B cell holding an antigen, the B cell begins to manufacture antibodies that specifically bind to the antigen.
- The antibodies can enhance the immune response by binding to microorganisms, making them more susceptible to phagocytosis and, by initiating the inflammatory response, helping promote the nonspecific response.



Figure 11 Visualizing Specific Immune Responses

Specific immune responses involve antigens, phagocytes, B cells, helper T cells, and cytotoxic T cells. The antibody-mediated response involves antibodies produced by B cells and memory B cells. The cytotoxic T cell response results in cytotoxic T cell activation.



Q1: What is the initial step in the sequence of an antibody-mediated immune response after a pathogen enters the body?

- a. Helper T cells reproduce and attach to B cells.
- b. B cells begin manufacturing specific antibodies.
- c. **A macrophage surrounds, internalizes, and digests the pathogen.**
- d. Cytotoxic T cells release cytokines to recruit immune cells to the area.

Q2: In the sequence of specific immunity, what does a macrophage display on its membrane immediately after digesting a pathogen?

- a. A heavy protein chain
- b. **A processed antigen**
- c. A complement protein
- d. An interferon receptor

Q3: Where does the interaction between a macrophage presenting a processed antigen and a helper T cell typically take place?

- a. In the red bone marrow
- b. On the surface of the skin
- c. **In lymphatic tissues such as the lymph nodes**
- d. In the stomach's hydrochloric acid

Q4: Which of the following correctly sequences the events leading to antibody production by B cells?

- a. Helper T cell binds macrophage → antibodies produced → B cell activated.
- b. Macrophage presents antigen → B cell produces antibodies → helper T cell activated.
- c. B cell binds antigen → macrophage activated → helper T cell produces antibodies.
- d. **Macrophage presents antigen → helper T cell activated → helper T cell binds to B cell → B cell produces antibodies.**

Q5: Why is the helper T cell considered a critical "bridge" in the sequence of the specific immune response?

- a. It acts as a physical barrier on the skin.
- b. **It activates antibody secretion in B cells and activates cytotoxic T cells.**
- c. It produces lysozyme to break down bacterial cell walls.
- d. It is the primary cell responsible for phagocytosis.

Q6: During a specific immune response, how does a macrophage communicate the presence of a pathogen to a helper T cell?

- a. By producing antibodies that specifically bind to the helper T cell's receptor.
- b. **By displaying a piece of the digested pathogen, called a processed antigen, on its membrane.**
- c. By releasing hydrochloric acid to activate the helper T cell in the bone marrow.
- d. By binding to a B cell to signal it to turn into a cytotoxic T cell.

Q7: Based on the sequence shown in Figure 11, what is the critical step that allows a helper T cell to activate a B cell?

- The B cell must first produce interferon to attract the helper T cell.
- The activated helper T cell must bind to a B cell that is already holding an antigen.**
- The helper T cell must release lysozyme to digest the B cell's heavy protein chains.
- The macrophage must directly attach to the B cell's CD4+ receptor.

Q8: In the cytotoxic T cell response, which chemicals serve as communication signals to recruit immune cells and stimulate them to divide?

- Antigens
- Antibodies
- Cytokines**
- Lysozymes

Q9: Which of the following best explains how interferon provides a second-line defense against viral infections?

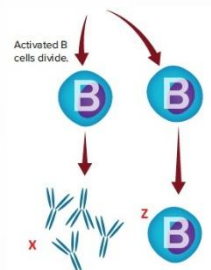
- It attracts macrophages to remove dead neutrophils and debris.
- It is secreted by virus-infected cells and stimulates neighboring cells to produce antiviral proteins that prevent replication.**
- It increases the permeability of blood vessels to allow white blood cells to escape.
- It coats the skin in a layer of oil to inhibit pathogen growth.

Q10: Which of the following describes the sequence of events during a nonspecific inflammatory response?

- Lysozyme breaks down cell walls, which immediately signals the thymus to mature T cells.
- Pathogens damage tissue, causing the release of chemicals that attract phagocytes, increase blood flow, and make blood vessels more permeable.**
- Cilia move infected mucus to the stomach where it is neutralized by complement proteins.
- Interferon binds to B cells, signaling them to divide and manufacture antibodies.

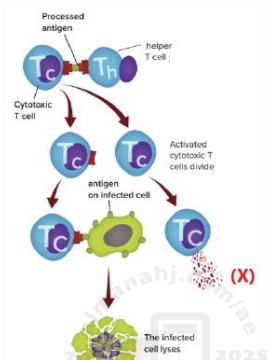
Q11. The figure below is illustration of Specific Immune Responses, study it and then answer the question: what do the letters (x) and (z) represent?

- (X): Antigens and (Z): Memory cells
- (X): Processed antigen and (Z): Cytotoxic B cell
- (X): Antibodies and (Z): Helper B cell
- (X): Antibodies and (Z): Memory cells**



Q12. The figure below illustrates the Specific Immune Response. Which of the following chemicals is released from the cytotoxic T cells and labelled with the letter (X) below?

- Histamine
- Interferon
- Acetylcholine
- Cytokines**

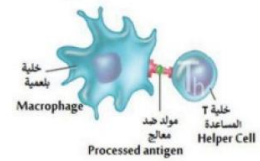


Q13. According to the sequencing of the cytotoxic T cell response, what must happen for a cytotoxic T cell to be activated to divide and secrete cytokines?

- A. The cytotoxic T cell must first produce its own antibodies.
- B. The infected cell must lyse and release its antigens into the blood.
- C. An activated helper T cell must present a processed antigen to the cytotoxic T cell.**
- D. A macrophage must directly bind to the cytotoxic T cell's CD4+ receptor.

Q14. In the figure below, the macrophage presents the antigen to the helper T cell by binding to a receptor on the helper T cell. This binding help T cell to divide. Which of the following stimulates this binding?

- A. The helper T cell presents a processed antigen for the macrophage
- B. The macrophage engulfs and presents an antigen outside the cell**
- C. Cytotoxic T cells release cytokines
- D. B cells produces antibodies



Q15. In the figure above, the macrophage presents the antigen to the helper T cell by binding to a receptor on the helper T cell. What is the importance of this binding?

- A. Helps the helper T cell to divide**
- B. Helps the macrophage cell to divide
- C. Converts antigen into processed antigen
- D. Produces direct antibodies

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Passive and Active Immunity

The body's first response to an invasion by a pathogen is called the primary response. For example, if the viral pathogen that causes chicken pox enters the body, nonspecific and specific immune responses eventually defeat the foreign virus and the body is cleared of the pathogen.

One result of the specific immune response is the production of memory B and T cells. **Memory cells** are long-living cells that are exposed to the antigen during the primary immune response. These cells are ready to respond rapidly if the body encounters the same pathogen later. Memory cells protect the body by reducing the likelihood of developing the disease if exposed again to the same pathogen.

Passive immunity

Sometimes temporary protection against an infectious disease is needed. This type of temporary protection occurs when antibodies are made by other people or animals and are transferred or injected into the body. For example, passive immunity occurs between a mother and her child. Antibodies produced by the mother are passed through the placenta to the developing fetus and through breast milk to the infant child. These antibodies can protect the child until the infant's immune system matures.

Antibodies developed in humans and animals that are already immune to a specific infectious disease are used to treat some infectious diseases in others. These antibodies are injected into people who have been exposed to that particular infectious disease. Passive immune therapy is available for people who have been exposed to hepatitis A and B, tetanus, and rabies. Antibodies also are available to inactivate snake and scorpion venoms.

Active immunity

Active immunity occurs after the immune system is exposed to disease antigens and memory cells are produced. Active immunity can result from having an infectious disease or immunization. **Immunization**, also called vaccination, is the deliberate exposure of the body to an antigen so that a primary response and immune memory cells will develop. **Table 3** lists some of the common immunizations offered in the United States. Immunizations contain killed or weakened pathogens, which are incapable of causing the disease.

Most immunizations include more than one stimulus to the immune system, given after the first immunization. These booster shots increase the immune response, providing further protection from the disease-causing organism.



Get It?

Describe the difference between passive immunity and active immunity.

Table 3 Common Immunization

Immunization	Disease	Contents
DPT	Diphtheria (D), tetanus (T), pertussis (P) (whooping cough)	D: inactivated toxin, T: inactivated toxin, P: inactivated bacteria
Polio	Poliomyelitis	Inactivated virus
MMR	Measles, mumps, rubella	All three inactivated viruses
Varicella	Chicken pox	Inactivated virus
HIB	Haemophilus influenzae (flu) type b	Portions of bacteria cell wall covering
HBV	Hepatitis B	Subunit of virus

Q1: Which of the following best describes the primary difference between passive and active immunity?

- A. Active immunity is temporary and involves receiving antibodies from an external source.
- B. Passive immunity provides temporary protection through transferred antibodies, while active immunity results from antigen exposure and memory cell production.**
- C. Passive immunity occurs only after a person recovers from an infectious disease like chicken pox.
- D. Active immunity is the body's first line of defense involving physical barriers like the skin.

Q2: Which of these is an example of natural passive immunity?

- A. Receiving a vaccination to develop immune memory cells.
- B. The production of cytokines by activated cytotoxic T cells to recruit immune cells.
- C. Antibodies produced by a mother being passed to a fetus through the placenta or to an infant through breast milk.**
- D. An injection of antibodies used to treat exposure to rabies or snake venoms.

Q3: How is active immunity acquired?

- A. It results from having an infectious disease or receiving an immunization (vaccination).**
- B. It is acquired only when an organism receives antibodies from another organism.
- C. It occurs instantly at birth as the body's first line of nonspecific defense.
- D. It is achieved by the deliberate injection of active, disease-causing toxins into a healthy host.

Q4: Passive immune therapy, such as injections for Hepatitis A or rabies, is characterized by which of the following?

- A. The stimulation of long-living memory B and T cells in the patient.
- B. Providing a permanent cure for a disease after only one injection.
- C. Providing temporary protection for individuals who have been exposed to a specific infectious disease.**
- D. Relying on the body's own inflammatory response to produce antibodies.

Q5: What is the role of a booster shot in a vaccination schedule?

- A. To provide a natural form of passive immunity to infants.
- B. To increase the immune response and provide further protection from a disease-causing organism.**
- C. To replace the need for the body to produce its own memory B cells.
- D. To act as a nonspecific chemical barrier against food-borne pathogens.

Q6: Why is active immunity considered more effective for long-term protection than passive immunity?

- A. Active immunity uses antibodies from animals that are more powerful than human ones.
- B. Passive immunity only works against viruses, while active immunity works against all pathogens.
- C. Active immunity involves the production of long-living memory cells that respond rapidly upon subsequent exposure.**
- D. Active immunity is the body's first response to any invasion and is always present at birth.

8	BIO.3.1.01.089 Explain why immunizations (vaccinations) are effective in preventing diseases with current real world applications	Table 3	18
23	BIO. 3.1.01.088 Compare and contrast passive and active immunity	Information from text	18

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HBV	Hepatitis B	Subunit of virus

Q1: What is the primary reason immunizations (vaccinations) are effective in preventing disease?

- a. They provide a physical barrier of dead skin cells.
- b. They kill all pathogens in the bloodstream immediately upon injection.
- c. **They trigger a primary response and the development of memory cells for future defense.**
- d. They provide temporary passive immunity through the placenta.

Q2: According to Table 3, which immunization is specifically designed to protect against a disease using portions of a bacterial cell wall covering?

- a. HBV (Hepatitis B)
- b. MMR (Measles, Mumps, Rubella)
- c. **HIB (Haemophilus influenzae type b)**
- d. Varicella (Chicken pox)

Q3: Based on the information in Table 3, which vaccine contains a subunit of a virus rather than a whole inactivated virus?

- a. Polio
- b. DPT
- c. Varicella
- d. **HBV**

Q4: What is the medical purpose of receiving a booster shot after an initial immunization has been administered?

- a. To provide natural passive immunity.
- b. **To increase the immune response and provide further protection.**
- c. To replace the need for the body to produce its own memory T cells.
- d. To prevent the virus from replicating in the red bone marrow.

Q5: Why varicella vaccine is it considered a preventive measure against chicken pox?

- a. It creates an immediate chemical barrier in the nasal secretions.
- b. **It triggers memory cells that enable a more rapid and greater response upon second exposure.**
- c. It contains active toxins that destroy the virus in the stomach.
- d. It provides the body with a permanent supply of artificial antibodies from an animal source.

Q6: Which of the following is a characteristic of passive immunity that distinguishes it from active immunity?

- A. **It provides temporary protection through antibodies produced by another person or animal.**
- B. It occurs only after the immune system is exposed to a disease antigen.
- C. It results in the production of long-living memory B and T cells.
- D. It is the result of a deliberate exposure to a weakened or killed pathogen.

Q7: How is natural active immunity primarily acquired?

- A. Through the transfer of antibodies from a mother to a fetus via the placenta.
- B. **By having an infectious disease, such as chicken pox, which triggers memory cell production.**
- C. Through an injection of antibodies to treat exposure to rabies or tetanus.
- D. By the secretion of lysozyme in tears to kill bacterial pathogens.

Q8: What is the primary purpose of a "booster shot" in an immunization schedule?

- A. To provide natural passive immunity through breast milk.
- B. To replace the need for the body to develop its own primary response.
- C. **To increase the immune response and provide further protection by stimulating memory cells.**
- D. To provide immediate, temporary antibodies for an infected patient.

Q9: Which medical treatment is an example of artificial passive immunity?

- A. Recovering from a viral infection like the flu.
- B. Receiving the MMR vaccine as an infant.
- C. **Receiving an injection of antibodies after being exposed to Hepatitis A or B.**
- D. The natural development of memory cells after a primary response.

Q10: What is the most significant long-term difference between active and passive immunity?

- A. **Active immunity produces memory cells for long-term, while passive immunity is temporary.**
- B. Passive immunity is the most effective response for preventing secondary infections.
- C. Active immunity involves receiving antibodies from an animal source.
- D. Passive immunity relies on the inflammatory response to create immunity.

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Why are immunizations effective in preventing disease? The characteristics of the secondary immune response, which is the response to a second exposure to an antigen, enable immunizations to be effective in preventing disease. Study the graph in **Figure 13**. Note that the secondary response to the antigen has a number of different characteristics. First, the response is more rapid than the primary response, as shown by the greater steepness in the portion of the curves plotted in red. Second, the overall response, both B and T cell response, is greater during the second exposure. Lastly, the overall memory lasts longer after the second exposure.

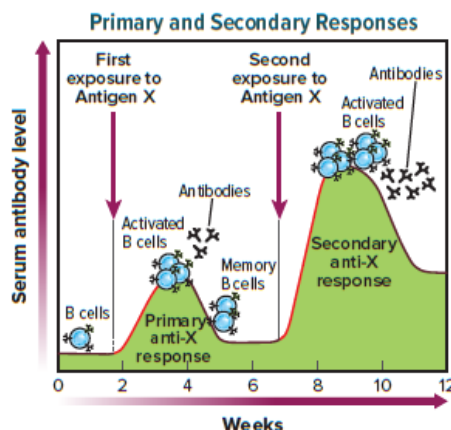


Figure 13 This graph shows the difference between the primary and secondary immune responses to exposure to an antigen.

Analyze the differences between the primary and secondary immune responses.

Get It?

Analyze how immunizations help prevent disease.

Immune System Failure

Defects in the immune system can result in an increased likelihood of developing infectious diseases as well as certain types of cancers. Some diseases can affect the immune system's effectiveness. One such disease called acquired immunodeficiency syndrome (AIDS) results from an infection by human immunodeficiency virus (HIV). AIDS is a serious health problem worldwide.

In 2015, approximately 18,303 AIDS cases were diagnosed in the U.S. In 2014, 6,721 people died of AIDS in the U.S. In 2015, an estimated 36 million people globally were living with HIV infection.

Recall the important role that helper T cells play in specific immunity. T cells are also called $CD4^+$ cells because these cells have a receptor on the outside of their plasma membrane. This $CD4^+$ receptor is used by medical professionals to identify these cells, as illustrated in **Figure 14**.

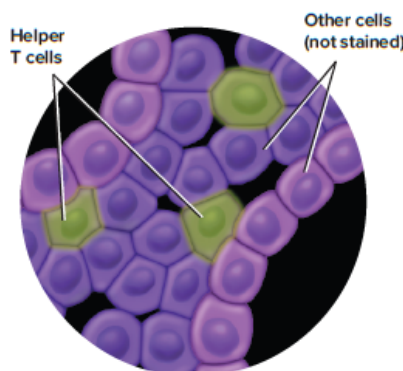


Figure 14 Helper T cells have receptors on the surface that are used to identify them in the laboratory.

HIV is an RNA virus that infects helper T cells. The helper T cells become HIV factories, producing new viruses that are released and infect other helper T cells. Over time, the number of helper T cells in an infected person decreases, making the person less able to fight disease. HIV infection usually has an early phase during the first six to twelve weeks while viruses are replicating in helper T cells.

The patient suffers symptoms such as night sweats and fever, but these symptoms are reduced after about eight to ten weeks. Then, the patient exhibits few symptoms for a period of time as long as ten years but is capable of passing the infection through sexual intercourse or blood products.

HIV is a secondary immunodeficiency disease, which means that the immune system of a previously healthy person fails. Without antiviral drug therapy, the patient usually dies from a secondary infection from another pathogen after about ten years of being infected with HIV. Current antiviral drug therapy is aimed at controlling the replication of HIV in the body. Resistant strains, expensive drugs, and side effects are all issues that patients face. Researchers and health care providers are working to meet these needs and continue the search for a cure.

Get It?

Summarize how the immune system protects and attempts to maintain a healthy balance in the body.



Q1: HIV is classified as an RNA virus that primarily targets and replicates within which immune cells?

- A. B lymphocytes in the bone marrow.
- B. **Helper T cells, also known as CD4+ cells.**
- C. Macrophages performing phagocytosis.
- D. Neutrophils in the blood plasma.

Q2: According to Figure 14, how do helper T cells contribute to the spread of HIV once they are infected?

- A. They produce antibodies that help the virus enter other cells.
- B. They release lysozyme which breaks down healthy cell walls.
- C. **They become "HIV factories," producing new viruses that are released to infect more cells.**
- D. They move to the skin to bypass the body's nonspecific barriers.

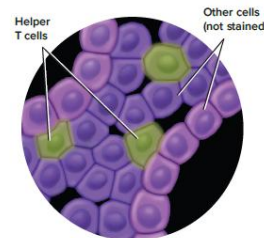


Figure 14 Helper T cells have receptors on the surface that are used to identify them in the laboratory.

Q3: Why is the destruction of helper T cells by HIV considered so destructive to the specific immune system?

- A. Helper T cells are the only cells capable of producing hydrochloric acid.
- B. The loss of helper T cells prevents the body from making red blood cells.
- C. **Helper T cells are required to activate both B cell antibody secretion and cytotoxic T cell responses.**
- D. Without helper T cells, the body cannot produce the interferon needed for nonspecific defense.

Q4: HIV is defined as a "secondary" immunodeficiency disease because:

- A. It is the second virus a patient catches after an initial disease.
- B. **The immune system of a previously healthy person fails due to the infection.**
- C. It only affects the nonspecific defenses of the body.
- D. It is a genetic disorder that is present at birth.

Q5: What is the typical outcome for an HIV patient who does not receive antiviral drug therapy?

- A. The patient becomes immune to all other infectious diseases.
- B. **The patient usually dies from a secondary infection from another pathogen after about ten years.**
- C. The patient's helper T cell count increases to fight the virus.
- D. The virus is eventually cleared by the body's memory B cells.

Q6: During the early phase of HIV infection (first six to twelve weeks), what symptoms does the patient typically experience?

- A. Permanent immunity to cancer.
- B. **Night sweats and fever, which are reduced after about eight to ten weeks.**
- C. Immediate failure of the digestive system and stomach acid production.
- D. A massive release of histamines leading to anaphylactic shock.

Q7: Which of the following describes the status of a patient during the asymptomatic period of HIV, which can last up to ten years?

- A. The patient is no longer infectious to others.
- B. The helper T cell count is steadily increasing.
- C. The virus has been completely removed from the body.
- D. **The patient exhibits few symptoms but is capable of passing the infection.**

Q8: What is the primary goal of current antiviral drug therapy for patients living with HIV?

- A. **To control the replication of HIV in the body.**
- B. To cure the disease completely by removing the virus.
- C. To replace all B cells with new cytotoxic T cells.
- D. To eliminate the need for the helper T cell's CD4+ receptor.

Q9: According to Figure 14, how do medical professionals identify helper T cells in a laboratory setting?

- A. By observing the cells producing lysozyme.
- B. **By identifying the CD4+ receptor on the outside of their plasma membrane.**
- C. By measuring the thickness of the cell's physical barrier.
- D. By counting the number of heavy and light chains the cell produces.

Q10: Which of the following is an issue that HIV patients face regarding current treatment options?

- A. The body's inability to produce any interferon.
- B. **Resistant strains of the virus, expensive drugs, and side effects.**
- C. A lack of available helper T cells to infect.
- D. The body's natural flora attacking the antiviral drugs.

Q11. According to Figure 13, how does the secondary anti-X response differ from the primary anti-X response?

- A. It results in a lower level of activated B cells.
- B. It occurs over a shorter duration of time with fewer antibodies produced.
- C. **It is more rapid and results in a significantly greater overall antibody level.**
- D. It relies primarily on the physical barriers of the skin rather than lymphocytes.

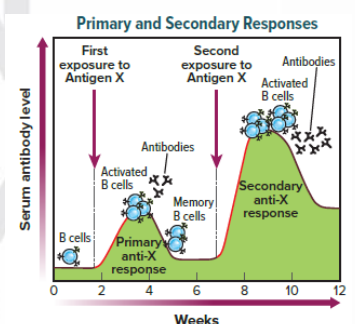


Figure 13 This graph shows the difference between the primary and secondary immune responses to exposure to an antigen.

Q12. The graph shows difference between primary and secondary response. What do the letters [A] and [B] represent?

- A. A — Cytotoxic T cells, B — Memory cells
- B. A — Memory cells, B — T cells
- C. A — Helper T cells, B — B cells
- D. **A — B cells, B — Memory cells**

