

## Chapter 12 The Lymphatic System

### OVERVIEW

The purpose of this chapter is to teach the anatomy and physiology of the lymphatic system. The latter part of this chapter discusses a few select pathology issues.

In this chapter a case study discussion continues from Chapter 11 (Individual Outcome 11.15) and Individual Outcome 12.4. Another group activity has students researching HIV as to its prevalence, prevention, mode of action, treatment, and prognosis.

Chapter figures can be found in the Online Learning Center (OLC). Discussion points, group activities, and quizzes listed in the summary table below are explained under their individual outcomes following the table. Answer keys to the text chapter review questions, workbook concept maps, and workbook review questions are located at the end of the chapter.

A review guide is also available on the OLC. This guide lists all of the learning outcomes for the chapter and gives space for students to take notes and make sketches. This can be an important tool to encourage students to pay attention to what they are learning and to use to either take initial notes or to organize their existing notes before exams.

Learning Outcome	CAAHEP Competencies	ABHES Competencies
12.1 Use medical terminology related to the lymphatic system.	I.C.1. Describe structural organization of the human body	3.a. Define and use entire basic structure of medical words and be able to accurately identify in the correct context, i.e., root, prefix, suffix, combinations, spelling and definitions
12.2 Explain the origin and composition of lymph.	I.C.2. Identify body systems	2.b. Identify and apply the knowledge of all body systems, their structure and functions, and their common diseases, symptoms and etiologies.
12.3 Describe lymph vessels.	I.C.2. Identify body systems	2.b. Identify and apply the knowledge of all body systems, their structure and functions, and their common diseases, symptoms and etiologies.
11.4 Explain the route of lymph from the blood and back again.	I.C.4. List major organs in each body system	2.b. Identify and apply the knowledge of all body systems, their structure and functions, and their common diseases, symptoms and etiologies.
12.5 Describe cells of the lymphatic system and list their functions.	I.C.5. Describe the normal function of each body system	2.b. Identify and apply the knowledge of all body systems, their structure and functions, and their common diseases, symptoms and etiologies.

12.6 Identify lymphoid tissues and organs and explain their functions.	I.C.5. Describe the normal function of each body system	2.b. Identify and apply the knowledge of all body systems, their structure and functions, and their common diseases, symptoms and etiologies.
12.7 Summarize three lines of defense against pathogens.	I.C.5. Describe the normal function of each body system	2.b. Identify and apply the knowledge of all body systems, their structure and functions, and their common diseases, symptoms and etiologies.
12.8 Contrast nonspecific resistance and specific immunity.	I.C.5. Describe the normal function of each body system	2.b. Identify and apply the knowledge of all body systems, their structure and functions, and their common diseases, symptoms and etiologies.
12.9 Describe the body's nonspecific defenses.	I.C.5. Describe the normal function of each body system	2.b. Identify and apply the knowledge of all body systems, their structure and functions, and their common diseases, symptoms and etiologies.
12.10 Explain the role of an APC in specific immunity.	I.C.5. Describe the normal function of each body system	2.b. Identify and apply the knowledge of all body systems, their structure and functions, and their common diseases, symptoms and etiologies.
12.11 Explain the process of humoral immunity.	I.C.5. Describe the normal function of each body system	2.b. Identify and apply the knowledge of all body systems, their structure and functions, and their common diseases, symptoms and etiologies.
12.12 Explain the process of cellular immunity.	I.C.5. Describe the normal function of each body system	2.b. Identify and apply the knowledge of all body systems, their structure and functions, and their common diseases, symptoms and etiologies.
12.13 Compare the different forms of acquired immunity.	I.C.5. Describe the normal function of each body system	2.b. Identify and apply the knowledge of all body systems, their structure and functions, and their common diseases, symptoms and etiologies.
12.14 Explain the importance of T helper cells to specific and nonspecific defense.	I.C.5. Describe the normal function of each body system	2.b. Identify and apply the knowledge of all body systems, their structure and functions, and their common diseases, symptoms and etiologies.
12.15 Explain the functions of the lymphatic system.	I.C.5. Describe the normal function of each body system	2.b. Identify and apply the knowledge of all body systems, their structure and functions, and their common diseases, symptoms and etiologies.
12.16 Summarize the effects of aging on the lymphatic system.	I.C.10. Compare body structure and function of the human body across the life span	2.b. Identify and apply the knowledge of all body systems, their structure and functions, and their common diseases, symptoms and etiologies.
12.17 Describe common diagnostic tests used for lymphatic system disorders.	I.C.6. Identify common pathology related to each body system	2.b. Identify and apply the knowledge of all body systems, their structure and functions, and their common diseases, symptoms and etiologies.
12.18 Describe lymphatic system disorders and relate abnormal function to pathology.	I.C.6. Identify common pathology related to each body system	2.b. Identify and apply the knowledge of all body systems, their structure and functions, and their common diseases, symptoms and etiologies.

**SUMMARY TABLE 12**

LEARNING OUTCOME	LECTURE OUTLINE	ACTIVITIES – TALKING POINTS	ASSESSMENTS
12.1 Use medical terminology related to the lymphatic system.		<i>WkBk Word Roots and Combining Forms</i>	<i>WkBk Chapter Review Questions:</i> <ul style="list-style-type: none"> <li>Word Deconstruction: 1-5</li> </ul>
12.2 Explain the origin and composition of lymph.	I. Overview II. Anatomy of the lymphatic system A. Lymph and lymph vessels		<i>WkBk Chapter Review Questions:</i> <ul style="list-style-type: none"> <li>MS: 1</li> </ul>
12.3 Describe lymph vessels.	<b>Chapter Figures:</b> 12.2 (Lymphatic capillaries) 12.3 (Valves in lymphatic vessels)	<b>Talking Point:</b> After discussing the valves in the lymphatic vessels, you can discuss (or review) the valves that are in veins.	<i>WkBk Chapter Review Questions:</i> <ul style="list-style-type: none"> <li>MS: 2</li> <li>Matching: 7</li> </ul>
21.4 Explain the route of lymph from the blood and back again.	<b>Chapter Figures:</b> 12.4 (Lymphatic drainage to the subclavian veins) 12.5 (Fluid exchange between the cardiovascular and lymphatic systems) 12.6 (The lymphatic system) 12.9 (Lymph drainage of the right breast)	<b>Discussion Point:</b> 1. See Individual Outcome 12.4.  <b>WkBk Coloring Book:</b> Figure 21.1 (Lymphatic system drainage)	<i>Spot Check:</i> 1, 2 <i>WkBk Chapter Review Questions:</i> <ul style="list-style-type: none"> <li>Matching: 6-10</li> </ul>
12.5 Describe cells of the lymphatic	B. Cells of the lymphatic	<i>WkBk Concept maps:</i>	<i>WkBk Chapter Review Questions:</i>

system and list their functions.	<p>system</p> <ol style="list-style-type: none"> <li>1. NK cells</li> <li>2. T cells             <ol style="list-style-type: none"> <li>a. T helper</li> <li>b. T cytotoxic</li> <li>c. T memory</li> <li>d. T memory</li> </ol> </li> <li>3. B cells             <ol style="list-style-type: none"> <li>a. B plasma</li> <li>b. B memory</li> </ol> </li> <li>4. Macrophages</li> <li>5. Dendritic cells</li> </ol>	<p>Figure 12.4 (Cells of the lymphatic system concept map)</p> <p><b>WkBk Figure:</b> Figure 12.19 (T cytotoxic cell attacking a cancer cell))</p>	<ul style="list-style-type: none"> <li>• MS: 3</li> <li>• Completion: 4</li> </ul>
12.6 Identify lymphoid tissues and organs and explain their functions.	<p>C. Lymphoid tissues and organs</p> <ol style="list-style-type: none"> <li>1. Mucosa associated lymphatic tissue (MALT)</li> <li>2. Peyer's patches</li> <li>3. Lymph nodes             <ol style="list-style-type: none"> <li>a. cervical</li> <li>b. axillary</li> <li>c. thoracic</li> <li>d. abdominal</li> <li>e. pelvic</li> <li>f. mesenteric</li> <li>g. popliteal</li> <li>h. inguinal</li> </ol> </li> </ol>	<p><b>Group Activity:</b> Lymphoid tissues. See Individual Outcome 12.6.</p> <p><b>WkBk Coloring Book:</b> Figure 12.2 (Lymphoid tissues of a child)</p>	<p><b>Spot Check:</b> 3, 4</p> <p><b>Quiz:</b> 1 (Covers LOs 12.2-12.6 See Individual Outcome 12.6)</p> <p><b>WkBk Chapter Review Questions:</b></p> <ul style="list-style-type: none"> <li>• Critical Thinking: 1</li> </ul>

	<p>4. Tonsils</p> <ol style="list-style-type: none"> <li>pharyngeal</li> <li>palatine</li> <li>lingual</li> </ol> <p>5. Thymus gland</p> <p>6. Spleen</p> <p><b>Chapter Figures:</b></p> <p>12.6 (Lymphoid tissues and organs)</p> <p>12.7 (Lymph node)</p> <p>12.8 (Inguinal lymph nodes of a cadaver)</p> <p>12.9 (Lymph drainage of the right breast)</p> <p>12.10 (Tonsils)</p> <p>12.11 (Thymus gland)</p> <p>12.12 (The spleen)</p>		
12.7 Summarize three lines of defense against pathogens.	<p>III. Physiology of the lymphatic system</p> <p>A. Three lines of defense</p> <ol style="list-style-type: none"> <li>External barriers</li> <li>Inflammation, antimicrobial proteins, fever, and other active attacks.</li> <li>Specific immunity</li> </ol>	<p><b>WkBk Concept Maps:</b></p> <p>Figure 12.6 (Inflammation concept map)</p>	<p><b>WkBk Chapter Review Questions:</b></p> <ul style="list-style-type: none"> <li>MS: 4</li> </ul>

12.8 Contrast nonspecific resistance and specific immunity.	B. Nonspecific resistance versus specific immunity		<b>WkBk Chapter Review Questions:</b> <ul style="list-style-type: none"> <li>MS: 5</li> </ul>
12.9 Describe the body's nonspecific defenses.	<p>C. Nonspecific defenses</p> <ol style="list-style-type: none"> <li>External barriers             <ol style="list-style-type: none"> <li>Skin</li> <li>Mucous membranes</li> </ol> </li> <li>Inflammation, antimicrobial proteins, fever, and other attacks             <ol style="list-style-type: none"> <li>Inflammation                 <ol style="list-style-type: none"> <li>chemicals</li> <li>Margination</li> <li>diapedesis</li> <li>chemotaxis</li> <li>phagocytosis</li> </ol> </li> <li>Antimicrobial proteins</li> <li>Fever</li> <li>Other attacks</li> </ol> </li> </ol> <p><b>Chapter Figures:</b> 12.13 (The inflammatory response, illustrating margination, diapedesis, chemotaxis, and phagocytosis)</p>	<p><b>Talking Point:</b> Inflammation was introduced in Chapter 3. A short review of previous knowledge may be helpful. In this chapter, the discussion continues in greater depth.</p> <p><b>WkBk Lab Exercises and Activities:</b> Figure 12.3 (Inflammation)</p> <p><b>WkBk Concept maps:</b> Figure 12.6 (Inflammation concept map)</p>	<p><b>Spot Check:</b> 5-7</p> <p><b>WkBk Chapter Review Questions:</b></p> <ul style="list-style-type: none"> <li>Matching: 1-5</li> <li>Completion: 2, 3</li> </ul>

	12.14 (Graph of a fever) presentation)		
12.10 Explain the role of an APC in specific immunity.	<p>D. Specific immunity</p> <p><b>Chapter Figure:</b> 12.15 (Antigen-presenting cell in the process of antigen presentation)</p>	<p><b>WkBk Lab Exercises and Activities:</b> Table 12.1 (Specific immunity)</p>	<p><b>WkBk Chapter Review Questions:</b></p> <ul style="list-style-type: none"> <li>• MS: 6</li> <li>• Completion: 5</li> </ul>
12.11 Explain the process of humoral immunity.	<p>1. Humoral immunity</p> <p><b>Chapter Figures:</b> 12.16 (Humoral immunity) 12.17 (Graph of primary and secondary response in humoral immunity)</p>	<p><b>WkBk Lab Exercises and Activities:</b> Table 12.1 (Specific immunity)</p> <p><b>WkBk Concept maps:</b> Figure 12.7 (Humoral immunity concept map)</p>	<p><b>Spot Check:</b> 8, 9</p> <p><b>Quiz:</b> 2 (Covers LOs 12.8, 12.9 See Individual Outcome 12.9)</p> <p><b>WkBk Chapter Review Questions:</b></p> <ul style="list-style-type: none"> <li>• MS: 7</li> </ul>
12.12 Explain the process of cellular immunity.	<p>2. Cellular immunity</p> <p><b>Chapter Figures:</b> 12.18 (Cellular immunity) 12.19 (T cytotoxic cell attacking a cancer cell)</p>	<p><b>WkBk Lab Exercises and Activities:</b> Table 12.1 (Specific immunity)</p> <p><b>WkBk Concept maps:</b> Figure 12.8 (Cellular immunity concept map)</p>	<p><b>Spot Check:</b> 9</p> <p><b>WkBk Chapter Review Questions:</b></p> <ul style="list-style-type: none"> <li>• MS: 8</li> </ul>
12.13 Compare the different forms	3. Forms of acquired		<b>Spot Check:</b> 10

of acquired immunity.	immunity a. passive b. active c. natural i. natural active immunity ii. natural passive immunity d. artificial i. artificial active immunity ii. artificial passive immunity		<b><i>WkBk Chapter Review Questions:</i></b> <ul style="list-style-type: none"> <li>MS: 9</li> <li>Critical Thinking: 2</li> </ul>
12.14 Explain the importance of T <sub>helper</sub> cells to specific and nonspecific defense.	E. Importance of T <sub>Helper</sub> cells in nonspecific resistance and specific immunity  <b>Chapter Figures:</b> 12.20 (Importance of T helper cells)		<b><i>WkBk Chapter Review Questions:</i></b> <ul style="list-style-type: none"> <li>MS: 10</li> </ul>
12.15 Explain the functions of the lymphatic system.	F. Functions of the lymphatic system 1. Fluid balance 2. Lipid absorption 3. Defense against disease 4. Immunity		<b><i>WkBk Chapter Review Questions:</i></b> <ul style="list-style-type: none"> <li>Critical Thinking: 1</li> </ul>



	<b>Chapter Figure:</b> 12.21 (Andre)		
12.16 Summarize the effects of aging on the lymphatic system.	IV. Effects of aging on the lymphatic system		<b>WkBk Chapter Review Questions:</b> <ul style="list-style-type: none"> <li>• Critical Thinking: 2</li> </ul>
12.17 Describe common diagnostic tests used for lymphatic system disorders.	V. Diagnostic Tests for Lymphatic System Disorders <ul style="list-style-type: none"> <li>A. Bone marrow aspiration and biopsy</li> <li>B. CT</li> <li>C. Lumbar puncture</li> <li>D. Lymph node biopsy</li> <li>E. MRI</li> <li>F. NMRI</li> <li>G. WBC count</li> <li>H. WBC differentiation</li> <li>I. X-ray</li> </ul>		<b>Spot check</b> 11  <b>WkBk Case Study:</b> 1, 2, 3
12.18 Describe lymphatic system disorders and relate abnormal function to pathology.	VI. Lymphatic system disorders <ul style="list-style-type: none"> <li>A. Lymphoma</li> <li>B. Multiple myeloma</li> <li>C. Splenomegaly</li> <li>D. Allergies</li> <li>E. Autoimmune disorders</li> <li>F. Immunodeficiency</li> </ul>	<b>Group Activity:</b> HIV. See Individual Outcome 12.17.  <b>Discussion Point:</b> HIV. See Group Activity Individual Outcome 12.17.	<b>Spot check:</b> 12  <b>Quiz:</b> 3 (Covers LOs 12.10-12.15, 12.17 See Individual Outcome 12.17)  <b>WkBk Chapter Review Questions:</b>

	<p>disorders</p> <ol style="list-style-type: none"> <li>1. Congenital immunodeficiency disorder</li> <li>2. Acquired immunodeficiency disorder</li> </ol> <p><b>Table:</b> 12.2 (Summary of diseases and disorders of the lymphatic system)</p> <p><b>Chapter Figures:</b></p> <p>12.22 (Multiple myeloma in plasma cells from a bone marrow aspiration)</p> <p>12.23 (Infected T cell)</p> <p>12.24 (Kaposi sarcoma)</p>		<ul style="list-style-type: none"> <li>• Completion:1</li> <li>• Critical Thinking: 3</li> </ul>
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## INDIVIDUAL OUTCOMES

### OUTCOME 12.4

**Spot Check 1:** Where specifically will lymph in the tissues of the left leg reenter the bloodstream?

*Answer: The left subclavian vein.*

**Spot Check 2:** Which collecting duct delivers the lymph from the left leg to that location?

*Answer: The thoracic duct.*

**Discussion Point: 1.**

Chapter 11 IM included a discussion point concerning how the venous return of a grocery check-out person who had been working 4 hours is accomplished. In this chapter the discussion can be expanded to predict the effects of the working conditions given the students' knowledge of the lymphatic system.

*A grocery check-out person stands still for long hours. The lack of skeleton muscle movement not only hampers the venous return of blood, but also the return of lymph to the circulatory system from the lower extremities. Swelling of the ankles can be reasonably be expected.*

## **OUTCOME 12.6**

**Spot Check 3:** Red bone marrow is shown in Figure 12.6. Why is red bone marrow relevant to this system?

*Answer: It produces the cells used in this system (leukocytes, and specifically lymphocytes).*

**Spot Check 4:** Which lymph nodes may be tender to the touch if Megan has a strep throat infection?

*Answer: The cervical lymph nodes.*

**Group Activity:** Lymphoid tissues

Divide the class in groups of two. Give each group a large sheet of paper in which they can trace the outline of the head and torso of one of the group members. On their sheet of paper they are to sketch and label the following lymphatic tissues and whatever other anatomy is needed to set the lymphatic tissues in context. For example, some of the respiratory, digestive, urinary, and reproductive tracts need to be drawn in order to show MALT. A list of functions for each structure should accompany the drawing.

- **MALT** (mucosa associated lymphatic tissue)
  - Sprinkling of lymphocytes in mucous membranes and connective tissue
  - Found in the lining of the respiratory, digestive, urinary, and reproductive tracts
- **Lymph nodes** (filters along the lymph vessels)
  - Cervical→ inferior and dorsal to the ear
  - Axillary→ armpit and breast
  - Thoracic→along trachea and bronchi in thoracic region
  - Abdominal→along the aorta and mesenteric arteries
  - Pelvic→along iliac arteries and veins
  - Inguinal→ groin
- **Tonsils**
  - Palatine
  - Pharyngeal
  - Lingual
- **Thymus**
- **Spleen**
- **Lymph vessels**
- **Lymphatic ducts**
  - **Thoracic duct**
  - **Right lymphatic duct**

**Quiz: 1**

- |   |  |
|---|--|
| 1. What is the composition of lymph?                                      | <i>Plasma with less proteins</i>   |
| 2. How does lymph get out to the tissues?                                 | <i>Through capillary walls</i>   |
| 3. How is lymph moved through lymph vessels?                              | <i>Skeletal muscle movement massages lymph along the lymph vessels and valves in the lymph vessels prevent backflow.</i>                                   |
| 4. Where is lymph returned to the circulatory system?                     | <i>Subclavian veins</i>  |
| 5. How many tonsils in a human?   | <i>Single pharyngeal tonsil (adenoids), 2 palatine tonsils, and numerous lingual tonsils</i>   |
| 6. What are three functions of the spleen?                                | <i>Reservoir for red blood cells, destroys old worn out red blood cells, and produce blood cells in the fetus and in adults in cases of extreme anemia</i> |
| 7. How does the body accomplish those functions if the spleen is removed? | <i>There is no reservoir. Liver takes over as sole destroyer of old red blood cells</i>  |
| 8. What does the right lymphatic duct drain?                              | <i>Lymph from the right arm, right side of the head and neck, and the right thorax</i>   |
| 9. What is the function of a lymph node?                                  | <i>To filter lymph</i>   |
| 10. What is (are) the function(s) of a macrophage?                        | <i>To phagocytize bacteria, debris, and dead neutrophils, and to serve as APCs</i>   |

**OUTCOME 12.9**

**Spot Check 5:** How does inflammation help with tissue repair?

*Answer: Increased heat from increased blood flow raises the local metabolic rate to promote cell division.*

**Spot Check 6:** How does inflammation help to remove debris and damaged tissue?

*Answer: Increased amount of lymph washes away debris, and increased vessel permeability allows macrophages easier access to the area of damage for phagocytosis.*

**Spot Check 7:** How does inflammation limit the spread of pathogens?

*Answer: Increased vessel permeability allows leukocytes access to the area and chemotaxis draws leukocytes to the site of the damaged tissues and pathogens so they can be destroyed.*

**Quiz: 2**

1. How does specific immunity differ from nonspecific defenses?

*Specific immunity requires a previous exposure to learn, react to, and remember the foreign antigen. It responds faster and stronger on subsequent exposures. Nonspecific immunity always responds in the same manner and speed no matter what the exposure. It does not learn or remember the foreign antigen.*

2. What are the symptoms of inflammation?

*Redness, swelling, heat, pain*

3. What causes each of those symptoms?

*Vasodilation increases blood flow to area (red blood cells do not leave the vessel)... →.... redness and heat, Lymph leaks out of vessels... →...swelling, Extra lymph puts pressure on nerve endings... → pain*

4. What are the methods of nonspecific immunity?

*External barriers, inflammation, antimicrobial proteins, fever, and other active attacks*

5. What is diapedesis?

*Leukocytes crawling through the blood vessel wall*

6. What produces pyrogens?

*Macrophages*

7. What is a pyrogen?

*A chemical that causes the hypothalamus to raise the set point for body temperature (starts a fever)*

8. What cells secrete interferons?

*Virally infected cells*

9. What do interferons do?

*Encourage healthy cells to make antiviral proteins to protect themselves.*

10. What nonspecific defense includes 20 inactive proteins that are activated in the presence of a pathogen?

*Complement system*

**OUTCOME 12.11**

**Spot Check 8:** What method of attack do antibodies to blood-typing antigens (A, B, Rh) use? (*Hint:* See Chapter 9.)

*Answer: The antibodies agglutinate the antigens.*

**Spot Check 9:** How do the locations of the lymphocytes involved in humoral and cellular immunity differ during the attack on the pathogen?

*Answer: The B cell in humoral immunity is safe and secure in lymphoid tissue while antibodies attack the pathogen anywhere in the body. In cellular immunity, the  $T_{\text{Cytotoxic}}$  cell is at the site of the pathogen delivering a direct and lethal cell-to-cell hit.*

**OUTCOME 12.13**

**Spot Check 10:** Which of the four types of acquired immunity listed above is an injection of RhoGAM for Rh– mothers? (*Hint:* See Chapter 10.)

*Answer: Artificial passive immunity. RhoGAM is Rh antibodies.*

**OUTCOME 12.17**

**Spot Check 11:** How can imaging tests such as x-rays, MRIs and CT scans be used to help diagnose lymphatic system disorders?

*Answer: X-rays: can be used to view the spleen for splenomegaly. MRI can be used to detect any changes in the lymphatic organs. CT can also be used to detect any changes in the lymphatic organs.*

**Quiz: 3**

- |  |  |
|--|--|
| 1. What is an MHC molecule?                                | <i>Molecule on an Antigen presenting cell(APC) that displays an antigen (epitope) for <math>T_{\text{helper}}</math> cells to inspect</i>  |
| 2. What cells are involved in humoral immunity?            | <i>B cells and <math>T_{\text{helper}}</math> cells</i>  |
| 3. Where do most B cells reside?                           | <i>Lymphoid tissue (lymph nodes, tonsils, spleen, MALT, and Peyer's patches)</i>   |
| 4. Where are B cells cloned?                               | <i>Germinal cells in lymphoid tissue (lymph nodes, tonsils, spleen, MALT, and Peyer's patches)</i>   |
| 5. Which B cells make antibodies?                          | <i>Plasma B cells</i>  |
| 6. What form of acquired immunity is a RhoGAM injection?   | <i>Passive artificial immunity</i>   |
| 7. What releases interleukin?                              | <i><math>T_{\text{helper}}</math> cells</i>  |
| 8. What is the cell of choice for the HIV virus to invade? | <i>T cells</i>   |
| 9. What does the acronym AIDS mean?                        | <i>Acquired Immunodeficiency Deficiency Syndrome</i>   |
| 10. What is molecular mimicry?                             | <i>A possible explanation for the cause of autoimmune disorders in which self-cells are mistakenly seen as foreign because they are so similar in structure to an antigen the body has already fought.</i> |

**OUTCOME 12.17**

**Case Study:**

1. Explain why it takes 48 hours for the test to produce results. Why is the timing so important?

*Answer: If there had been a previous exposure to the tuberculin antigen, memory B cells would produce a peak amount of antibodies to fight the antigen within 2 days rather than the 13 to 16 days for a first exposure. Inflammation is a sign of the peak attack.*

2. What might inflammation at the injection site indicate?

*Answer: Inflammation may indicate that the patient has been previously exposed to the tuberculin bacterium or currently have tuberculosis.*



3. Explain why there would be inflammation at the site 48 hours after the test was administered if the individual had been previously exposed to the pathogen.

*Answer: If there had been a previous exposure to the tuberculin antigen, memory B cells would have been developed. This would have been the first exposure. Now that memory B cells are produced (due to the first exposure) they go into action right away (48 hours) instead of 2 or more weeks such as what occurs with the first exposure.*

## OUTCOME 12.18

**Spot Check 12:** Explain the difference in the following types of lymphatic system disorders: hypersensitivities, autoimmune disorders, and immunodeficiency disorders.

*Answer: hypersensitivities are an allergic reaction to a foreign antigen. An autoimmune disorder is a reaction to self-antigens. An immunodeficiency disorder is a situation where the immune system is not able to respond to foreign antigens.*

### Group Activity: HIV

Divide the class in groups. Develop a class list of questions to research concerning HIV or choose from the list below. The questions can be divided between the groups or each group can research all of the questions. The research then drives a whole class discussion.

- Who gets HIV infections?
- What is the prevalence of HIV in the state?
- What are the preventative measures to avoid HIV exposure?
- Where can one be tested in local area.?
- How do the tests work?
- What treatments can be given for an HIV infection?
- How do the treatments work?
- What is the prognosis for an HIV infection that is being treated versus untreated.

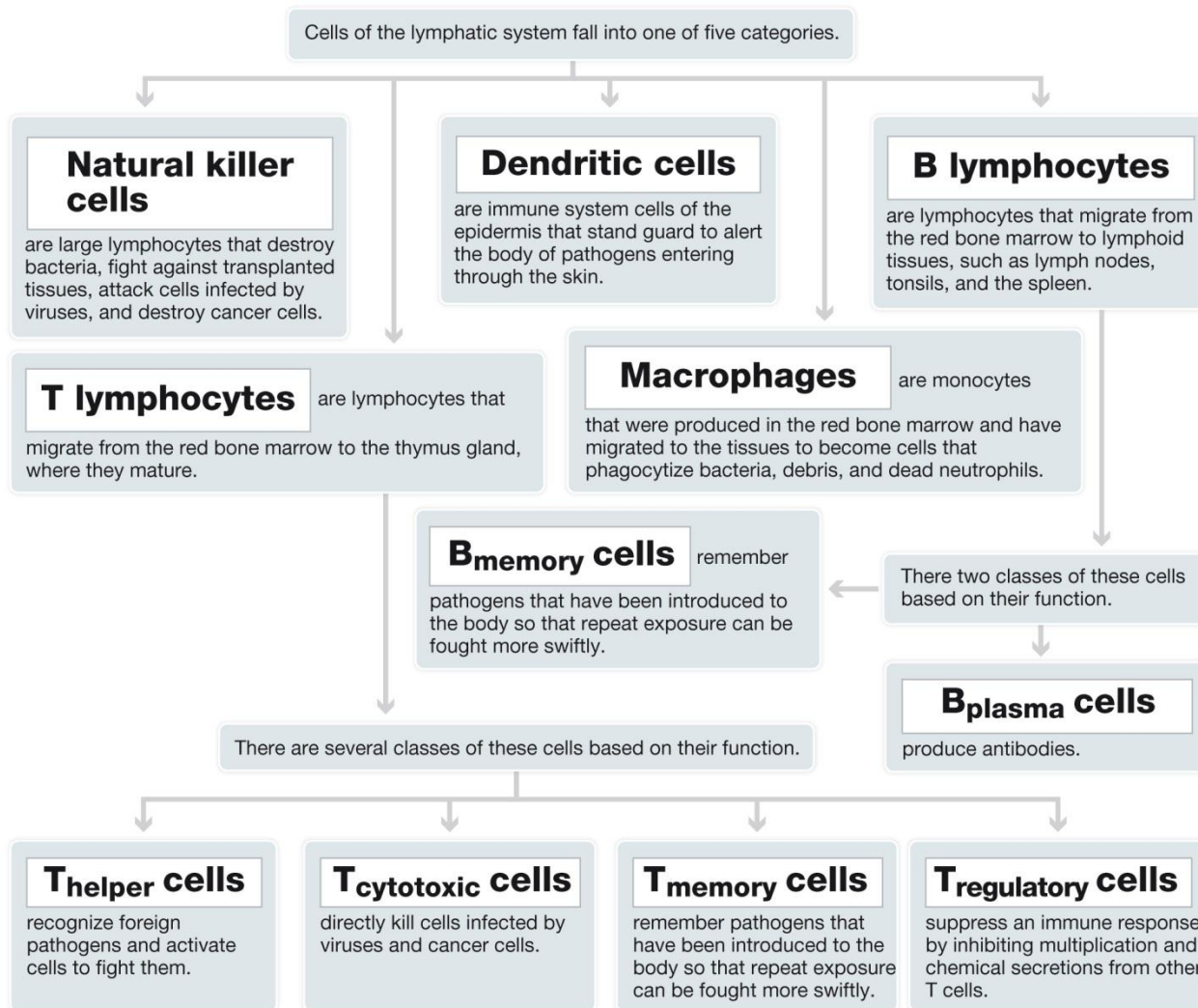
## ANSWER KEYS

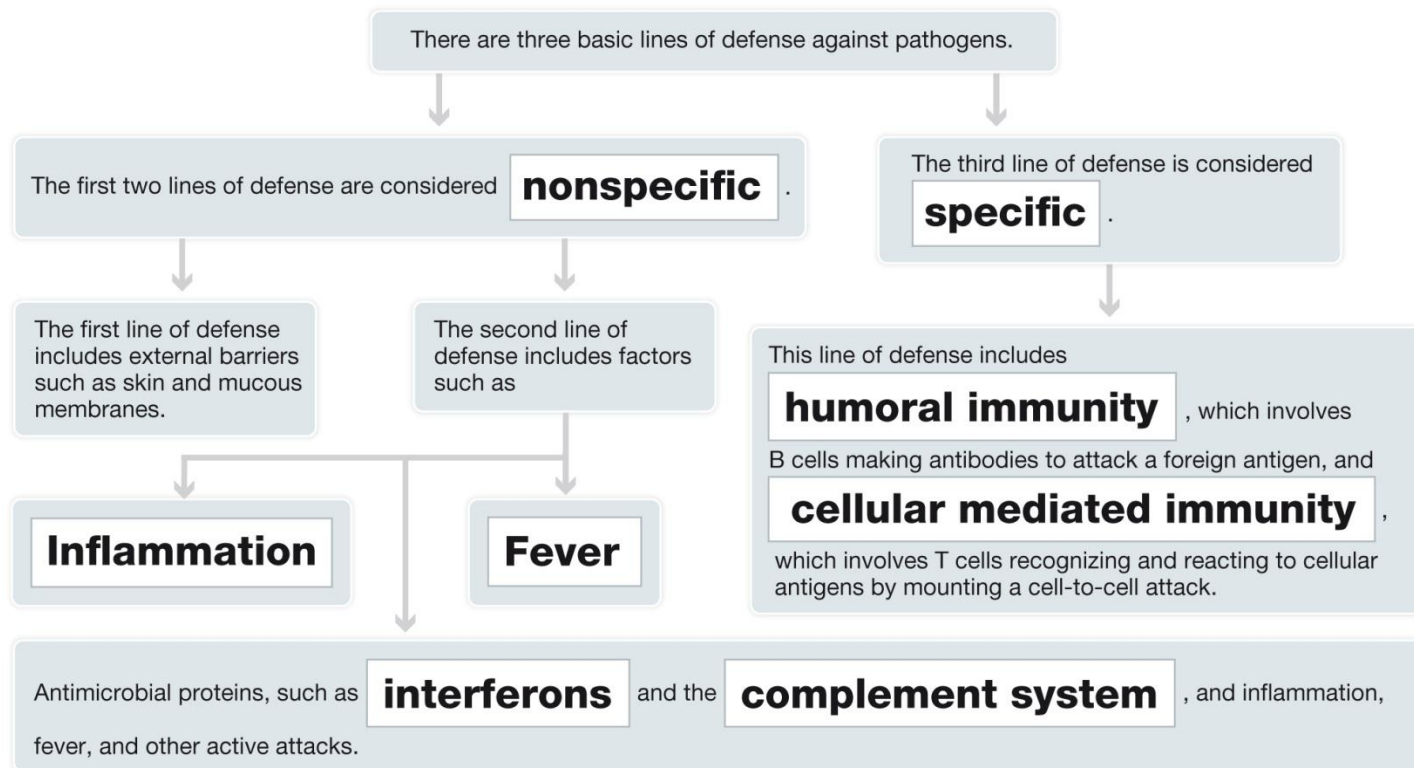
### Chapter Review Questions

1. C
2. B
3. A
4. C
5. A
6. A
7. A
8. B
9. D
10. C
11. D
12. A
13. B
14. C
15. B
16. B
17. B
18. A

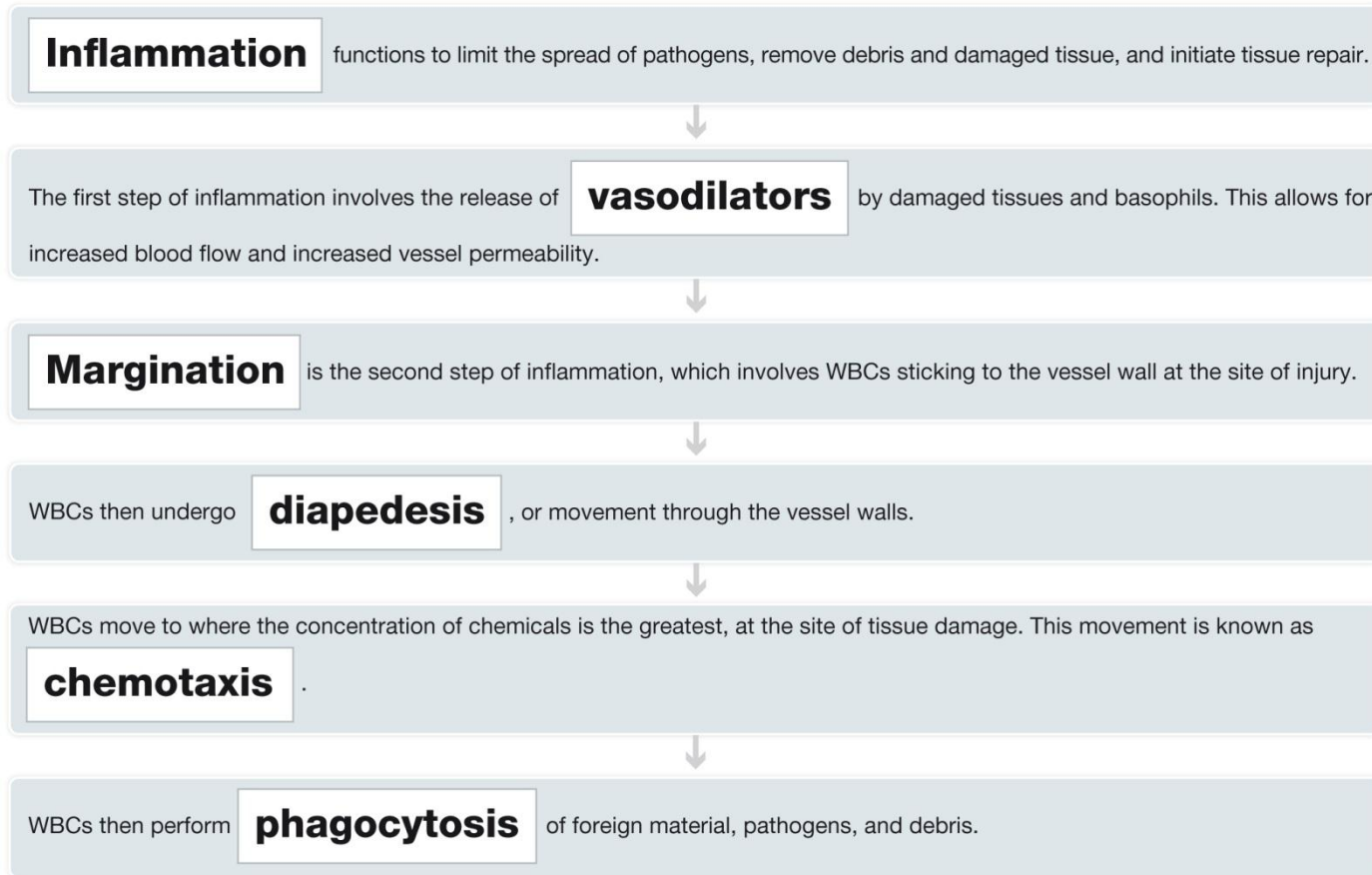
## WORKBOOK CONCEPT MAPS:

## Cells of the lymphatic system

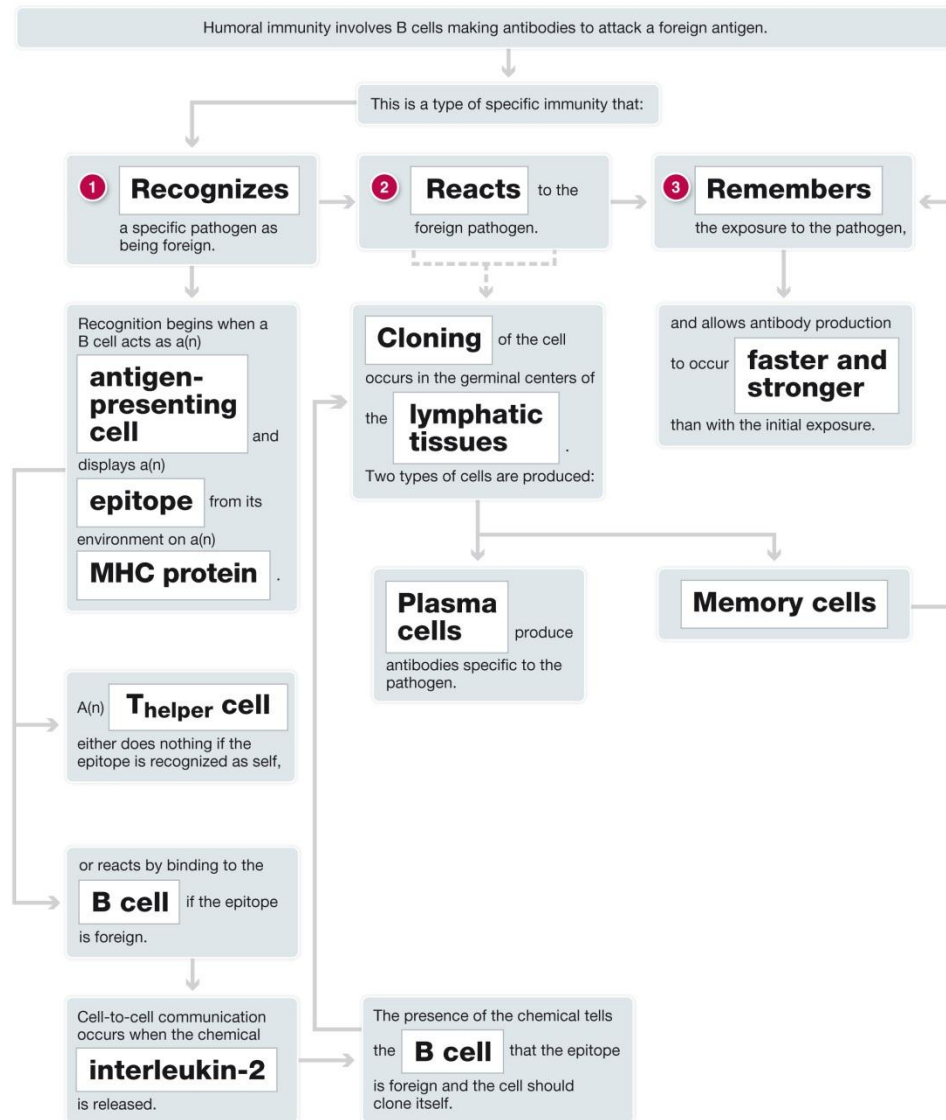


**Three lines of defense**

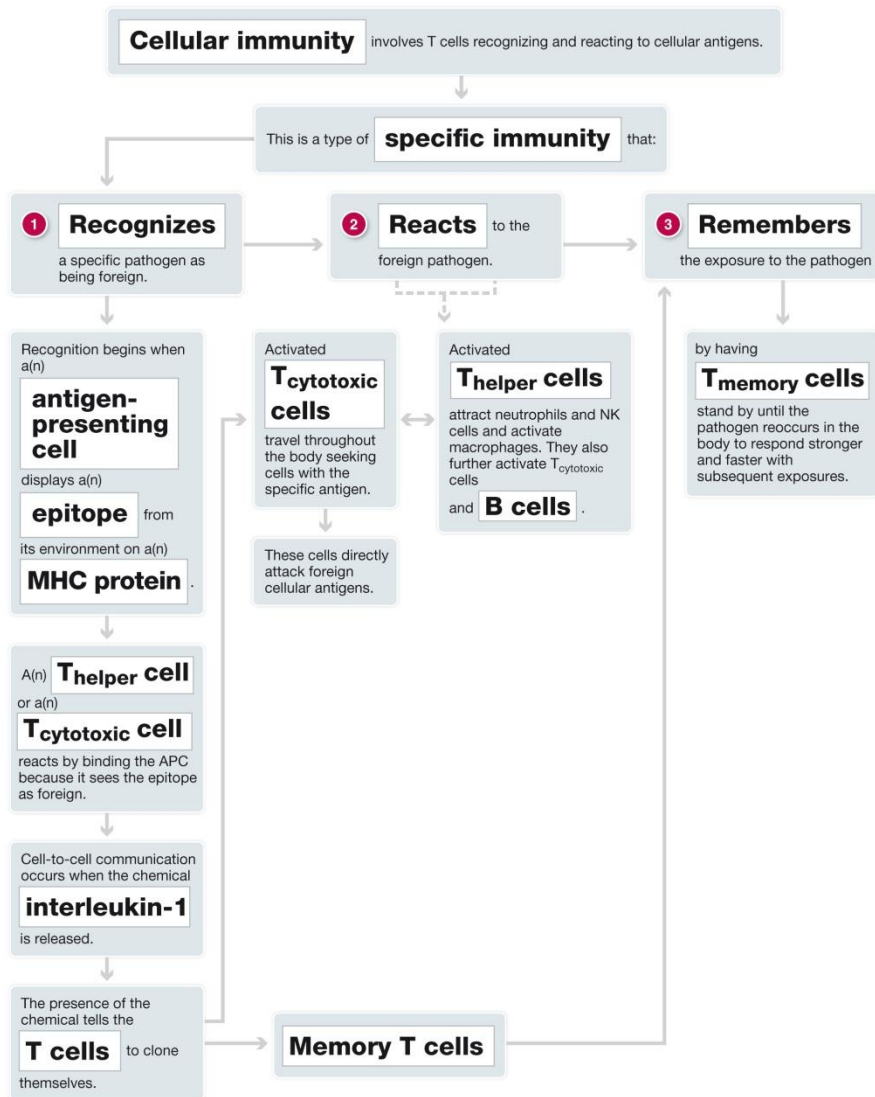
**Inflammation**



## Humoral Immunity



## Cellular immunity



**WORKBOOK CHAPTER REVIEW QUESTIONS:**

**Word Deconstruction:**

In the textbook, you built words to fit a definition using the combining forms, prefixes, and suffixes. Here you are to break down the term into its parts (prefixes, roots, and suffixes) and give a definition. Prefixes and suffixes can be found inside the back cover of the textbook.

FOR EXAMPLE Dermatitis: dermat/itis—inflammation of the skin

1. Thymic: Thym/ic, pertaining to the thymus gland

2. Lymphadenosis: Lymphaden/osis, condition of the lymph nodes

3. Lymphemia: Lymph/emia, a blood condition involving lymph

4. Immunology: Immuno/logy, study of immune system

5. Splenomegaly: Spleno/megaly, enlargement of the spleen



**Multiple Select:**

Select the correct choices for each statement. The choices may be all correct, all incorrect, or any combination of correct or incorrect.

1. What are the origin and composition of lymph?

- a. Lymph is plasma with the nutrients and wastes removed.
- b. Lymph is plasma with added proteins.
- c. Lymph is mostly water.*
- d. Lymph contains glucose.*
- e. Lymph contains carbon dioxide.*

2. How would you describe lymph vessels?

- a. Lymph capillary walls have three tunics.
- b. Collecting ducts are open-ended to receive lymph from the tissues.
- c. Vessels carrying lymph get larger before lymph is returned to the bloodstream.*
- d. Lymph vessels do not have valves.
- e. Lymph vessel walls contain smooth muscle that constricts to move lymph.

3. Which of the following statements pertain(s) to cells of the lymphatic system?

- a. T<sub>cytotoxic</sub> cells are important in humoral immunity and nonspecific defense.
- b. Neutrophils are important in nonspecific defense.*

c. Dendritic cells are found mostly in lymph nodes.

d. B cells are in constant circulation.

*e. B cells are produced in the red bone marrow and are cloned in germinal centers of lymph nodes.*

4. What are the three lines of defense?

*a. Mucous membranes are part of the first line of defense.*

b. Dendritic cells are important in the third line of defense.

c. Fever is controlled by the thalamus.

d. Fever helps speed cell division for tissue repair.

e. The complement system is 20 inactive proteins important for blood clotting.

5. How would you contrast specific and nonspecific defenses?

a. Specific immunity works only after nonspecific defenses have failed

b. Nonspecific defenses and specific immunity require a prior exposure to be effective.

c. B lymphocytes work in both nonspecific defense and specific immunity.

*d. T lymphocytes work in both nonspecific defense and specific immunity.*

*e. Macrophages work in both nonspecific defense and specific immunity.*

6. What is the role of APC in specific immunity?

*a. An APC samples its external environment.*

***b. An APC digests a sample from its external environment.***

c. An APC posts an MHC protein on its epitope.

d. An APC releases interleukin-2 if the sample is foreign.

e. An APC releases interleukin-1 if the sample is foreign.

7. How would you describe humoral immunity?

***a. Humoral immunity involves B and T cells.***

b. Humoral immunity results in direct cell-to-cell attacks.

c. Humoral immunity works against all pathogens equally.

***d. Humoral immunity results in the production of antibodies.***

e. Humoral immunity requires T<sub>cytotoxic</sub> cells.

8. How would you describe cellular immunity?

a. Cellular immunity involves B and T cells.

***b. Cellular immunity results in direct cell-to-cell attacks.***

c. Cellular immunity works against all pathogens equally.

d. Cellular immunity results in the production of antibodies.

***e. Cellular immunity requires T<sub>cytotoxic</sub> cells.***

9. Which of the following statements describe(s) a form of acquired immunity?

- a. A RhoGAM injection is an example of artificial active immunity.
- b. A RhoGAM injection is an example of natural passive immunity.
- c. Nursing an infant to provide the antibodies in breast milk is an example of natural active immunity.
- d. A flu nasal spray of weakened flu viruses is meant to provide natural active immunity.
- e. Catching the flu from your significant other should result in natural active immunity.*

10. What is the importance of T<sub>helper</sub> cells?

- a. T<sub>helper</sub> cells release interleukins.*
- b. T<sub>helper</sub> cells are necessary to recognize what is foreign.*
- c. T<sub>helper</sub> cells activate macrophages.*
- d. T<sub>helper</sub> cells release interferons.
- e. T<sub>helper</sub> cells release pyrogens.

### Matching:

Match the term to the correct definition.

- |   |                |
|---|----------------|
| <u>a</u> 1. Leukocytes stick to vessel walls. | a. Margination |
| <u>c</u> 2. Leukocytes move toward chemicals. | b. Histamine   |
| <u>d</u> 3. Leukocytes engulf (eat) bacteria. | c. Chemotaxis  |

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- \_\_\_*e*\_\_\_ 4. Leukocytes move through vessel walls. d. Phagocytosis
- \_\_\_*b*\_\_\_ 5. This chemical causes vasodilation. e. Diapedesis

### Matching:

Match the following structures to their functions. Some answers may be used more than once.

- \_\_\_*d*\_\_\_ 6. Collects lymph directly from tissues a. Thoracic duct
- \_\_\_*b*\_\_\_ 7. Contains valves to prevent back-flow b. Lymph vessel
- \_\_\_*e*\_\_\_ 8. Filters lymph c. Right lymphatic duct
- \_\_\_*a*\_\_\_ 9. Drains lymph from the left arm into a subclavian vein d. Lymph capillary
- \_\_\_*c*\_\_\_ 10. Drains lymph from the right arm into a subclavian vein e. Lymph node

### Completion:

Fill in the blanks to complete the following statements.

1. Autoimmune diseases may result from *molecular mimicry*, in which the immune system attacks self-antigens because they resemble foreign antigens previously fought.
2. Macrophages release *pyrogens* that cause the hypothalamus to raise the temperature set point.
3. Virally-infected cells may release *interferons* so that other healthy cells make antiviral proteins to protect themselves.

4. B cells, macrophages, and dendritic cells function as antigen presenting cells in the lymphatic system.
5. A(n) epitope is a piece of antigen from the external environment of an APC that is displayed on an MHC protein.

### Critical Thinking

1. What would be the effect on the functions of the lymphatic system if the thymus was removed from an infant? Explain. Specific immunity would not function due to loss of mature T cells. Non-specific resistance would be diminished.

2. As stated in the introduction to Chapter 11 in the text, Deborah is a 58-year-old woman who received a smallpox vaccination when she was 5 years old. What type of acquired immunity does she have for smallpox? Would it be effective today? Explain.

Artificial active immunity. Its effectiveness is questionable – although lymphocytes can live for decades, 53 years is a long time since the initial exposure for the memory cells to survive.

3. Dorothy went to the prom with Daniel in early May. It was the perfect date, and everything seemed magical. Even though they had not planned to have sex, they did. Because they had not planned for it, the sex was unprotected. Their human biology teacher began class the following week with a discussion of HIV. The discussion made Dorothy and Daniel anxious about their prom night, so they decided to be tested for HIV infection. Where could they be tested if they lived in your area? What is the test? When should they be tested? Do they need follow-up testing? Why or why not? What can they do in the future to reduce their risk of HIV infection? Explain.

Answers will vary as to where. HIV antibody test. Right away and again 6 months after possible exposure. It may take that long for sufficient antibodies to be developed to indicate an HIV infection. Abstinence or protected sex.

### Case Study:

1. The test shows a reaction if previously exposed to the tuberculin antigen. Second exposure to an antigen takes less time to react than first exposure. If previously exposed, a reaction should occur within 2 days rather than the 13 to 16 days for a first exposure.

2. Inflammation at the injection site indicates that the individual has likely been exposed to the tuberculosis bacteria.
3. If previously exposed to the tuberculin antigen, the memory B cells produce a peak amount of antibodies to fight the antigen within 2 days.