1. Concepts: Fill in the following sections with information from the text and lecture.

1. Lymphatic Vessels and Lymph Nodes:

2. Innate Body Defenses - Non-specific Defenses:
3. Adaptive Defenses - Humoral and Cell Mediated Immunity:
The lymphatic system, with its many lymphoid organs and vessels derived from veins of the cardiovascular system, is a rather strange system. Although both types of organs help to maintain homeostasis, these two elements of the lymphatic system have substantially different roles. The lymphatic vessels keep the cardiovascular system functional by maintaining blood volume. The lymphoid organs help defend the body from pathogens by providing operating sites for phagocytes and cells of the immune system.

The immune system, which serves as the body’s specific defense system, is a unique functional system made up of billions of individual cells, most of which are lymphocytes. The sole function of this defensive system is to protect the body against an incredible array of pathogens. In general, these “enemies” fall into three major camps:

(1) microorganisms (bacteria, viruses, and fungi) that have gained entry into the body, (2) foreign tissue cells that have been transplanted (or, in the case of red blood cells, infused) into the body, and (3) the body’s own cells that have become cancerous. The result of the immune system’s activities is immunity, or specific resistance to disease.

The body is also protected by a number of nonspecific defenses provided by intact surface membranes such as skin and mucosae, and by a variety of cells and chemicals that can quickly mount an attack against foreign substances. The specific and nonspecific defenses enhance each other’s effectiveness.

THE LYMPHATIC SYSTEM

Lymphatic Vessels

1. Complete the following statements by writing the missing terms in the answer blanks.

   Together the cardiovascular and lymphatic systems make up the circulatory system. Although the cardiovascular system has a pump (the heart) and arteries, veins, and capillaries, the lymphatic system lacks two of these structures: the a. ___________________ and b. ___________________. Like the c. ___________________ of the cardiovascular system, the vessels of the lymphatic system are equipped with d. ___________________ to prevent back-flow. The lymphatic vessels act primarily to pick up leaked fluid, now called e. ___________________, and return it to the bloodstream. About f. ________________ of fluid is returned every 24 hours.
2. Figure 12-1 provides an overview of the lymphatic vessels. In part A, the relationship between lymphatic vessels and the blood vessels of the cardiovascular system is depicted schematically. Part B shows the different types of lymphatic vessels in a simple way. First, label the following structures in Figure 12-1.

Heart Veins Lymphatic vessels/lymph node
Arteries Blood capillaries Loose connective tissue around blood and lymph capillaries

Then, identify by labeling these specific structures in part B:

Lymph capillaries Lymphatic collecting vessels Valves
Lymph (Thoracic) duct Lymph node Subclavian Vein

Figure 12-1
3. Figure 12-2 depicts several different lymphoid organs. Label all lymphoid organs indicated by a leader line and add labels as necessary to identify the sites where the axillary, cervical, and inguinal lymph nodes would be located. Box in the portion of the body that is drained by the right lymphatic duct.
4. Figure 12-3 is a diagram of a lymph node. First, label all structures on the diagram that have leader lines. Then, add arrows to the diagram to show the direction of lymph flow through the organ. Circle the region that would approximately correspond to the medulla of the organ. Finally, answer the questions that follow.

**Figure 12-3**

<table>
<thead>
<tr>
<th>Structure</th>
<th>Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germinal centers of follicles</td>
<td>Hilum</td>
</tr>
<tr>
<td>Cortex (other than germinal centers)</td>
<td>Afferent lymphatics</td>
</tr>
<tr>
<td>Medullary cord</td>
<td>Efferent lymphatics</td>
</tr>
<tr>
<td>Capsule</td>
<td>Subcapsular Sinus</td>
</tr>
<tr>
<td>Trabeculae</td>
<td>Medullary Sinus</td>
</tr>
</tbody>
</table>

a. Which cell type is found in greatest abundance in the germinal centers?

b. What is the function of their daughter cells, the plasma cells?

c. What is the major cell type in cortical areas other than the germinal centers?

d. The third important cell type in lymph nodes (usually found clustered around the medullary sinuses) are the ___________________________ These cells act as ___________________________

e. Of what importance is the fact that there are fewer efferent than afferent lymphatics associated with lymph nodes?
5. Figure 12-4 diagrams the events involved in the inflammatory response. Assume the following events have already occurred: tissue injury and invasion of microbes, and release of inflammatory chemicals by mast cells. Each subsequent event is represented by a square with one or more arrows. From the list below, write the correct number in each event square in the figure. Then, label the structures that appear below the numbered list.

- a. WBCs are drawn to the injured area by the release of inflammatory chemicals.
- b. Tissue repair occurs.
- c. Local blood vessels dilate, and the capillaries become engorged with blood.
- d. Phagocytosis of microbes occurs.
- e. Fluid containing clotting proteins is lost from the bloodstream and enters the injured tissue area.
- f. Margination and diapedesis occur.

#### List

- Monocyte
- Epithelium
- Erythrocyte(s)
- Neutrophil(s)
- Macrophage
- Subcutaneous tissue
- Endothelium of capillary
- Microorganisms
- Fibrous repair tissue

---

**Figure 12-4**

Miss School, Miss Out!
6. A schematic of the life cycle of the lymphocytes involved in immunity is shown in Figure 12-5. First, label the areas listed below on the figure. Then respond to the statements following the figure, which relate to the two-phase differentiation process of B and T cells.

A. Area where immature lymphocytes arise  
B. Area where T cells become immunocompetent  
C. Area where the antigen challenge and clonal selection are likely to occur  
D. Area seeded by immunocompetent B and T cells  
E. Area where B cells become immunocompetent

**Figure 12-5**

a. What signifies that a lymphocyte has become immunocompetent?

b. During what period of life does immunocompetence develop?

c. What determines which antigen a particular T or B cell will be able to recognize?
   A. its genes or  
   B. "its" antigen

d. What triggers the process of clonal selection in a T or B cell?
   A. its genes or  
   B. binding to "its" antigen

e. During development of immunocompetence, the ability to tolerate ___________________________ must also occur if the immune system is to function normally.
7. Figure 12-7 is a flowchart of the immune response that tests your understanding of the interrelationships of that process. Several terms have been omitted from this schematic.

**Figure 12-7**
8. T cells and B cells exhibit certain similarities and differences. Check (✓) the appropriate spaces in the table below to indicate the lymphocyte type that exhibits each characteristic.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>T cell</th>
<th>B cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>Originates in bone marrow from stem cells called hemocytoblasts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Progeny are plasma cells</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Progeny include regulatory, helper, and cytotoxic cells</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Progeny include memory cells</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is responsible for directly attacking foreign cells or virus-infected cells</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Produces antibodies that are released to body fluids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bears a cell-surface receptor capable of recognizing a specific antigen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forms clones upon stimulation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accounts for most of the lymphocytes in the circulation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DISORDERS OF IMMUNITY**

10. Using the key choices, identify the type of immunity disorder described. Insert the appropriate term or letter in the answer blank.

**Key Choices**

<table>
<thead>
<tr>
<th>Allergy/Hypersensitivity</th>
<th>Autoimmune disease</th>
<th>Immunodeficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. _____________________</td>
<td>AIDS</td>
<td></td>
</tr>
<tr>
<td>b. _____________________</td>
<td>The immune system mounts an extraordinarily vigorous response to an otherwise harmless antigen</td>
<td></td>
</tr>
<tr>
<td>c. _____________________</td>
<td>A poison ivy reaction</td>
<td></td>
</tr>
<tr>
<td>d. _____________________</td>
<td>Occurs when the production or activity of immune cells or complement is abnormal</td>
<td></td>
</tr>
<tr>
<td>e. _____________________</td>
<td>The body’s own immune system produces the disorder; a breakdown of self-tolerance</td>
<td></td>
</tr>
<tr>
<td>f. _____________________</td>
<td>Affected individuals are unable to combat infections that would present no problem for normally healthy people</td>
<td></td>
</tr>
<tr>
<td>g. _____________________</td>
<td>Multiple sclerosis and rheumatic fever</td>
<td></td>
</tr>
<tr>
<td>h. _____________________</td>
<td>Hay fever and contact dermatitis</td>
<td></td>
</tr>
<tr>
<td>i. _____________________</td>
<td>Typical symptoms of the acute response are tearing, a runny nose, and itching skin</td>
<td></td>
</tr>
</tbody>
</table>

Miss School, Miss Out!
12 The Lymphatic System and Body Defenses

Crossword Puzzle

Across
1. Process during which a B cell or T cell becomes sensitized through binding contact with an antigen.
4. A protein molecule, released by plasma cells, that mediates humoral immunity; an antibody.
6. Immunity produced by an encounter with an antigen; provides immunologic memory.
7. Type of T lymphocyte that orchestrates cellular immunity by direct contact with other immune cells and by releasing chemicals called lymphokines.
10. Short-lived immunity resulting from the introduction of “borrowed antibodies” obtained from an immune animal or human donor; immunologic memory is not established.
11. Clumping of (foreign) cells; induced by cross-linking of antigen-antibody complexes.
12. An agent or chemical substance that induces fever.
13. Immunity conferred by antibodies present in blood plasma and other body fluids.

Down
1. A group of blood-borne proteins, which, when activated, enhance the inflammatory and immune responses and may lead to cell lysis.
2. Ability of the body’s immune cells to recognize (by binding) specific antigens; reflects the presence of plasma membrane-bound receptors.
3. A nonspecific defensive response of the body to tissue injury; includes dilation of blood vessels and an increase in vessel permeability; indicated by redness, heat, swelling, and pain.
5. Proteins involved in cell-mediated immune responses that enhance immune and inflammatory responses.
6. A substance or part of a substance (living or nonliving) that is recognized as foreign by the immune system, activates the immune system, and reacts with immune cells or their products.
8. Endocrine gland active in immune response.
9. Small lymphatic organ that filters lymph; contains macrophages and lymphocytes.

Miss School, Miss Out!
The Lymphatic System consists of:

1. 
2. 
3. Lymph Nodes
4. 
5. 
6. 
7. 

The Lymphatic System and Body Defenses:

1st Line of Defense

8. 
9. 
10. 
11.

2nd Line of Defense

12. 
13. 
14. T-Cells
15. B-Cells

3rd Line of Defense

16. 
17. 
18. 
19. 

Autoimmune Disorders

20. 
21. 
22. 
23. 
24. 
25. 

B-Cells

memory B-Cells

most important

12. 
13. 
14. 
15. 

Miss School, Miss Out!