CHAPTER 15
THE IMMUNE SYSTEM

CHAPTER SCOPE

An efficient and effective **immune system** that can defend the body against invading pathogens, mediate local inflammatory responses, reject tissue transplants, and provide immunological surveillance against cancer, requires the cooperation and complex interaction of many tissues located throughout the body. In this chapter, many of the circulating white blood cells, or *leukocytes* initially introduced with blood in chapter 13 will play *direct* defense roles calling for actual contact with and destruction of (*phagocytosis*) potentially disease-causing foreign particles. Certain leukocyte cell populations such as the **T** and **B lymphocytes** and **monocytes** will be involved in overall body defense against invasions. Monocytes that are activated by exposure to foreign antigen molecules transform into aggressive *macrophages*. The defensive role of other leukocyte cells is *indirect* since the activation of each cell type produces specific chemicals such as **antibodies** and **lymphokines** and others that operate as part of the immune defense system.

To help explain the complex communication network that connects the various immune cell types and the logistical details that must exist to carry out immune defense, many new concepts are described. Some of the mechanisms presented here include *innate* (*nonspecific*) and *adoptive* (*specific*) forms of *immunity, antigen-antibody reactions, immunological tolerance, active* and *passive immunity, clonal selection theory, monoclonal antibody formation, tumor immunology*, and *autoimmunity*.

The last section discusses specific diseases caused by immune system disorders. These clinical cases of breakdown in the immune system's formidable defensive methods will serve as a teaching tool to help clarify some of these complex interactions required to keep us healthy. Like many other examples of homeostasis in the body such as heart rate, blood pH, and breathing, these defensive actions of the immune system that maintain a healthy body largely go unnoticed and certainly unappreciated. Since most of us are exposed daily to many potentially pathogenic substances, it seems truly remarkable that our immune system seldom malfunctions such that illness is the ultimate result.

I. DEFENSE MECHANISMS

Nonspecific immune protection is provided by such mechanisms as phagocytosis, fever, and the release of interferons. Specific immunity, which involves the functions of lymphocytes, is directed at specific molecules, or parts of molecules, known as antigens.

A. Multiple Choice

___ 1. Which defense mechanism is *not* in either the external or the internal category of *innate*, or *nonspecific* immunity?
   a. epithelial membranes (skin) that cover the body surfaces
   b. strong acidity of gastric juice (pH of 1 to 2)
   c. phagocytosis of pathogen-associated molecular patterns (PAMPs)
   d. recruitment and activation of lymphocyte cell populations
   e. All of these defense mechanisms are innate, or nonspecific.

___ 2. Which cell type does *not* participate in phagocytosis?
   a. neutrophils within the blood and all tissues
   b. monocytes within the blood
   c. macrophages within the connective tissues (histiocytes)
   d. Kupffer cells that are "fixed" within the liver
   e. lymphocytes within the blood

___ 3. The highly mobile cells that are the first to arrive at the site of an infection, are the
   a. neutrophils
   b. monocytes
   c. macrophages
   d. basophils
   e. lymphocytes

___ 4. Which organelle is found within phagocytic cells that contain powerful digestive enzymes, which participate directly in the process of phagocytosis?
   a. nucleus
   b. mitochondrion
   c. endoplasmic reticulum
   d. lysosome
   e. Golgi apparatus

___ 5. The thermoregulatory control center or "thermostat" that regulates the body's response to changes in temperature such as during a fever, is located in the
   a. hypothalamus.
   b. pituitary.
   c. cerebral cortex.
   d. adrenal gland.
   e. thyroid gland.

___ 6. Which statement about *haptens* is *false*?
   a. They are small organic molecules that are not antigenic by themselves.
   b. Bonded to protein, haptens can become antigenic.
   c. Bonded to protein, haptens are available for research or diagnostic purposes.
   d. They are able to attract phagocytes (chemotaxis).
   e. All of these statements about haptens are true.

___ 7. The clumping of antigen-to-antibody particles during an immunoassay such as the modern pregnancy test, is known as
   a. clustering.
   b. agglutination.
   c. chemotaxis.
   d. diapedesis.
   e. hapten formation.

___ 8. Populations of lymphocytes known as **B lymphocytes**
   a. secrete antibodies into blood and lymph fluids.
   b. are said to provide cell-mediated immunity.
   c. attack host cells infected with viruses, fungi, or cancer cells.
   d. are originally derived from the thymus gland.
   e. must come into close contact with infected cells to destroy them.

___ 9. The gland located under the sternum that is seeded by lymphocytes from the fetal liver and spleen, and after birth from the bone marrow, that gradually regresses after puberty, is the
   a. thymus.
   b. thyroid.
   c. tonsils.
   d. pineal.

___ 10. Which of the following is *not* considered a secondary lymphoid organ?
   a. tonsils
   b. Peyer's patches (under the intestinal mucosa)
   c. liver
   d. spleen
   e. lymph nodes

___ 11. Which of the following events best represents the *innate* (nonspecific) mechanism of an inflammatory reaction that follows the entry of bacteria through a break in the skin?
   a. B lymphocytes are activated to produce specific antibodies
   b. histamine vasodilation and increased capillary permeability
   c. phagocytosis by neutrophils and macrophages; with the activation of complement protein
   d. chemotaxis and extravasation of new phagocytes to the infected area
   e. opsonization or "buttering" antibodies onto foreign cells such as bacteria

___ 12. During local inflammation activated monocytes are converted into macrophages that are responsible for
a. ingesting microorganisms and fragments of extracellular matrix.
b. phagocytosis of extracellular matrix fragments.
c. producing nitric oxide to help destroy bacteria.
d. release of lysosomal enzymes to destroy leukocytes and other tissues cells.
e. All of these are actions of activated monocytes-macrophages.

___ 13. Which symptom is *not* characteristic of local inflammation?
a. redness
b. warmth
c. swelling (edema)
d. pus formation
e. All of these are characteristic responses to local inflammation.

B. True or False/Edit

___ 14. The process of phagocytosis such as that which follows the exposure of lipopolysaccharides (LPS) in the membranes of gram-negative bacteria or peptidoglycans in the cell walls of gram-positive bacteria is an integral part of both specific and nonspecific immune defense activities.

___ 15. *Specific* immune response refers to the selective action of lymphocytes that is acquired after a prior exposure to a particular disease-causing agent (pathogen).

___ 16. Blood flowing through capillaries of the liver and spleen encounter "fixed" phagocytic cells that remove invading pathogens, rendering the blood sterile after a few passes through those organs.

___ 17. *Chemotaxis* refers to the movement of erythrocytes to the site of an infection, lured by chemical attractants.

___ 18. *Macrophages* are neutrophils that have transformed and become phagocytic after exposure to some foreign substance at the site of an infection.

___ 19. *Diapedesis* refers to the sequential movement of large phagocytic cells from the blood as they squeeze between adjacent endothelial cells of postcapillary venules and into the tissue spaces.

____ 20. Body cells can signal attack by macrophages and commit suicide (*apoptosis*) by displaying a normally hidden internal membrane phospholipid molecule called *phosphatidylserine* on their surface.

___ 21. Many fevers result from exposure to certain bacteria, which release *endogenous pyrogen* molecules that in turn stimulate leukocytes to release chemicals known as *endotoxins*.

___ 22. *Interferons* are polypeptides produced in small amounts by host cells infected with one virus, which can then interfere with the ability of a second, unrelated strain of virus to infect other cells in the same host.

___ 23. There are three major categories of short-acting, nonspecific *interferons*: alpha, beta, and gamma.

___ 24. Most antigens are polysaccharides because of their large size and their complex structure.

___ 25. Each antigen molecule triggers the formation of one and only one type of antibody molecule that is specific for that antigen.

___ 26. About 65% to 85% of circulating lymphocytes in the blood and most of the lymphocytes in the germinal centers of lymph nodes and spleen are **B lymphocytes**.

___ 27. Since the bone marrow produces T lymphocytes and the thymus produces B lymphocytes, the bone marrow and thymus are considered to be primary lymphoid organs.

___ 28. Unlike the shorter five-day to seven-day life span of the B lymphocyte, the small T lymphocyte has a longer life that spans months or years, especially those that have not yet been stimulated.

___ 29. Heparin, an anticoagulant and histamine, a vasodilator and bronchoconstrictor are just two of a variety of molecules released by activated mast cells.

___ 30. With a time delay, activated monocytes or macrophages secrete *tumor necrosis factor* (TNFa) that acts as a chemokine to recruit neutrophils to the infected site.

___ 31. If allowed to go untreated, local infections may result in a fever when endogenous pyrogen molecules are released from leukocytes and macrophages.

___ 32. In certain diseases such as Alzheimer's disease, asthma, or type 1 diabetes mellitus, the inflammatory processes required to protect the body can inflict more harm than the pathogens themselves.

II. FUNCTIONS OF B LYMPHOCYTES

B lymphocytes secrete antibodies that can bind to antigens in a specific fashion. This bonding stimulates a cascade of reactions whereby a system of plasma proteins called complement is activated. Some of the activated complement proteins kill the cells containing the antigen; others promote phagocytosis, resulting in a more effective defense against pathogens.

A. Multiple Choice

___ 33. Which plasma protein does *not* form a distinct band in the *globulin* class during electrophoresis of blood?
   a. fibrinogen
   b. albumin
   c. alpha-1 globulin
   d. beta globulin
   e. gamma globulin

___ 34. Which is *not* a subclass of *immunoglobulins*?
   a. IgA
   b. IgB
   c. IgD
   d. IgE
   e. IgM

___ 35. Which subclass of immunoglobulin molecules mediates allergic reactions?
   a. IgA
   b. IgB
   c. IgD
   d. IgE
   e. IgM

___ 36. Which statement about the *complement system* of serum proteins is *false?*
   a. Complements are inactive serum proteins until activated by antibodies.
   b. In the classic pathway, IgG and IgM antibodies bind to antigens on the invading cell's membrane.
   c. Complement protein function components are recognition, activation, and attack, in that order.
   d. The recognition phase consists of complement fixation, in which complement proteins attach to the cell membrane and destroy the victim cell.
   e. In the alternative pathway of complement activation, the initial steps involve coating bacterial cells with polysaccharides but the final steps are the same as those of the classic pathway.

___ 37. The $C3_a$ and $C5_a$ proteins dilate blood vessels and increase capillary permeability by stimulating mast cells to secrete
   a. complements $C^5{}_b$ through C9.
   b. histamine.
   c. IgG antibodies.
   d. gamma globulin.
   e. complements C4, C2, and C3

___ 38. Which of the following effects is *not* due to the action of complement fragments that wander into the tissue fluids surrounding a bacterial invasion.
   a. formation of a membrane attack complex
   b. chemotaxis or attraction of phagocytic cells
   c. opsonization of bacterial cells to enhance phagocytosis
   d. stimulation of mast cells and basophils to release histamine

B. True or False/Edit

___ 39. *B lymphocytes* exposed to antigens can transform into *plasma cells* — cell factories that live for about a week, releasing about two thousand specific antibody proteins per second.

___ 40. Most of the immunoglobulins in serum are in the IgA subclass, whereas most of the antibodies in external secretions, such as saliva and milk, are in the IgG subclass.

___ 41. All antibodies have a "Y" shape composed of four interconnected protein chains, with the "fork" region serving as antigen-binding fragment and the "stalk" region the crystallizable fragment.

___ 42. That portion of the antibody that binds specifically to the antigen is the called the F_{ab} region or the constant stalk region of the antibody molecule.

___ 43. The classic and alternative pathways of complement activation start differently but converge at the step where C3 is cleaved into $C3_a$ and $C3_b$.

___ 44. During the attack phase, complement proteins C4, C2, and C3 form a membrane attack complex – a large pore that allows the osmotic influx of water that can kill the bacterial cell.

___ 45. In the destruction of a bacterial cell by complement proteins, it is important to note that the antibodies, not the complement proteins, directly kill the cell.

___ 46. Histamine causes vasodilation and increased capillary permeability allowing plasma proteins to leak out and into the tissue fluid, causing localized swelling or edema.

C. Label the Figure — The Events of Local Inflammation

A wood sliver, a bug bite, a skin scratch, or scrape — at some time all of us have experienced a local inflammatory reaction such as these. Study the sequence of events that occur following the entry of bacteria through a cut in the skin, producing the local inflammatory reaction. Notice the reaction occurs in the dermis, outside the capillary yet many of the cells involved are recruited from the blood. Name the cells that produce antibodies and those that secrete histamine. Refer to figure 15.5 in your text for help, OK?

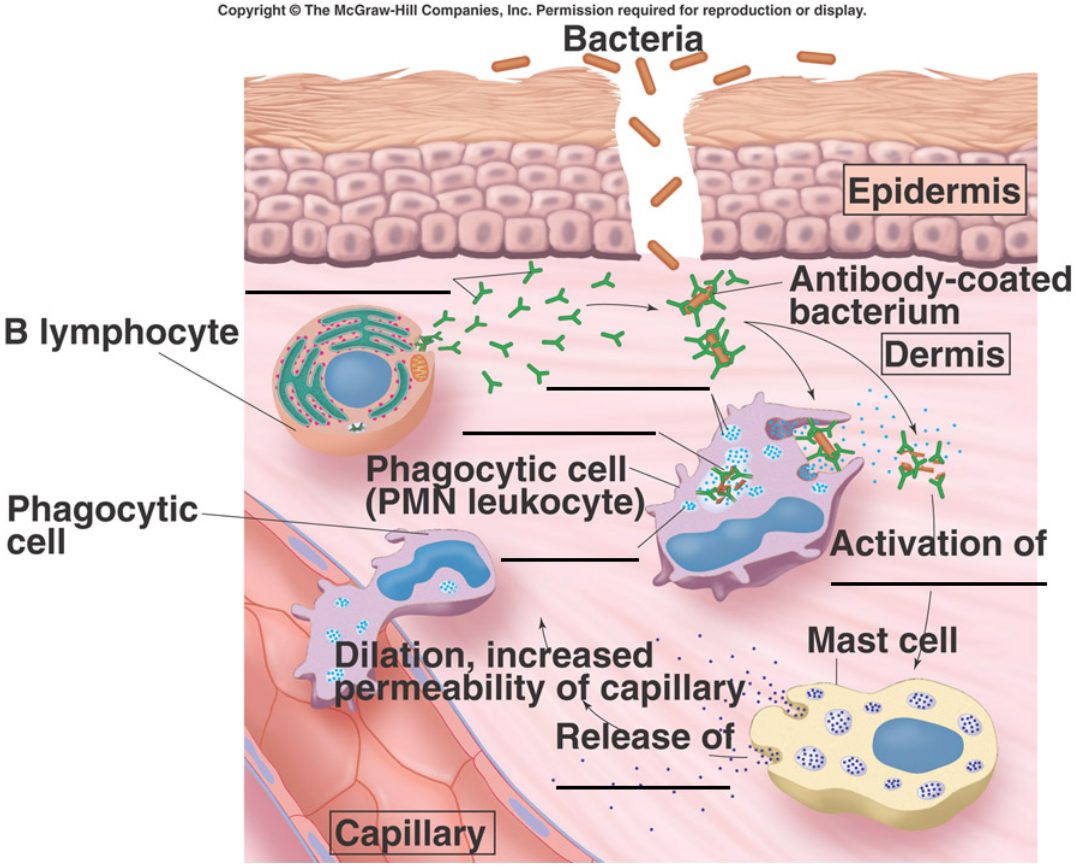

Figure 15.1 The events of a local inflammation.

III. FUNCTIONS OF T LYMPHOCYTES

Each subpopulation of T lymphocytes has specific immune functions. Killer T cells affect cell-mediated destruction of specific victim cells, and helper and suppressor T cells play supporting roles. T cells are activated only by antigens presented to them on the surface of particular antigen-presenting cells. Activated helper T cells produce lymphokines that stimulate other cells of the immune system.

A. Multiple Choice

___ 47. Which of the following does *not* describe killer, or cytotoxic T lymphocytes?
a. They can be identified in the laboratory by a surface molecule called CD8.
b. Their function is to kill at a distance through secretion of antibodies.
c. They secrete perforins and enzymes called granzymes.
d. Part of their destruction of victim cells involves the activation of caspase enzymes that are involved in apoptosis.
e. They kill their victim cells by cell-mediated destruction.

___ 48. Which function is *not* characteristic of T lymphocytes?
a. attacking virus and fungal infections
b. stimulating the direct formation of antibodies
c. carrying out rejection of transplants
d. patrolling the body as defense against cancer
e. All of these are T lymphocyte functions.

___ 49. The subpopulation of T lymphocytes that is attacked by the human immunodeficiency virus (HIV) in persons with AIDS is that group known as
a. helper T cells.
b. suppressor T cells.
c. cytotoxic T cells.
d. killer T cells.

___ 50. The word used to describe autocrine proteins secreted by T lymphocytes that are often referred to as the cytokines of lymphocytes, is the term
a. interleukins.
b. interferons.
c. lymphokines.
d. antibodies.

___ 51. The two cell types that are most responsible for engulfing and presenting foreign antigens together with surface histocompatibility antigens on the membrane for the activation of helper T lymphocytes, are macrophages and
a. B lymphocytes.
b. dendritic cells.
c. platelets.
d. neutrophils.
e. mast cells.

___ 52. The membrane surface molecules that are carefully matched between a donor and the recipient to avoid organ transplantation rejection, are called
a. histocompatibility antigens.
b. lymphokines.
c. interleukins.
d. interferons.
e. antibodies.

___ 53. Genes labeled A, B, C, and D, located on chromosome number 6, are unique, in that they
a. comprise the major histocompatibility complex (MHC).
b. produce two classes of human leukocyte antigens (HLA), called class-1 and class-2 antigens.
c. genetically mark the membrane surface of all tissue cells in the body (except mature red blood cells) with characteristic antigens.
d. are involved in activating macrophages, B lymphocytes, T cells, and other cells of the immune system.
e. All of these statements are correct regarding the genes.

___ 54. Which specific type of molecule is *not* secreted by helper T cells following their activation by antigen-presenting macrophages?
a. macrophage colony-stimulating factor
b. gamma interferon
c. tumor necrosis factor
d. interleukin-2
e. All of these molecules are secreted by activated helper T cells.

___ 55. After an infection has been cleared and the activated T lymphocytes have been destroyed, the FAS surface receptor on T cells binds to FAS ligand, resulting in
   a. apoptosis (cell suicide) of the lymphocytes.
   b. further activation and secretion of lymphokines.
   c. the formation of "memory" cells to prevent later reinfection.
   d. turning off the activation, with a return of the lymphocyte to its former state.

B. True or False/Edit

___ 56. Unlike T cells, B lymphocytes provide specific immune protection without secreting antibodies.
___ 57. Most bacterial infections in the body are fought indirectly by antibodies released from B cells (humoral) rather than direct contact by T lymphocytes (cell-mediated) – (one exception: attack on the tubercle bacilli).
___ 58. The activity of B cells and cytotoxic T cells is decreased by helper T lymphocytes and increased by suppressor T lymphocytes.
___ 59. Acquired immune deficiency syndrome (AIDS) that has killed more Americans than were killed in both World Wars, appears to be caused by a virus that specifically attacks and destroys the killer T lymphocyte subpopulations.
___ 60. The T lymphocytes secrete lymphokines and other cells such as macrophages secrete other proteins called cytokines that help regulate many aspects of the immune system.
___ 61. There appears to be two subtypes of *helper* T lymphocytes — the **T_H1** subtype that secretes lymphokines that activate killer T cells and promotes humoral immunity; and the **T_H2** subtype that stimulates B lymphocyte to promote cell-mediated immunity.
___ 62. In order for a *helper* T lymphocyte to respond to a foreign antigen, that antigen must be attached to the membrane of another cell such as a macrophage or a dendritic cell, and thereby be "presented" to the *helper* T lymphocyte.
___ 63. Synthesis of the histocompatibility antigens is directed by a group of four genes labeled A, B, C, and D that are located on chromosome number 6; and are known as the *major histocompatibility complex* (MHC).
___ 64. *Class-2* MHC molecules are protein molecules coded for by histocompatibility genes A, B, C, and D that are ultimately placed on the plasma membrane of all cells in the body except those of mature red blood cells.
___ 65. The coreceptor protein known as **CD8** is associated with the killer T lymphocyte membrane receptor and the coreceptor protein known as **CD4** is associated with the helper T lymphocyte membrane receptor.
___ 66. *Helper* T lymphocytes are normally activated by contact with macrophages "presenting" both the foreign antigens and the local class-2 MHC antigens already present on their membrane surfaces.
___ 67. *Interleukin-2* secreted by activated helper T lymphocytes stimulates macrophages to secrete *tumor necrosis factor*, an agent that is particularly effective in killing cancer cells.
___ 68. The *glucocorticoids* such as *cortisone* inhibit the secretion of cytokines and thus are used clinically to treat inflammatory disorders and to inhibit the rejection of transplanted organs.

IV. ACTIVE AND PASSIVE IMMUNITY

When a person is first exposed to a pathogen, the immune response may be insufficient to combat the disease. In the process, however, the lymphocytes that have specificity for that antigen are stimulated to divide many times and produce a clone. This is active immunity, and it can protect the person from getting the disease upon subsequent exposures.

A. Multiple Choice

___ 69. Which of the following descriptions is a characteristic part of the *secondary* response?
   a. It represents the response to an initial exposure of that pathogen.
   b. The latent period between the secondary exposure and the appearance of antibodies is about 5-10 days.
   c. Antibody concentrations during this response reach a plateau in a few days and decline after a few weeks.
   d. The production of antibody can reach a maximum in less than two hours and is maintained for a long time.

___ 70. The *clonal selection theory* helps to explain
a. the primary immune response.
b. the secondary immune response.
c. the secretion of monoclonal antibodies.
d. passive immunity.
e. None of these helps explain the clonal selection theory.

___ 71. A "**clone**" is best described as a large population of
a. genetically identical cells.
b. antibody or immunoglobulin molecules belonging to the same subtype.
c. cancer cells growing within a tumor.
d. specific antigen molecules found on the membrane surface of lymphocytes.

___ 72. Antibodies made against self-antigens are called
a. immunoglobulins.
b. autoantibodies.
c. gamma globulins.
d. transplant antigens.

___ 73. Which statement about *passive* immunity is *false*?
a. A mother may transfer some IgG antibodies passively through the placenta to the fetus.
b. A mother may transfer some IgA antibodies passively to the newborn in her first breast milk (colostrum).
c. It can occur when either attenuated pathogens or similar vaccines are injected.
d. Passive immunity can occur when antiserum or antitoxin preparations are injected.
e. Passive immunity does not protect the individual against subsequent exposure to the same antigen.

___ 74. Which statement about the preparation and properties of *monoclonal antibodies* is *false*?
a. These antibodies are raised when an antigen is injected into animals to activate B lymphocyte production, which are then isolated from the spleen.
b. The selected B lymphocytes are hybridized (fused) with multiple myeloma (cancer) cells so that they will survive and reproduce in large numbers.
c. Isolated lymphocyte-myeloma fusions (hybridomas) secrete large amounts of the desired antibodies.
d. Monoclonal antibodies are clinically very specific against important antigens such as interferon, reproductive hormones, and cancer.
e. All of these statements are true.

B. True or False/Edit

___ 75. The secondary response results in the greater secretion of antibodies—sooner, faster, and with longer maintained protection.

___ 76. The English physician who inoculated a healthy boy with cowpox; and later, with smallpox to demonstrate his immunity was Edward Jenner.

___ 77. The term *attenuation* refers to a laboratory process in which the antigens present on a pathogen are greatly altered yet the virulence of the pathogen is essentially unchanged.

___ 78. One B lymphocyte can produce only one type of antibody, with specificity for one antigen.

___ 79. According to the clonal selection theory, foreign antigens select and interact with surface receptors only on the membranes of those specific lymphocytes that are genetically capable of responding with antibody synthesis.

___ 80. A vaccine is usually a pathogen that has been treated to reduce or destroy its antigenicity but retains its virulence.

___ 81. The injected Salk vaccine and the oral Sabin vaccine were both developed to sensitize individuals against the smallpox virus and its antigens.

___ 82. *Immune tolerance* is more complete and longer lasting when antigens are exposed to the weak immune system of a fetus or newborn than when exposed to that of adults.

___ 83. Two general proposals to help explain the mechanisms of immune tolerance are the *clonal deletion theory* in which lymphocytes with self-antigens are destroyed and the *clonal anergy* (without working) *theory* in which these lymphocytes are permanently inactivated.

V. TUMOR IMMUNOLOGY

Tumor cells can reveal antigens that stimulate the destruction of the tumor. When cancers develop, this immunological surveillance system — primarily the function of T cells and natural killer cells--has failed to prevent the growth and metastasis of the tumor.

A. Multiple Choice

___ 84. *Dedifferentiation* is a term that refers to the process by which tumor cells become
   a. relatively unspecialized and similar to the less specialized cells of an embryo.
   b. more specialized and thus similar to the more complex cells of the adult.
   c. stimulated to divide erratically with less inhibitory control than that seen in normal cells.
   d. altered by mutations that interfere with the normal expression of MHC antigens.

___ 85. Which of the following cytokines has *not* recently proved useful in the treatment of cancer or is *not* currently undergoing experimental investigation?
   a. interleukin-2 (IL-2)
   b. alpha-fetoprotein
   c. gamma interferon
   d. interleukin-12 (IL-12)

___ 86. Which statement about *natural killer* (NK) cells is *false*?
   a. NK cells are not processed (matured) by the thymus gland.
   b. NK cells can attack and destroy tumor cells.
   c. NK cells provide a first line of cell-mediated defense, destroying tumors in a nonspecific fashion.
   d. NK cells must first be activated by macrophages that present foreign tumor antigens.
   e. NK cells and killer T cells can interact as part of the immune response to the presence of tumors.

___ 87. Which statement about cancer is *false*?
   a. Cancer can be caused by a virus.
   b. The risk of cancer increases with age as lymphocytes age and thymus hormone production declines.
   c. Cancer grows faster when corticosteroid hormone levels in the bloodstream are lowered by stressful conditions.
   d. Cancer normally develops from tumor cells that escape the body's immunological surveillance system.
   e. Burkitt's lymphoma and Kaposi's sarcoma are examples of cancer.

B. True or False/Edit

___ 88. *Oncology* is the study of tumors or clones of single cells that have become transformed.

___ 89. Most tumors appear to be specific cell clones that escape the normal inhibitory controls and behave in a relatively more unspecialized way.

___ 90. Killer T cells are identical to natural killer (NK) cells.

___ 91. Tumors are usually described as either benign or metastatic.

___ 92. *Carcinoembryonic antigen* helps in the diagnosis of liver cancer and *alpha-fetoprotein* aids in the diagnosis of colon cancer.

___ 93. Recent evidence suggests that natural killer (NK) cells attack cells in much the same way as killer (cytotoxic) T lymphocytes, in that perforin proteins are inserted into the victim cell membrane while the granzyme enzyme enters and indirectly destroys the victim cell's DNA.

___ 94. Although the production of human interferons has not proved to be the "magic bullet" against cancer, interferons have been used effectively in certain forms of lymphomas, renal carcinoma, melanoma, Kaposi's sarcoma, and breast cancer.

___ 95. The risk of developing cancer increases with age partly because aging lymphocytes appear to accumulate genetic errors over the years that decrease their effectiveness.

VI. DISEASES CAUSED BY THE IMMUNE SYSTEM

Immune mechanisms that normally protect the body are very complex and subject to errors that can result in diseases. Autoimmune diseases and allergies are two categories of disease that are not caused by an invading pathogen, but rather by a derangement in the normal functions of the immune system.

A. Multiple Choice

___ 96. The autoimmune disease characterized by the abnormal production of IgM antibodies that attack IgG type antibodies, is called
a. Hashimoto's thyroiditis.
b. sympathetic ophthalmia.
c. thrombocytopenia.
d. rheumatoid arthritis.
e. rheumatic fever.

___ 97. In Graves' autoimmune disease
a. normally "hidden" antigens escape and stimulate the autoimmune response.
b. self-antigens combine with circulating drugs to produce new antigens that stimulate the autoimmune response.
c. class-2 MHC molecules unexpectedly appear in tissues that stimulate autoantibody production.
d. self-antigens cross-react with foreign antigens, causing inflammation and damage.

___ 98. Which statement about *systemic lupus erythematosus* (SLE) is *false*?
a. SLE results from the abnormal combination of self-antigens and autoantibodies.
b. SLE victims produce antibodies against their own DNA and nuclear protein.
c. SLE is an autoimmune disease that results in the formation of immune complexes that cause inflammation and tissue damage throughout the body.
d. SLE is characterized by unexpected immediate hypersensitivity reactions.
e. All of these statements about SLE are true.

___ 99. Which of the following conditions belongs to that form of allergy known as *delayed* hypersensitivity?
a. allergic rhinitis (runny or stuffy nose)
b. conjunctivitis (red eyes)
c. allergic asthma (difficulty breathing)
d. contact dermatitis (poison ivy)
e. atopic dermatitis (skin hives)

___ 100. Which immunoglobulin is most responsible for the symptoms of *immediate* hypersensitivity?
a. IgG
b. IgE
c. IgM
d. IgD
e. IgA

___ 101. The chemical released during an *immediate* hypersensitivity response, such as hay fever, that is *most* responsible for the itching, sneezing, tearing, and runny nose, is
a. histamine.
b. prostaglandins.
c. leukotrienes.
d. serotonin.
e. bradykinin.

___ 102. Which statement about *delayed* hypersensitivity is *false*?
a. It is a cell-mediated T cell response, rather than a B cell humoral response involving antibodies.
b. Its symptoms are caused primarily by the action of various secreted lymphokines.
c. Both the tuberculosis tine test and the Mantoux test are examples.
d. Antihistamines are clinically effective as treatment in sufferers of delayed hypersensitivity.
e. A relatively longer time is required for the development of symptoms (hours to days).

B. True or False/Edit

___ 103. Diseases that are *not* caused by foreign pathogens but by abnormal responses of the immune system are the autoimmune diseases, the immune complex diseases, and the allergies or hypersensitivities.

___ 104. Autoimmune diseases result in the production of autoantibodies by B cells to self-antigens, which may result in inflammation and organ death.

___ 105. *Rheumatoid arthritis* and *rheumatic fever* are two autoimmune diseases that are caused by similar defects in the immune system.

___ 106. Type I diabetes mellitus is an autoimmune disease in which class-2 MHC molecules mistakenly appear on the beta cells of the pancreas, resulting in autoimmune destruction of these insulin-producing cells.

___ 107. The formation of immune complexes activates complement proteins in the bloodstream, which promote inflammation and phagocytosis.
___ 108. *Immediate* hypersensitivity is primarily caused by an abnormal T lymphocyte response to an allergen, whereas *delayed* hypersensitivity is due to an abnormal B lymphocyte response.
___ 109. Allergy and hypersensitivity refer to the same abnormal response by the immune system to the presence of antigens (or allergens).
___ 110. *Asthma* is caused by an allergic reaction in which leukotrienes are secreted mainly by activated eosinophils that result in inflammation and constriction of lung bronchiole smooth muscle and difficulty breathing.
___ 111. In the typical flare-and-wheal reaction, the flare is due to local edema, and the wheal results from vasodilation of blood vessels.

CHAPTER REVIEW

A. Completion

112. Certain pathogens that enter the body are engulfed by _____ in an innate, nonspecific way. Viral infections are often limited by polypeptides called _____, which help protect other cells from subsequent viral infection. _____ immune responses usually begin with large, complex, and foreign molecules called _____ that stimulate _____ lymphocytes to secrete _____ molecules.
113. Since these antibodies are released into the blood, they provide _____ immunity, whereas T lymphocytes require cell contact known as _____-_____ immunity.
114. There are _____ (number) subclasses of antibodies, or _____, which are identified by these capital letters that follow Ig: _____ _____ _____ _____
115. They differ in the polypeptides that make up the constant region of their _____ chains, whereas the two _____ regions of each antibody combine with specific _____.
116. Opsonization is the process of combining _____ with _____, resulting in phagocytosis. Destruction of foreign cells may also be accomplished by the _____ system of plasma proteins that are activated by _____-_____ complexes.
117. These free-floating proteins promote opsonization and _____, attracting other leukocytes to the area and promoting the release of _____ from mast cells.
118. During the primary immune response, Ig _____ antibodies are produced _____ (quickly/slowly) and the person may get sick. During the secondary response, Ig _____ antibodies are produced _____ (quickly/slowly) by large numbers of identical _____ (B/T) lymphocytes known as a _____, which provides the person with resistance to the pathogen.
119. A person receiving antibody protection made by another organism, such as the antibodies a fetus receives from its mother or a victim receives from antiserum injections, is an example of _____ immunity. Monoclonal antibodies are made by artificially fusing _____ lymphocytes with _____ _____ cells, forming specific antibody "factories" known as _____.
120. T lymphocytes are processed by the _____ gland, which also secretes hormones. There are _____ (number) subtypes of T lymphocytes. The _____ subtype of T lymphocytes requires _____ with the fungus, virus, or certain bacteria to kill these invaders or to reject _____ tissues or organs.
121. Helper T lymphocytes _____ — and suppressor T lymphocytes _____ — the function of B lymphocytes and _____ T lymphocytes. Important chemicals secreted by T lymphocytes that participate in the immune response are known as _____, such as interleukin-2.
122. HLA or _____ antigens must combine with proteins on the _____ lymphocyte and the foreign antigen for activation. The immune cell most responsible for "presenting" these antigens is the _____, which partially digests the invader alerting the _____ T lymphocytes, which secrete interleukin-2.
123. Interleukin-2 also may stimulate _____ T lymphocytes, which proliferate slowly, providing a(n) _____ feedback control of the immune system and stimulate B lymphocytes to synthesize and to secrete _____ in response to the specific foreign _____.
124. Immunological surveillance against cancer is provided mainly by the_____ T lymphocytes that participate in specific immune attacks and the_____ _____ cells that are more involved in _____ immune defense. Psychological or physical stress seems to _____ (strengthen/weaken) the body's immunological surveillance mechanisms.
125. Autoimmune diseases are caused by the production of _____ antibodies against _____ -antigens, resulting in inflammation and destruction of specific tissues. Immediate and delayed hypersensitivity are two types of _____.

126. Immediate hypersensitivity stimulates the synthesis of specific Ig _____ antibodies from _____ lymphocytes; these antibodies attach to _____ cells and basophils, which in turn secrete specialized chemicals such as _____, _____, and _____.
127. Delayed hypersensitivity is a _____ lymphocyte or _____-mediated immune response, resulting in the release of proteins known as _____ that produce the symptoms seen in the allergy sufferer.

B. Label the Figure — The Effect of an Antigen on B and T Lymphocytes

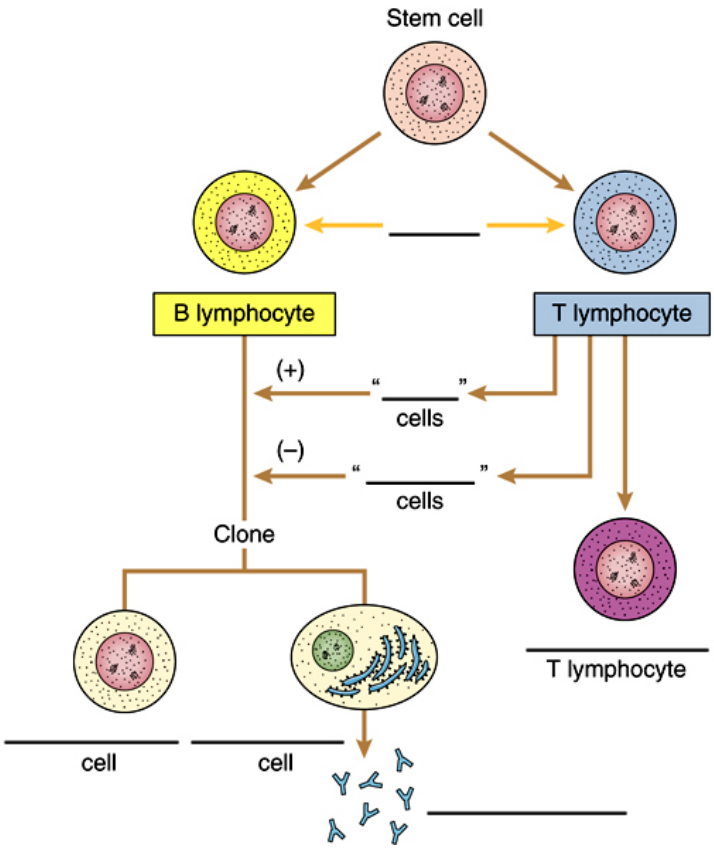

Figure 15.2 Study figure 15.2 carefully. A given antigen can stimulate the production of both B and T lymphocyte clones. The ability to produce B lymphocyte clones, however, is also influenced by the relative effects of helper and suppressor T lymphocytes. **Label**: antigen, helper cells, suppressor cells, antibodies, cytotoxic "killer" T lymphocyte, memory cell, and plasma cell. As always, try to identify as many as possible before looking up figure 15.14 in your text.

C. Essay

Essay Tutorial

This essay tutorial will answer the first essay question found in the "**Review Activities**" section of your *Human Physiology* textbook. Please read *Essay Question* 1 in the "**Test Your Understanding of Concepts and Principles**" section at the end of chapter 15 and let me guide you through one possible answer. Watch for key terms in boldface type, helpful tips and general suggestions on writing the essay or short-answer questions. Enjoy!

128. Explain how *antibodies* help to destroy invading bacterial cells.

Answer. Antibodies are specific polypeptides secreted in large numbers by transformed B lymphocytes known as *plasma* cells in response to the presence of antigens. These Y-shaped antibodies combine with the antigens and serve to identify the targets for immunological attack and to activate nonspecific immune processes that destroy the invader. For example, bacteria "buttered" with antibodies are better targets for phagocytosis by roving neutrophils and macrophages recruited from the blood. This process of promoting phagocytosis using antibodies is called *opsonization*.

In addition, antigen-antibody combinations trigger *complement fixation*, whereby normally inactive plasma proteins (complements) attach themselves to the bacterial cell membrane and can indirectly destroy the cell by puncturing large holes in the membrane. Other complement proteins that are not fixed (or are free-floating) lead to bacterial destruction by such mechanisms as chemotaxis, opsonization, and histamine release from mast cells.

Are you getting better at spotting key words in the question and directing your answer around these words? How about the organization of your answers? Remember, your essay skills will improve with practice, so how about practicing with a few of mine?

129. Distinguish between the sequence of innate *nonspecific* and adoptive *specific* immune events that follow local inflammation when bacteria enter through a break in the skin. (*Hint*: Use a table format.)

130. Describe the source of *histocompatibility* (MHC) *antigens* and the roles the two classes of MHC antigens play in immune defense.

131. Distinguish between the *primary* and the *secondary* response of an individual's immune system following the entry of a pathogen into the body.

132. Define **autoimmune disease** and describe *three* mechanisms by which these diseases may disrupt the immune system by discussing examples of autoimmune diseases from your text.

133. Distinguish between *immediate* and *delayed hypersensitivity*. Include the cell types involved, the time involved, the chemicals that cause the symptoms, and suggestions for treatment.

Answers — Chapter 15

I. Defense Mechanisms
   A. 1. d, 2. e, 3. a, 4. d, 5. a, 6. d, 7. b, 8. a, 9. a, 10. c, 11. c, 12. e, 13. e
   B. 14. T, 15. T, 16. T, 17. F—Replace "erythrocytes" with "leukocytes," 18. F—Replace "neutrophils" with "monocytes," 19. T, 20. T, 21. F—Switch "endogenous pyrogens" with "endotoxins," 22. T, 23. T, 24. F—Replace "polysaccharides" with "proteins," 25. F—Antigens may have many antigenic determinant sites per molecule, with each site responsible for making specific antibodies,26. F—Replace "B" with "T," 27. F—Switch "T" with "B," 28. T, 29. T, 30. F—Replace "monocyte" with "mast cell," 31. T, 32. T

II. Functions of B Lymphocytes
   A. 33. a, 34. b, 35. d, 36. d, 37. b, 38. a
   B. 39. T, 40. F—Switch "IgA" and "IgG," 41. T, 42. F—Replace "constant stalk" with "variable fork," 43. T, 44. F—Replace "C4, C2, and C3" with "C5 through C9," 45. F—Complement proteins kill cells directly, 46. T
   C. Label the Figure (text figure 15.5)

III. Functions of T Lymphocytes
   A. 47. b, 48. b, 49. a, 50. c, 51. b, 52. a, 53. e, 54. c, 55. a
   B. 56. F—Switch "T" and "B," 57. T, 58. F—Switch "decreased" and "increased," 59. F—Replace "killer" with "helper," 60. T, 61. F—Switch "humoral" and "cell-mediated," 62. T, 63. T, 64. F—Replace "2" with "1," 65. T, 66. T, 67. T, 68. T

IV. Active and Passive Immunity
   A. 69. d, 70. b, 71. a, 72. b, 73. c, 74. e
   B. 75. T, 76. T, 77. F—In attenuation, the virulence is reduced while the antigens are unaffected, 78. T, 79. T, 80. F—Switch "antigenicity" and "virulence," 81. F—Replace "smallpox" with "polio," 82. T, 83. T

V. Tumor Immunology
   A. 84. a, 85. b, 86. d, 87. c
   B. 88. T, 89. T, 90.F—Killer T cells are specific; NK cells are nonspecific, 91. F—Replace "metastatic" with "malignant," 92. F—Switch "liver" and "colon," 93. T, 94. T, 95. T

VI. Diseases Caused by the Immune System
   A. 96. d, 97. c, 98. d, 99. d, 100. b, 101. a, 102. d
   B. 103. T, 104. T, 105. F—Replace "similar" with "different," 106. T, 107. T, 108. F—Switch "T" and "B," 109. T, 110. T, 111. F—Flare is due to local edema, wheal results from edema

Chapter Review
   A. 112. phagocytes; interferons; Specific, antigens B, antibody, 113. humoral, cell-mediated, 114. five, immunoglobulins, G, A, M, D, E, 115. heavy, variable, antigens, 116. antigens, antibodies; complement, antigen-antibody, 117. chemotaxis, histamine, 118. M, slowly; G, quickly, B, clone, 119. passive; B, multiple myeloma, hybridomas, 120. thymus; three; killer, contact, transplanted, 121. stimulate, suppress, killer; lymphokines, 122. histocompatibility, T; macrophage, helper, 123. suppressor, negative, antibodies, antigen, 124. killer, natural killer, nonspecific; weaken, 125. auto, self; allergy, 126. E, B, mast, histamine, prostaglandins, leukotrienes, 127. T, cell, lymphokines
   B. Label the Figure — The effect of an antigen on B and T lymphocytes, Text figure 15.1