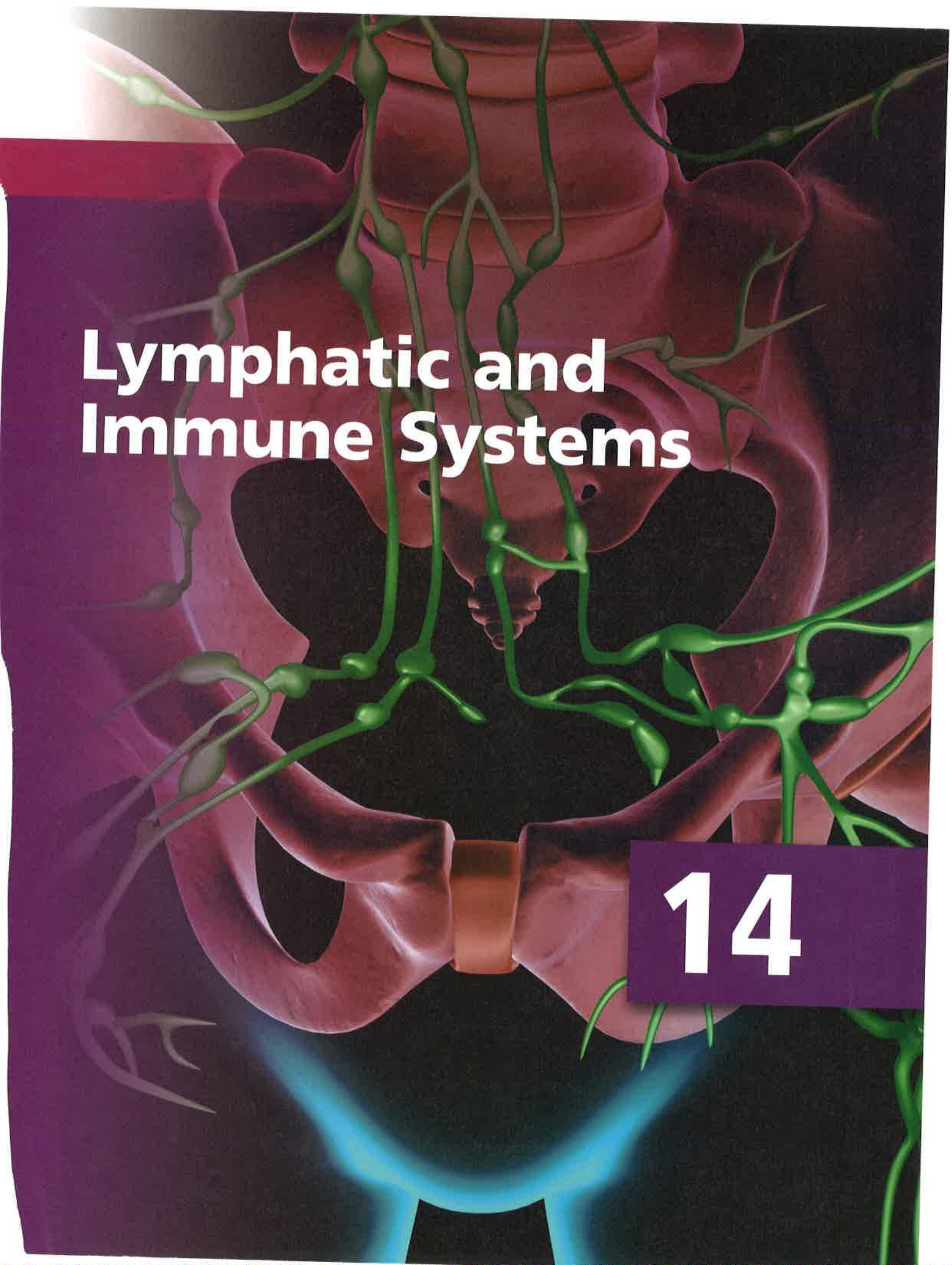

Lymphatic and Immune Systems

14

INTRODUCTION

The lymphatic system and the immune system are considered together in this chapter because some aspects of their functions in the body are very closely related.

Lymph is a clear, watery fluid that surrounds body cells and flows in a system of thin-walled lymph vessels (the lymphatic system) that extends throughout the body.

Lymph differs from blood, but it has a close relationship to the blood system. Lymph fluid does not contain erythrocytes or platelets, but it is rich in two types of white blood cells (leukocytes): **lymphocytes** and **monocytes.** The liquid part of lymph is similar to blood plasma in that it contains water, salts, sugar, and wastes of metabolism such as urea and creatinine, but it differs in that it contains less protein. Lymph actually originates from the blood. It is the same fluid that filters out of tiny blood capillaries into the spaces between cells. This fluid that surrounds body cells is called **interstitial fluid.** Interstitial fluid passes continuously into specialized thin-walled vessels called **lymph capillaries,** which are found coursing through tissue spaces (Figure 14-1). The fluid in the lymph capillaries, now called **lymph** instead of interstitial fluid, passes through larger lymphatic vessels and through clusters of lymph tissues **(lymph nodes),** finally reaching large lymph vessels in the upper chest. Lymph enters these large lymphatic vessels, which then empty into the bloodstream. Figure 14-2 illustrates the relationship between the blood and the lymphatic systems.

The lymphatic system has several functions. First, it is a drainage system to transport needed proteins and fluid that have leaked out of the blood capillaries (and into the interstitial fluid) back to the bloodstream via the veins. Second, the lymphatic vessels in the intestines absorb lipids (fats) from the small intestine and transport them to the bloodstream.

A third function of the lymphatic system relates to the **immune system:** the defense of the body against foreign organisms such as bacteria and viruses. Lymphocytes and monocytes, originating in bone marrow, lymph nodes, and organs such as the spleen and thymus gland, protect the body by producing antibodies and by mounting a cellular attack on foreign cells and organisms.

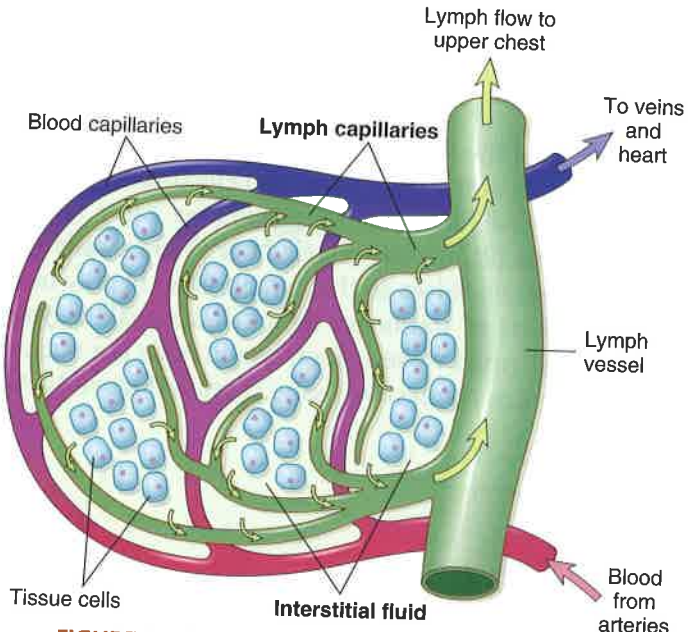

FIGURE 14–1 Interstitial fluid and lymph capillaries.

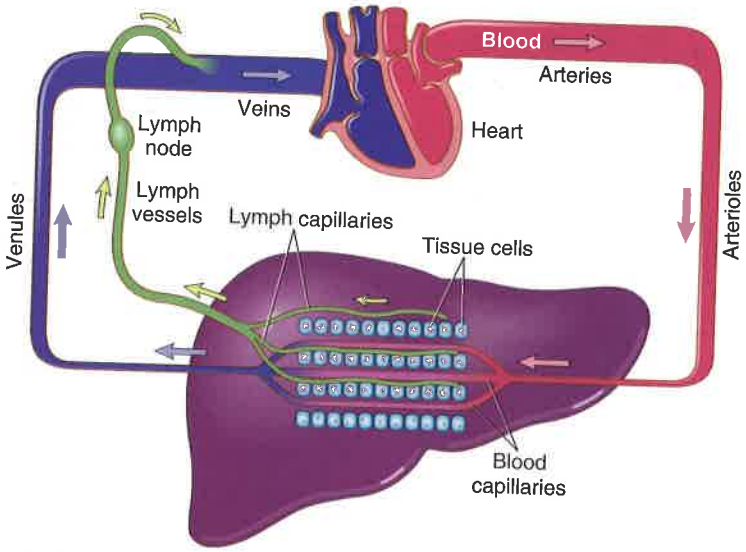

FIGURE 14–2 Relationship between the circulatory systems of blood and lymph.

LYMPHATIC SYSTEM

ANATOMY

Label Figure 14-3A as you read the following paragraphs.

Lymph capillaries [1] begin at the spaces around cells throughout the body. Like blood capillaries, they are thin-walled tubes. Lymph capillaries carry lymph from the tissue spaces to larger **lymph vessels** [2]. Lymph vessels have thicker walls than those of lymph capillaries and, like veins, contain valves so that lymph flows in only one direction, toward the thoracic cavity. Collections of stationary lymph tissue, called **lymph nodes** [3], are located along the path of the lymph vessels. Each lymph node is a mass of lymph cells and vessels, surrounded by a fibrous, connective tissue capsule (Figure 14-4).

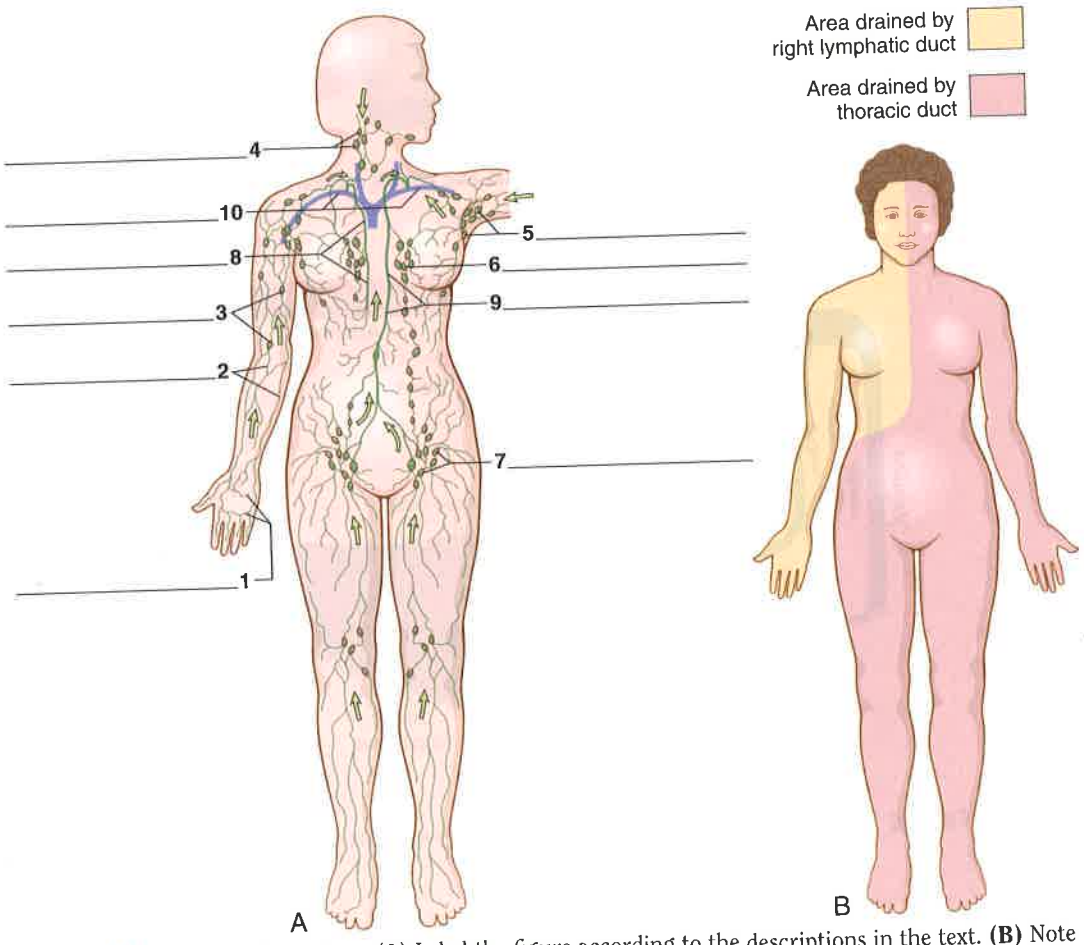

FIGURE 14–3 Lymphatic system. (A) Label the figure according to the descriptions in the text. **(B)** Note the different regions of the body drained by the right lymphatic duct and the thoracic duct.

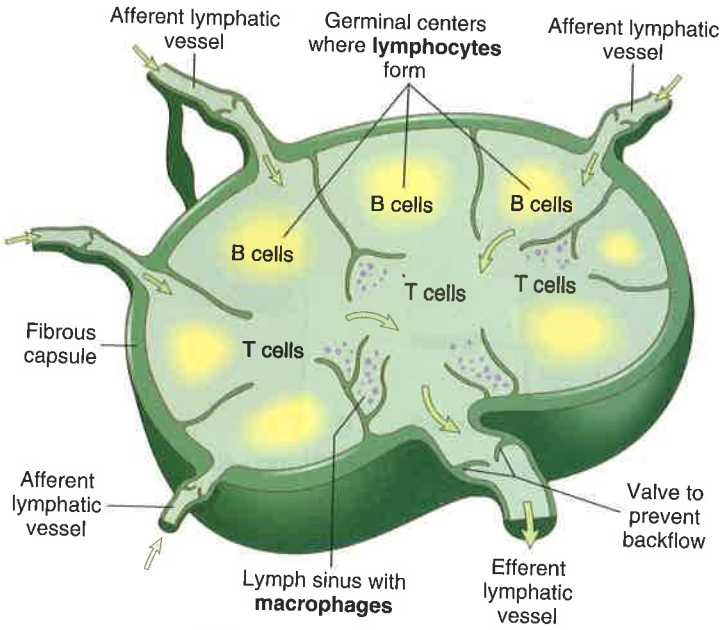

FIGURE 14–4 A lymph node.

Lymph nodes not only produce lymphocytes but also filter lymph and trap substances from infectious, inflammatory, and cancerous lesions. Special cells called **macrophages,** located in lymph nodes (as well as in the spleen, liver, and lungs), swallow (phagocytose) foreign substances. When bacteria are present in lymph nodes that drain a particular area of the body, the nodes become swollen with collections of cells and their engulfed debris and become tender. Lymph nodes also fight disease when specialized lymphocytes called **B lymphocytes (B cells),** present in the nodes, produce antibodies. Other lymphocytes, the **T lymphocytes (T cells),** attack bacteria and foreign cells by accurately recognizing a cell surface protein as foreign, attaching to the foreign or cancerous cells, poking holes in them, and injecting them with toxic chemicals.

Label the major sites of lymph node concentration on Figure 14-3A. These are the **cervical** [4], **axillary** (armpit) [5], **mediastinal** [6], and **inguinal** (groin) [7] regions of the body. Remember that **tonsils** are masses of lymph tissue in the throat near the back of the mouth (oropharynx), and **adenoids** are enlarged lymph tissue in the part of the throat near the nasal passages (nasopharynx).

Lymph vessels all lead toward the thoracic cavity and empty into two large ducts in the upper chest. These are the **right lymphatic duct** [8] and the **thoracic duct** [9]. The thoracic duct drains the lower body and the left side of the head, whereas the right lymphatic duct drains the right side of the head and the chest (a much smaller area) (see Figure 14-3B). Both ducts carry the lymph into **large veins** [10] in the neck, where the lymph then enters the bloodstream.

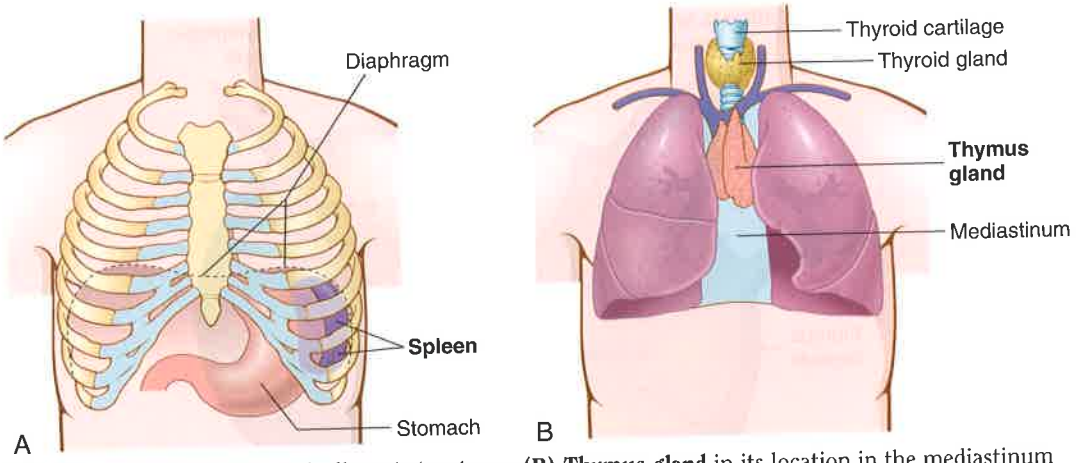

FIGURE 14-5 **(A) Spleen** and adjacent structures. **(B) Thymus gland** in its location in the mediastinum between the lungs.

SPLEEN AND THYMUS GLAND

The spleen and the thymus gland are specialized organs that are also a part of the lymphatic system.

The **spleen** (Figure 14-5A) is located in the left upper quadrant of the abdomen, next to the stomach. Although the spleen is not essential to life, it has several important functions:

1. Destruction of old erythrocytes by macrophages. In the slow-moving circulation of the spleen, red cell breakdown (hemolysis) liberates hemoglobin, which is converted to bilirubin in the liver and then is excreted into the bile.
2. Filtration of microorganisms and other foreign material from the blood.
3. Activation of lymphocytes by antigens filtered from the blood. Activated B cell lymphocytes produce antibodies. Activated T cell lymphocytes attack foreign materials.
4. Storage of blood, especially erythrocytes and platelets.

The spleen is susceptible to injury. A sharp blow to the upper abdomen (as from the impact of a car's steering wheel) may cause rupture of the spleen. Massive hemorrhage can occur when the spleen is ruptured, and immediate surgical removal (splenectomy) may be necessary. After splenectomy, the liver, bone marrow, and lymph nodes take over the functions of the spleen.

The **thymus gland** (see Figure 14-5B) is a lymphatic organ located in the upper mediastinum between the lungs. During fetal life and childhood it is quite large, but it becomes smaller with age. The thymus gland is composed of nests of lymphoid cells resting on a platform of connective tissue. It plays an important role in the body's ability to protect itself from disease (immunity), especially in fetal life and during the early years of growth. It is known that a thymectomy (removal of the thymus gland) performed in an animal during the first weeks of life impairs the ability of the animal to make antibodies and to produce immune cells that fight against foreign antigens such as bacteria and viruses. Thus, the thymus gland is important in development of an effective immune system in childhood.

Early in development, in the thymus, lymphocytes learn to recognize and accept the body's own antigens as "self" or friendly. This acceptance of "self" antigens is called **tolerance.** When the tolerance process fails, immune cells react against normal cells, resulting in various conditions (autoimmune disease). See page 556, under **autoimmune disease** (aut/o = self).

IMMUNE SYSTEM

The immune system is specialized to defend the body against **antigens** (such as toxins, bacterial proteins, or foreign blood cells). This system includes **leukocytes** such as **neutrophils, monocytes,** and **macrophages,** which are phagocytes found in tissues throughout the body. In addition, **lymphoid organs,** such as the lymph nodes, spleen, and thymus gland, produce **lymphocytes** and **antibodies.**

NATURAL AND ACQUIRED IMMUNITY

Immunity is the body's ability to resist foreign organisms and toxins (poisons) that damage tissues and organs. **Natural immunity** is protection that is inherited and is present at birth to fight off infection. It is not dependent on previous contact with an infectious agent. When bacteria enter the body, **phagocytes** such as **neutrophils** (white blood cells) migrate to the site of infection and ingest the bacteria. They release proteins that attract other immune system cells and cause localized inflammation. Other white blood cells, such as **monocytes** and **macrophages,** then move in to clear away dead cells and debris as the infection subsides.

In addition to natural immunity, a healthy person can develop **acquired immunity.** This is the body's ability to form antibodies and mobilize lymphocytes to fight an infection after exposure to an antigen. An example of acquired immunity is the production of antibodies after exposure to a virus that causes an upper respiratory infection (cold or flu). These antibodies remain in the body to protect against further infection at a later time. Another example of acquired immunity is **vaccination.** By exposing a person to proteins, killed viruses, or bacterial components, it is possible to stimulate lymphocytes to produce antibodies. These antibodies will protect against an attack of the disease, should the person be exposed to the virus at a later time.

There are some instances when immediate immunity (protection) is needed. Poisons (toxins) entering the body through snake bites can be counteracted by giving ready-made antibodies produced in another person or animal. These antibodies are **antitoxins.** Also, injections of antibodies such as **immunoglobulins** can provide protection against disease and lessen its severity. A further example of acquired immunity is that in newborns receiving **maternal antibodies** through the placenta or in breast milk after birth. Figure 14-6 reviews the general differences between natural and acquired immunity.

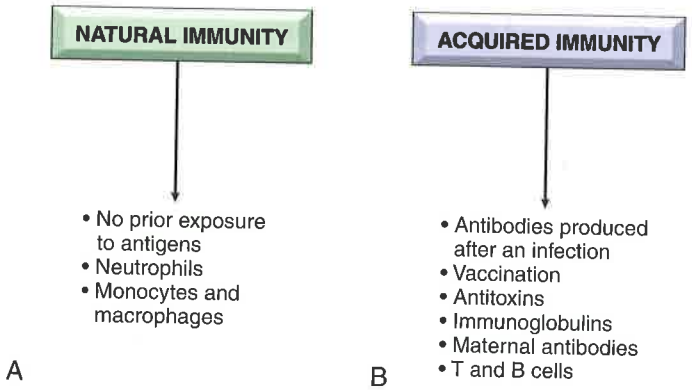

FIGURE 14-6 **Types of immunity.**

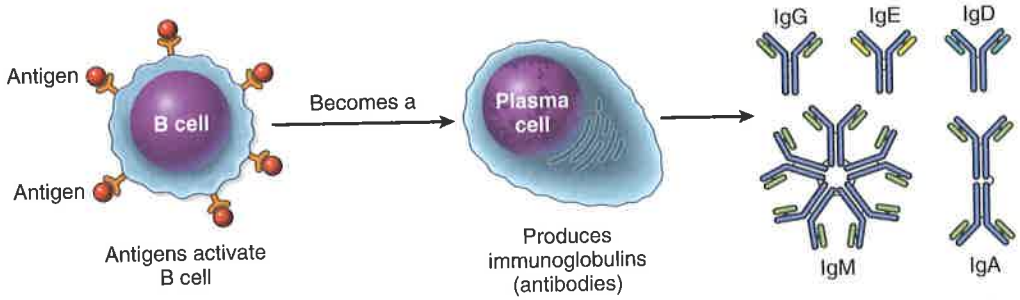

FIGURE 14–7 B cell, plasma cell, and immunoglobulins. The production of antibodies by plasma cells is called **humoral immunity.**

Acquired immunity involves two major disease-fighting cell types: **B lymphocytes (B cells)** and **T lymphocytes (T cells). B lymphocytes** produce antibodies when exposed to specific antigens, such as viruses and bacteria. B cells originate from bone marrow stem cells. When a B cell is confronted with a specific type of antigen, it transforms into an antibody-producing cell known as a **plasma cell.** Plasma cells produce antibodies called **immunoglobulins.** Examples are **IgM, IgA, IgG, IgE,** and **IgD.** Immunoglobulins travel to the site of an infection and block the effect of antigens. IgG, the most abundant immunoglobulin, crosses the placenta to provide immunity for newborns. IgE is important in causing allergic reactions and fighting parasitic infections. Figure 14-7 reviews the relationship of B cells, plasma cells, and immunoglobulins.

T cells produce a different type of immunity. They also originate from stem cells in the bone marrow, but are further processed in the thymus gland, where they are acted on by thymic hormones. When a T cell encounters an antigen, the T cell multiplies rapidly to produce specific types of cells that destroy the antigen. T cells also react to transplanted tissues and skin grafts when rejection occurs in a recipient.

Examples of specific types of T cells are **cytotoxic T cells, helper T cells,** and **suppressor T cells.** These cells contribute in different ways to the immune response. **Cytotoxic T cells** attach to antigens (bacteria, viruses, or foreign cells, such as skin grafts from another person) and kill the offending organism. They also produce proteins called **cytokines,** such as **interferons** and **interleukins,** that aid other cells in antigen destruction.

Helper T cells promote the responses of B cells and other T cells to neutralize antigens. **Suppressor T cells,** also called **regulatory T cells (Tregs),** control B cell and T cell activity and stop the immune response when an antigen has been destroyed. Figure 14-8 reviews the different types of T cells and their abbreviations.

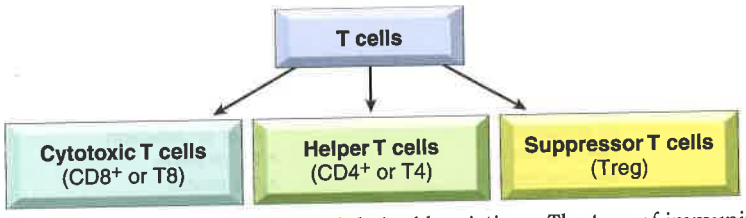

FIGURE 14–8 Types of T cells (lymphocytes) and their abbreviations. The type of immunity produced by T cells is called **cell-mediated immunity.**

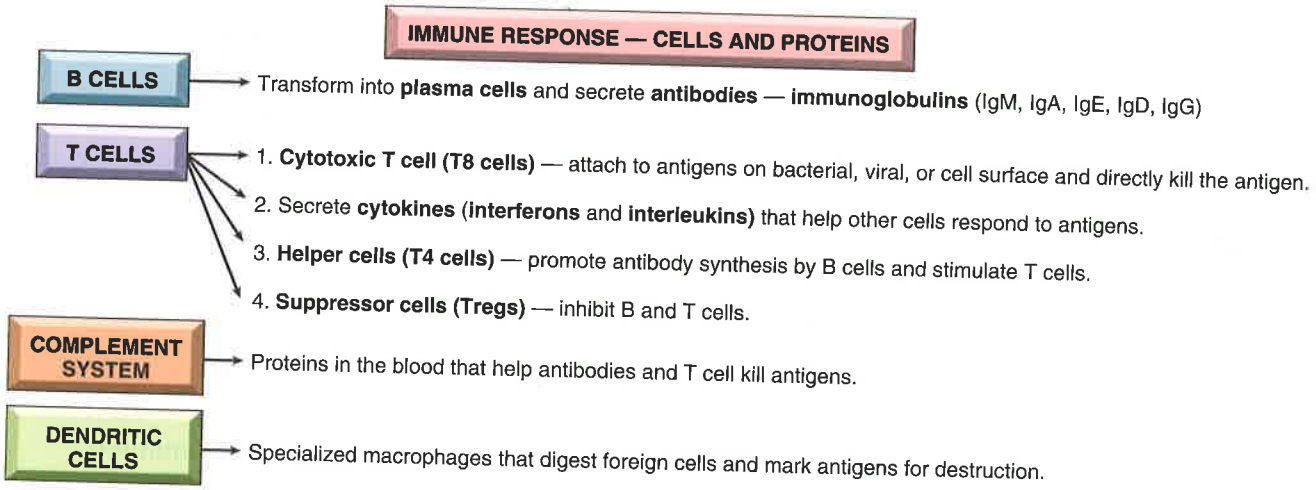

FIGURE 14–9 Functions of B cell (humoral immunity) and T cell lymphocytes (cell-mediated immunity).

The immune system is helped by a number of other proteins and cells found in circulating blood. These include the **complement system,** a group of proteins in the blood that helps antibodies and T cells kill their target. Another warrior is the **dendritic cell,** which is a specialized macrophage that digests foreign cells. Antigen fragments appear on the surface of dendritic cells, which helps B and T cells to recognize and mark antigens for destruction.

Figure 14-9 reviews the roles that B cells, T cells, the complement system, and dendritic cells play in the immune response.

IMMUNOTHERAPY

Immunotherapy is the use of antibodies, B cells (producing antibodies), and T cells to treat disease such as cancer. Examples of immunotherapy are:

Monoclonal antibodies (MoAb)—These are antibodies created in a laboratory by special reproductive (cloning) techniques. They are designed to attack specific cancer cells. An example of monoclonal antibody therapy is the drug rituximab (Rituxan), made to kill malignant lymphoma cells. The antibody may be linked to various toxins or radioactive particles and delivered to tumor cells, to add to the killing effect.

Vaccines—These preparations contain antigens (proteins) from tumor cells that stimulate T cells to recognize and kill cancer cells. Vaccines may be injected or given as a nasal spray.

Transfer of immune cells—In bone marrow transplantation, T lymphocytes from a donor can replace a patient's immune system with new cells that recognize tumor cells as foreign and kill them.

VOCABULARY

This list reviews many of the new terms introduced in the text. Short definitions reinforce your understanding of the terms. Refer to the Pronunciation of Terms on page 572 for help with unfamiliar or difficult words.

acquired immunity	Production of antibodies and lymphocytes after exposure to an antigen.
adenoids	Mass of lymphatic tissue in the nasopharynx.
antibody	Protein produced by B cell lymphocytes to destroy antigens.
antigen	Substance that the body recognizes as foreign; evokes an immune response. Most antigens are proteins or protein fragments found on the surface of bacteria, viruses, or organ transplant tissue cells.
axillary nodes	Lymph nodes in the armpit (underarm).
B cell (B lymphocyte)	Lymphocyte that originates in the bone marrow and transforms into a plasma cell to secrete antibodies. The B refers to the bursa of Fabricius, an organ in birds in which B cell differentiation and growth were first noted to occur.
cervical nodes	Lymph nodes in the neck region.
complement system	Proteins in the blood that help antibodies and T cells kill their target.
cytokines	Proteins that aid and regulate the immune response. Examples are interferons and interleukins.
cytotoxic T cell	T lymphocyte that directly kills foreign cells (**$CD8^+$ cell** or **T8 cell**)
dendritic cell	Specialized macrophage that digests foreign cells and helps B and T cells to mark antigens for destruction.
helper T cell	Lymphocyte that aids B cells and cytotoxic T cells in recognizing antigens and stimulating antibody production; also called **$CD4^+$ cell** or **T4 cell.**
immunity	Body's ability to resist foreign organisms and toxins. This includes natural immunity and acquired immunity.
immunoglobulins	Antibodies (gamma globulins) such as IgA, IgE, IgG, IgM, and IgD that are secreted by plasma cells in response to the presence of an antigen.
immunotherapy	Use of immune cells, antibodies, or vaccines to treat or prevent disease.
inguinal nodes	Lymph nodes in the groin region.
interferons	Proteins (cytokines) secreted by T cells to aid and regulate the immune response.
interleukins	Proteins (cytokines) that stimulate the growth of B and T lymphocytes.
interstitial fluid	Fluid in the spaces between cells. This fluid becomes lymph when it enters lymph capillaries.

lymph	Thin, watery fluid found within lymphatic vessels and collected from tissues throughout the body. Latin *lympha* means clear spring water.
lymph capillaries	Tiniest lymphatic vessels.
lymphoid organs	Lymph nodes, spleen, and thymus gland.
lymph node	A collection of stationary solid lymphatic tissue along lymph vessels.
lymph vessel	Carrier of lymph throughout the body; lymphatic vessels empty lymph into veins in the upper part of the chest.
macrophage	Large phagocyte found in lymph nodes and other tissues of the body.
mediastinal nodes	Lymph nodes in the area between the lungs in the thoracic (chest) cavity.
monoclonal antibody	Antibody produced in a laboratory to attack antigens and to destroy cells. It is useful in immunotherapy.
natural immunity	Protection that an individual inherits to fight infection.
plasma cell	Lymphocyte that produces and secretes antibodies. It originates from B lymphocytes.
right lymphatic duct	Large lymphatic vessel in the chest that receives lymph from the upper right part of the body.
spleen	Organ near the stomach that produces, stores, and eliminates blood cells.
suppressor T cell	Lymphocyte that inhibits the activity of B and T lymphocytes. Also called a **Treg (regulatory T cell).**
T cell (T lymphocyte)	Lymphocyte that originates in the bone marrow but matures in the thymus gland; it acts directly on antigens to destroy them or produce chemicals (cytokines) such as interferons and interleukins that are toxic to antigens.
tolerance	The ability of T lymphocytes to recognize and accept the body's own antigens as "self" or friendly. Once tolerance is established, the immune system will not react against the body.
thoracic duct	Large lymphatic vessel in the chest that receives lymph from below the diaphragm and from the left side of the body above the diaphragm; it empties the lymph into veins in the upper chest.
thymus gland	Organ in the mediastinum that conditions T lymphocytes to react to foreign cells and aids in the immune response.
tonsils	Mass of lymphatic tissue in the back of the oropharynx.
toxin	Poison; a protein produced by certain bacteria, animals, or plants.
vaccination	Exposure of an individual to a foreign protein (antigen) that provokes an immune response. The response will destroy any cell that possesses the antigen on its surface and will protect against infection. The term comes from the Latin *vacca*, cow—the first inoculations were given with organisms that caused the disease cowpox to produce immunity to smallpox.
vaccine	Weakened or killed microorganisms, toxins, or other proteins given to induce immunity to infection or disease.

TERMINOLOGY

Write the meanings of the medical terms in the spaces provided.

COMBINING FORMS

COMBINING FORM	MEANING	TERMINOLOGY	MEANING
immun/o	protection	autoimmune disease	*Examples are rheumatoid arthritis and lupus erythematosus. These are chronic, disabling diseases caused by the abnormal production of antibodies against normal body tissues. Signs and symptoms are inflammation of joints, skin rash, and fever. Glucocorticoid drugs (prednisone) and other immunosuppressants (azathioprine, methotrexate) are effective as treatment but make patients susceptible to infection.*
		immunoglobulin	
		immunosuppression	*This may occur because of exposure to drugs (corticosteroids) or as the result of disease (AIDS and cancer). Immunosuppressed patients are susceptible to infection with fungi,* Pneumocystis *bacteria, and other pathogens.*
lymph/o	lymph	lymphopoiesis	
		lymphedema	*Interstitial fluid collects within the spaces between cells as a result of obstruction of lymphatic vessels and nodes. Radiation therapy may destroy lymphatics and produce lymphedema, as in breast cancer treatment (Figure 14-10).*
		lymphocytopenia	
		lymphocytosis	
		lymphoid	*The suffix -oid means resembling or derived from. Lymphoid organs include lymph nodes, spleen, and thymus gland.*

FIGURE 14–10 **Lymphedema** of right arm secondary to mastectomy, lymphadenectomy, and radiotherapy. (From Swartz MH: Textbook of Physical Diagnosis, History and Examination, 4th ed., Philadelphia, Saunders, 2002.)

COMBINING FORM	MEANING	TERMINOLOGY	MEANING
lymphaden/o	lymph node (gland)	lymphadenopathy	
		lymphadenitis	
splen/o	spleen	splenomegaly	
		Note that the combining form for spleen contains only one e.	
		splenectomy	
		asplenia	
		The condition may be congenital or result from surgical removal.	
		hypersplenism	
		A syndrome marked by splenomegaly and often associated with blood cell destruction, anemia, leukopenia, and thrombocytopenia.	
thym/o	thymus gland	thymoma	
		thymectomy	
tox/o	poison	toxic	

PREFIXES

PREFIX	MEANING	TERMINOLOGY	MEANING
ana-	again, anew	anaphylaxis	
		The suffix -phylaxis means protection. This is an exaggerated or unusual hypersensitivity to previously encountered foreign proteins or other antigens. Vasodilation and a decrease in blood pressure can be life-threatening.	
inter-	between	interstitial fluid	
		The suffix -stitial means pertaining to standing or positioned.	

PATHOLOGY

IMMUNODEFICIENCY

Some immunodeficiency disorders are present at birth. An example is **severe combined immunodeficiency disease (SCID).** Affected infants are born with a deficiency of B cells and T cells, resulting in a lack of immunity. The thymus is small, and children have little or no protection against infection.

acquired immunodeficiency syndrome (AIDS)

Group of clinical signs and symptoms associated with suppression of the immune system and marked by opportunistic infections, secondary neoplasms, and neurologic problems.

AIDS is caused by the **human immunodeficiency virus (HIV).** HIV destroys **helper T cells** (also known as **$CD4^+$ cells,** containing the CD4 protein antigen). This disrupts the immune response, allowing infections to occur. Infectious diseases associated with AIDS are called **opportunistic infections** because HIV lowers resistance and allows infection by bacteria and parasites that are easily otherwise contained by normal defenses. Table 14-1 lists many of these opportunistic infections; use the table as a reference.

TABLE 14-1 Opportunistic Infections with AIDS

Infection	Description
candidiasis	Yeast-like fungus *(Candida)*, normally present in the mouth, skin, intestinal tract, and vagina, overgrows, causing infection of the mouth (thrush), respiratory tract, and skin.
cryptococcal infection (Crypto)	Yeast-like fungus *(Cryptococcus)* causes lung, brain, and blood infections. Pathogen is found in pigeon droppings and nesting places, air, water, and soil.
cryptosporidiosis	Parasitic infection of the gastrointestinal tract and brain and spinal cord. The pathogen, *Cryptosporidium*, is a one-celled organism commonly found in farm animals.
cytomegalovirus (CMV) infection	Virus causes enteritis (inflammation of the intestinal tract) and retinitis (inflammation of the retina at the back of the eye). Found in saliva, semen, cervical secretions, urine, feces, blood, and breast milk, but usually causes disease only when the immune system is compromised.
herpes simplex	Viral infection causes small blisters on the skin of the lips or nose or on the genitals. Herpes simplex virus also can cause encephalitis.
histoplasmosis (Histo)	Fungal infection caused by inhalation of dust contaminated with *Histoplasma capsulatum*; causes fever, chills, and lung infection. Pathogen is found in bird and bat droppings.
Mycobacterium avium-intracellulare (MAI) complex infection	Bacterial disease manifesting with fever, malaise, night sweats, anorexia, diarrhea, weight loss, and lung and blood infections.
Pneumocystis pneumonia (PCP)	One-celled organism *(P. jiroveci)* causes lung infection, with fever, cough, and chest pain. Pathogen is found in air, water, and soil and is carried by animals. Infection is treated with trimethoprim-sulfamethoxazole (Bactrim), a combination of antibiotics, or with pentamidine. Aerosolized pentamidine, which is inhaled, can prevent occurrence of PCP.
toxoplasmosis (Toxo)	Parasitic infection involving the central nervous system (CNS) and causing fever, chills, visual disturbances, confusion, hemiparesis (slight paralysis in half of the body), and seizures. Pathogen *(Toxoplasma)* is acquired by eating uncooked lamb or pork, unpasteurized dairy products, and raw eggs or vegetables.
tuberculosis (TB)	Bacterial disease (caused by *Mycobacterium tuberculosis*) involving the lungs, brain, and other organs. Signs and symptoms are fever, cough, loss of weight, anorexia, and blood in sputum.

FIGURE 14–11 (A) Kaposi sarcoma. (B) Wasting syndrome. (A, From Swartz MH: Textbook of Physical Diagnosis, History and Examination, 4th ed., Philadelphia, 2002, Saunders; B from Lemmi FO, Lemmi CAE: Physical Assessment Findings CD-ROM, Philadelphia, Saunders, 2000.)

Malignancies associated with AIDS are **Kaposi sarcoma** (a cancer arising from the lining cells of capillaries that produces dark purplish skin nodules) and **lymphoma** (cancer of lymph nodes). **Wasting syndrome,** marked by weight loss and decrease in muscular strength, appetite, and mental activity, also may occur with AIDS (Figure 14-11A and B).

Persons who were exposed to HIV and now have antibodies in their blood against this virus are **HIV-positive.** HIV is found in blood, semen, vaginal and cervical secretions, saliva, and other body fluids. Transmission of HIV may occur by three routes: sexual contact, blood inoculation (through sharing of contaminated needles, accidental needlesticks, or contact with contaminated blood or blood products), and passage of the virus from infected mothers to their newborns. Table 14-2 summarizes the common routes of transmission of HIV.

HIV-infected patients may remain asymptomatic for as long as 10 years. Signs and symptoms associated with HIV infection are lymphadenopathy, neurologic disease, oral thrush (fungal infection), night sweats, fatigue, and evidence of opportunistic infections.

Drugs that are used to treat AIDS are inhibitors of the viral enzyme called **reverse transcriptase (RT).** After invading the helper T cell (carrying the $CD4^+$ antigen), HIV releases reverse transcriptase to help it grow and multiply inside the cell. Examples of **reverse transcriptase inhibitors (RTIs)** are zidovudine and lamivudine (Epivir). A second class of anti-HIV drugs are **protease inhibitors.** These drugs inhibit another viral enzyme called protease. HIV needs protease to reproduce. Use of combinations of protease inhibitors (nelfinavir, amprenavir) and RTIs is called **HAART (highly active antiretroviral therapy).** This treatment has in many cases abolished evidence of viral infection in affected people.

TABLE 14-2 Common Routes of Transmission

Route	People Affected
Receptive oral and anal intercourse	Men and women
Receptive vaginal intercourse	Women
Sharing of needles and equipment (users of intravenous drugs)	Men and women
Contaminated blood (for transfusion) or blood products	Men and women (in hemophiliacs)
From mother, in utero	Neonates

HYPERSENSITIVITY

allergy

Abnormal hypersensitivity acquired by exposure to an antigen.

Allergic (all/o = other) reactions occur when a sensitized person, who has previously been exposed to an agent **(allergen),** reacts violently to a subsequent exposure. This reaction varies in intensity from **allergic rhinitis** or hay fever (caused by pollen or animal dander) to **systemic anaphylaxis,** in which an extraordinary hypersensitivity reaction occurs throughout the body, leading to fall in blood pressure (hypotension), shock, respiratory distress, and edema (swelling) of the larynx. Anaphylaxis can be life-threatening, but the patient usually survives if the airways are kept open and treatment is given immediately (epinephrine and antihistamines).

Other allergies include **asthma** (pollens, dust, molds), **hives** (caused by food or drugs), and **atopic dermatitis** (rash from soaps, cosmetics, chemicals). Atopic means related to **atopy,** a hypersensitivity or allergic state arising from an inherited predisposition. A person who is atopic is prone to allergies (Figure 14-12).

MALIGNANCIES

lymphoma

Malignant tumor of lymph nodes and lymph tissue.

There are many types of lymphoma, varying according to the particular cell type and degree of differentiation. Some examples are:

Hodgkin disease—Malignant tumor of lymphoid tissue in the spleen and lymph nodes. This disease is characterized by **lymphadenopathy** (lymph nodes enlarge), splenomegaly, fever, weakness, and loss of weight and appetite. The diagnosis often is made by identifying a malignant cell **(Reed-Sternberg cell)** in the lymph nodes. If disease is localized, the treatment may be radiotherapy or chemotherapy. If the disease is more widespread, chemotherapy is given alone. There is a very high probability of cure with available treatments. Figure 14-13 illustrates staging of Hodgkin disease.

FIGURE 14–12 Atopic dermatitis. (From Zitelli BJ, Davis HW: Atlas of Pediatric Physical Diagnosis, 3rd ed., St. Louis, Mosby, 1997.)

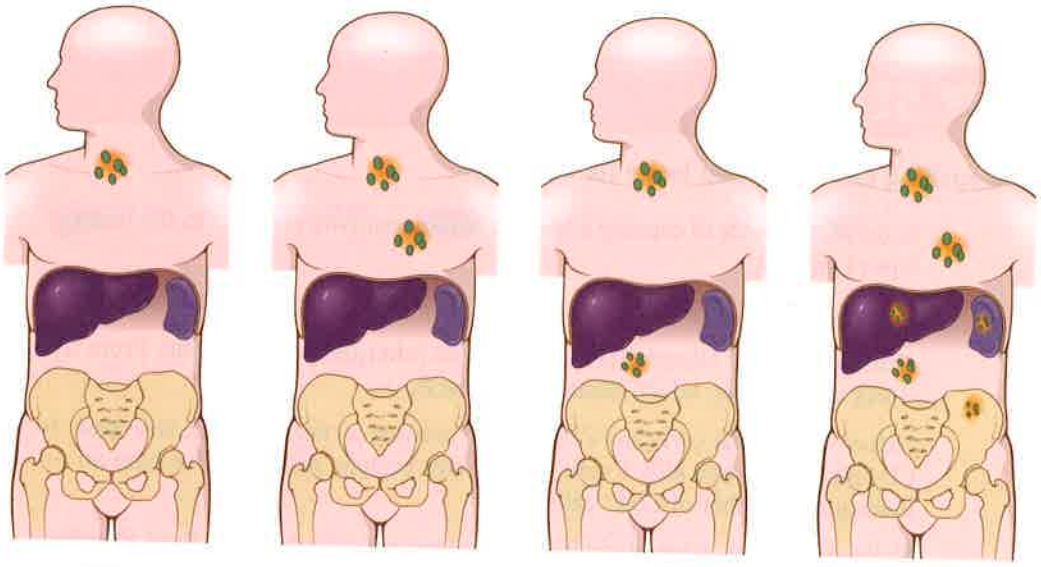

FIGURE 14–13 Staging of Hodgkin disease involves assessing the extent of spread of the disease. Lymph node biopsies, laparotomy with liver and lymph node biopsies, and splenectomy may be necessary for staging.

Non-Hodgkin lymphomas—These include **follicular lymphoma** (composed of collections of small lymphocytes in a follicle or nodule arrangement) and **large cell lymphoma** (composed of large lymphocytes that infiltrate nodes and tissues diffusely). Non-Hodgkin lymphomas are mostly B cell lymphomas and rarely T cell malignancies. Chemotherapy may cure or stop the progress of this disease.

multiple myeloma

Malignant tumor of bone marrow cells.

This is a tumor composed of **plasma cells** (antibody-producing B lymphocytes) associated with high levels of one of the specific immunoglobulins, usually IgG. **Waldenström macroglobulinemia** is another tumor of malignant B cells. This disease involves B cells that produce large quantities of IgM (a globulin of high molecular weight). Increased IgM concentration impairs the passage of blood through capillaries in the brain and eyes, causing a hyperviscosity syndrome (thickening of the blood).

thymoma

Malignant tumor of the thymus gland.

Some signs and symptoms of thymoma are cough, dyspnea, dysphagia, fever, chest pain, weight loss, and anorexia. Often, the tumor is associated with disorders of the immune system that cause muscular weakness (myasthenia gravis) or anemia.

Surgery is the principal method of treating thymoma; postoperative radiation therapy is used for patients with evidence of spread of the tumor.

STUDY SECTION

Practice spelling each term and know its meaning.

allergen	Substance capable of causing a specific hypersensitivity reaction in the body; a type of antigen.
anaphylaxis	Exaggerated or unusual hypersensitivity to foreign protein or other substance.
atopy	Hypersensitive or allergic state involving an inherited predisposition. From the Greek word *atopia*, which means strangeness.
CD4$^+$ cells	Helper T cells that carry the CD4 protein antigen on their surface. HIV binds to CD4 and infects and kills T cells bearing this protein. AIDS patients have an inadequate number of CD4$^+$ cells.
Hodgkin disease	Malignant tumor of lymphoid tissue in spleen and lymph nodes; Reed-Sternberg cell often is found on microscopic analysis.
human immunodeficiency virus (HIV)	Virus (retrovirus) that causes AIDS.
Kaposi sarcoma	Malignant lesion associated with AIDS; arises from the lining of capillaries and appears as red, purple, brown, or black skin nodules.
non-Hodgkin lymphomas	Group of malignant tumors involving lymphoid tissue. Examples are follicular lymphoma and large cell lymphoma.
opportunistic infections	Infectious diseases associated with AIDS; they occur because HIV infection lowers the body's resistance and allows infection by bacteria and parasites that normally are easily contained.
protease inhibitor	Drug that treats AIDS by blocking the production of protease, a proteolytic enzyme that helps create new viral pieces for HIV.
reverse transcriptase inhibitor (RTI)	Drug that treats AIDS by blocking reverse transcriptase, an enzyme needed to make copies of HIV.
wasting syndrome	Weight loss, decrease in muscular strength, appetite, and mental activity; associated with AIDS.

LABORATORY TESTS AND CLINICAL PROCEDURES

LABORATORY TESTS

CD4$^+$ cell count

Measures the number of CD4$^+$ T cells (helper T cells) in the bloodstream of patients with AIDS.

A normal count usually is between 500 and 1500 CD4$^+$ cells per mm^3. If the CD4$^+$ count falls below 250 to 200, it is recommended to start treatment with anti-HIV drugs.

ELISA

Screening test to detect anti-HIV antibodies in the bloodstream.

Antibodies to HIV begin to appear within 2 weeks of infection with HIV. If the result of this test is positive, it is confirmed with a **Western blot** test, which is more specific. ELISA is an abbreviation for enzyme-linked immunosorbent assay.

immunoelectrophoresis — **Test that separates immunoglobulins (IgM, IgG, IgE, IgA, IgD).**
This procedure detects the presence of abnormal levels of antibodies in patients with conditions such as multiple myeloma and Waldenström macroglobulinemia.

viral load test — **Measurement of the amount of AIDS virus (HIV) in the bloodstream.**
Two viral load tests are a PCR (polymerase chain reaction) assay and an NASBA (nucleic acid sequence–based amplification) test.

CLINICAL PROCEDURES

computed tomography (CT) scan — **X-ray imaging produces cross-sectional and other views of anatomic structures.**
These x-ray views show abnormalities of lymphoid organs, such as lymph nodes, spleen, and thymus gland.

ABBREVIATIONS

AIDS	acquired immunodeficiency syndrome
CD4⁺ cell	helper T cell
CD8⁺ cell	cytotoxic T cell
CMV	cytomegalovirus—causes opportunistic AIDS-related infection
Crypto	*Cryptococcus*—causes opportunistic AIDS-related infection
ELISA	enzyme-linked immunosorbent assay—test to detect anti-HIV antibodies
G-CSF	granulocyte colony-stimulating factor—cytokine that promotes neutrophil production
GM-CSF	granulocyte-macrophage colony-stimulating factor—cytokine secreted by macrophages to promote growth of myeloid progenitor cells and their differentiation to granulocytes
HAART	highly active antiretroviral therapy—use of combinations of drugs that are effective against AIDS
HD	Hodgkin disease
Histo	histoplasmosis—fungal infection seen in AIDS patients
HIV	human immunodeficiency virus—causes AIDS
HSV	herpes simplex virus
IgA, IgD, IgE, IgG, IgM	immunoglobulins
IL1 to IL15	interleukins
KS	Kaposi sarcoma
MAI	*Mycobacterium avium-intracellulare* (MAI) complex—group of pathogens that cause lung and systemic disease in immunocompromised patients
MoAb	monoclonal antibody
NHL	non-Hodgkin lymphoma
PCP	*Pneumocystis* pneumonia—opportunistic AIDS-related infection
PI	protease inhibitor
RTI	reverse transcriptase inhibitor—for example, zidovudine (Retrovir) or lamivudine (Epivir)
SCID	severe combined immunodeficiency disease
T4 cell	helper T cell (lymphocyte) (same as CD4⁺ cell)
T8 cell	cytotoxic T cell (lymphocyte) (same as CD8⁺ cell)
Treg	regulatory T cell (suppressor T cell)
Toxo	toxoplasmosis—parasitic infection associated with AIDS

PRACTICAL APPLICATIONS

Answers to the questions are on page 571.

MEDICAL TERMINOLOGY IN SENTENCES

1. In addition to the opportunistic infections and malignancies that typically characterize AIDS, pathology of the CNS occurs with some regularity. Specifically, CNS lymphomas, encephalitis, meningitis, progressive leukoencephalopathy toxoplasmosis, and myelitis have been reported in patients with HIV infection. Dementia and delirium [clouding of consciousness] also have been reported as psychiatric complications.
2. Protease inhibitors interrupt HIV replication, blocking an enzyme called protease. When protease is blocked, HIV cannot infect new cells. Protease inhibitors can reduce HIV viral load in the blood and increase $CD4^+$ T cell counts. Examples of protease inhibitors are indinavir (Crixivan) and nelfinavir (Viracept).
3. Lymph nodes that are nontender and rock-hard are suggestive of a diagnosis of metastatic carcinoma.
4. Infectious mononucleosis and Hodgkin disease are more common in young adults, whereas non-Hodgkin lymphoma and chronic lymphocytic leukemia are more common in middle-aged and elderly people.
5. Oral candidiasis (thrush) manifesting without a history of recent antibiotic therapy, chemotherapy, or immunosuppression may indicate the possibility of HIV infection or diabetes.

Questions about Medical Terminology Sentences

1. What parts of the body commonly are affected by the AIDS virus?
   a. Kidney and urinary bladder
   b. Brain and spinal cord
   c. Pancreas and thyroid glands
2. Which CNS condition often is seen in AIDS patients?
   a. Inflammation of the brain and membranes around the brain
   b. Fluid collection in the brain
   c. Disk impinging on the spinal cord
3. Protease is a/an
   a. Antiviral enzyme
   b. Enzyme that helps HIV infect new cells
   c. Reverse transcriptase inhibitor
4. $CD4^+$ T cell counts can be increased by
   a. High levels of HIV in the blood
   b. Protease inhibitors
   c. Lymphocyte-inhibiting agents
5. A diagnosis of metastatic carcinoma means
   a. The tumor has spread to a secondary location
   b. Lymph nodes are not usually affected
   c. The tumor is localized
6. Hodgkin disease
   a. Commonly affects elderly people
   b. Is a type of lymphoma affecting young adults
   c. Is an infectious disease