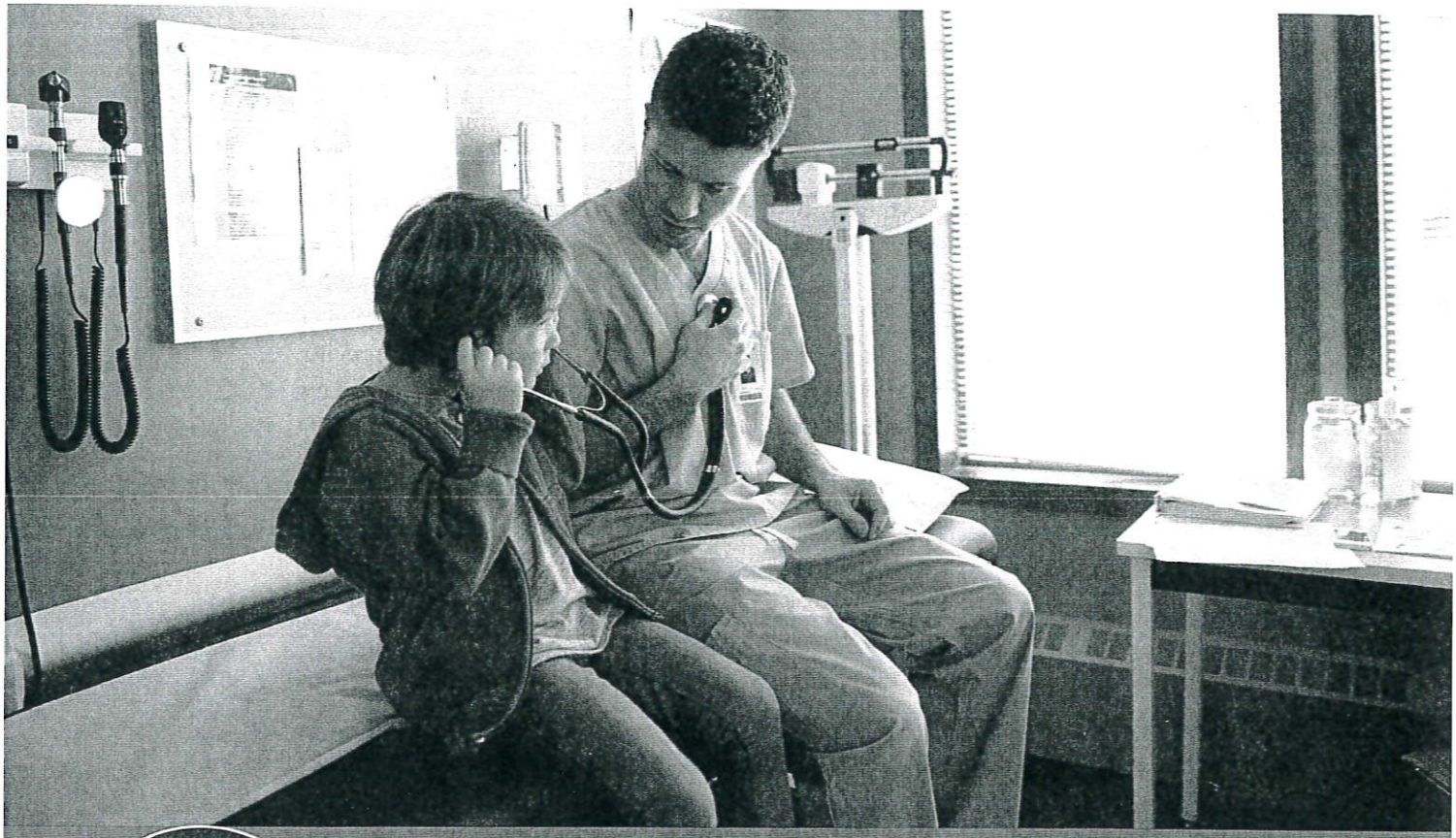

CHAPTER 27

The Immune System

Learning Objectives

After completing this chapter, you should be able to:

27.1 Define and spell the terms for this chapter.
27.2 Identify the structures of the lymphatic system.
27.3 Explain the functions of the immune system.
27.4 Describe how the immune system changes during the life span of a child to an older adult.
27.5 Identify key components to the immune response.
27.6 Differentiate between types of immunity.
27.7 Describe common pathology associated with the immune system.

Case Study

Rosa Gutierrez, age 49, is being seen today by Dr. Bahjat. She has been suffering from what appears to be a multitude of individual problems including low blood pressure, flulike symptoms, extreme fatigue, and what she describes as "hot and cold flashes." Following a thorough physical exam, which includes a complete blood cell count and an evaluation of her entire treatment history, Rosa is diagnosed with chronic fatigue syndrome. As part of her care, Dr. Bahjat has informed her that she must take an active role in her treatment. This includes getting plenty of rest and being monitored for any additional viral infections.

Terms to Learn

acquired active immunity
active immunity
adenoids
afferent vessels
allergen
allergy
anaphylaxis
antibodies
antibody-mediated response
antigen
artificially acquired active immunity
asymptomatic
autoimmune diseases
B lymphocytes
cell-mediated response
chemotherapy
chronic fatigue syndrome (CFS)
complement
cortex
efferent vessels
germinal centers
immune response
immune system
immunosuppressants
infectious mononucleosis
innate immunity
leukocytes
lymph
lymphatic system
lymphedema
lymphocytes
medulla
metastasis
neutrophils
oncogenes
passive immunity
phagocytes
radiation therapy
rheumatoid arthritis (RA)
systemic lupus erythematosus (SLE)
T lymphocytes
thymus gland
tonsils
vaccine

The human body is an intricate specimen that is well guarded and protected by a defense system known as the **immune system**. The immune system consists of tissues, organs, and physiological processes that identify abnormal cells, foreign substances (such as bacteria or toxins), and foreign tissues (such as transplanted organs), and defend against those that might be harmful to the body.

FUNCTION AND STRUCTURES OF THE LYMPHATIC SYSTEM

The immune system has several essential elements. One of these is the **lymphatic system**, which is a subsystem of the circulatory system.

Functions of the Lymphatic System

The functions of the lymphatic system are expanded upon throughout the chapter. Although they are complex in nature, the lymphatic system's overall functions can be easily broken down into four distinct parts. It is responsible for:

- Maintaining fluid balance by draining excess fluid from tissues and returning this fluid to the bloodstream
- Acting as a waste removal system for wastes produced by cells
- Working with the digestive system to absorb and transport fatty acids from the digestive tract to the bloodstream
- Defending the body against infectious and other harmful agents

Overview of the Lymphatic System

The lymphatic system (Figure 27-1) is a network of vessels, ...es, and ducts that more or less parallel in function but are separate from the blood vessels of the circulatory system. This system helps maintain fluid balance by removing excess fluid from the spaces between body cells (interstitial spaces). The fluid, called **lymph**, comes from blood plasma that has leaked out from capillaries. Lymph fluid is straw-colored and similar in appearance to plasma. The lymphatic system collects the lymph and returns it to the bloodstream.

The lymphoid tissues of the lymphatic system function as part of the immune system, helping to defend the body against harmful substances.

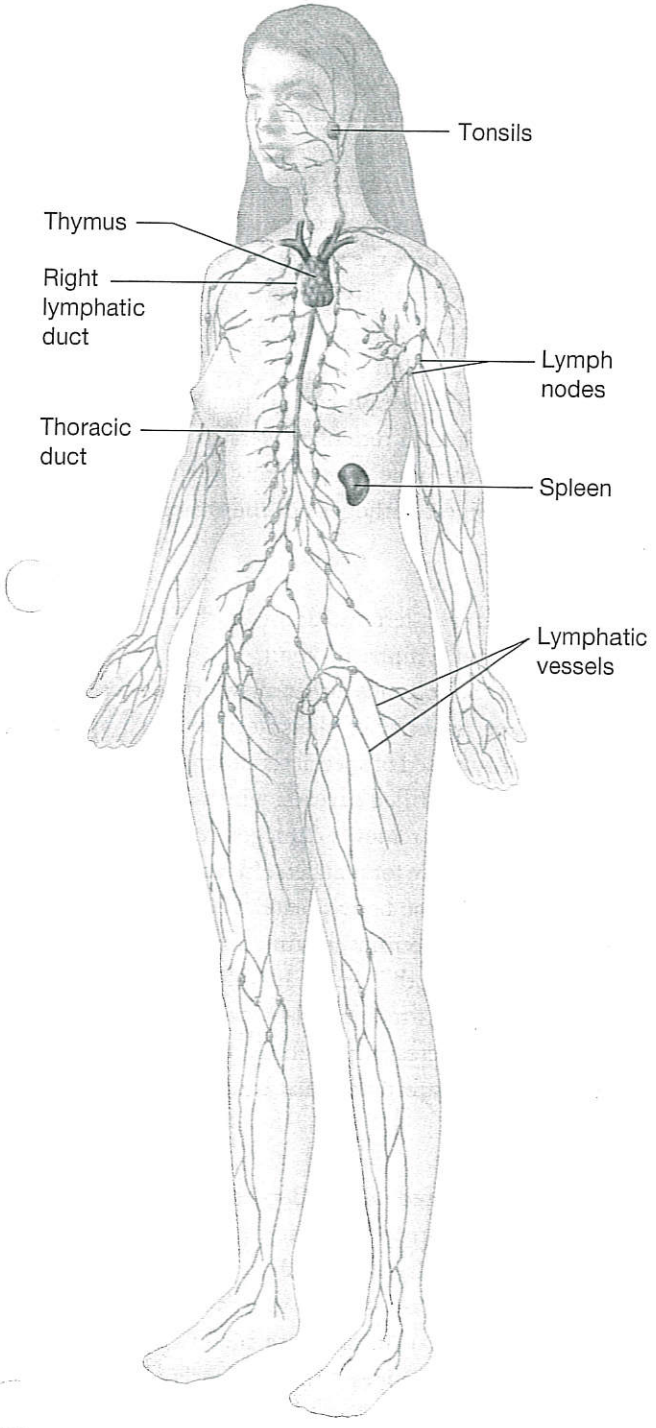

FIGURE 27-1 Components of the lymphatic system.

Lymphatic Pathways

Lymphatic pathways are the structures throughout the lymphatic system that collect and circulate lymph. As noted earlier, lymph is body fluid that comes from plasma (the fluid portion of blood) that has leaked out from the capillaries of the circulatory system. Lymph is highly oxygenated and contains nutrients and small proteins.

Similar to the cardiovascular system, the lymphatic pathways are an intricate system of vessels. The smallest are lymphatic capillaries that join together to form larger lymphatic vessels. The lymphatic vessels transport the lymph to lymph nodes (which are discussed in the next section). From the lymph nodes, lymph is carried away by lymph vessels to lymphatic trunks. Larger than the vessels, the lymphatic trunks circulate the lymph to lymphatic collecting ducts. The two main lymphatic ducts found in the human body are the thoracic duct and the right lymphatic duct. From these two ducts, the lymph empties into the subclavian veins (the veins than run under the right and left clavicle bones). Here, the lymph enters the bloodstream by mixing with the blood that is flowing through the subclavian veins. Figure 27-2 illustrates the lymphatic pathways from smallest to largest structures.

Lymph Nodes

Lymph nodes come in many different sizes and shapes, but most are bean-shaped and about 1 inch long. Covered with a thick fibrous capsule, each node is subdivided into different compartments by inward-pointing trabeculae ("support beams" of tissue that help form a framework). All lymph

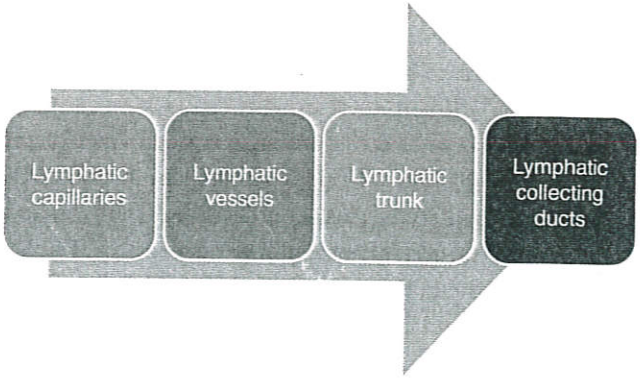

FIGURE 27-2 Structures of the lymphatic pathway from smallest to largest.

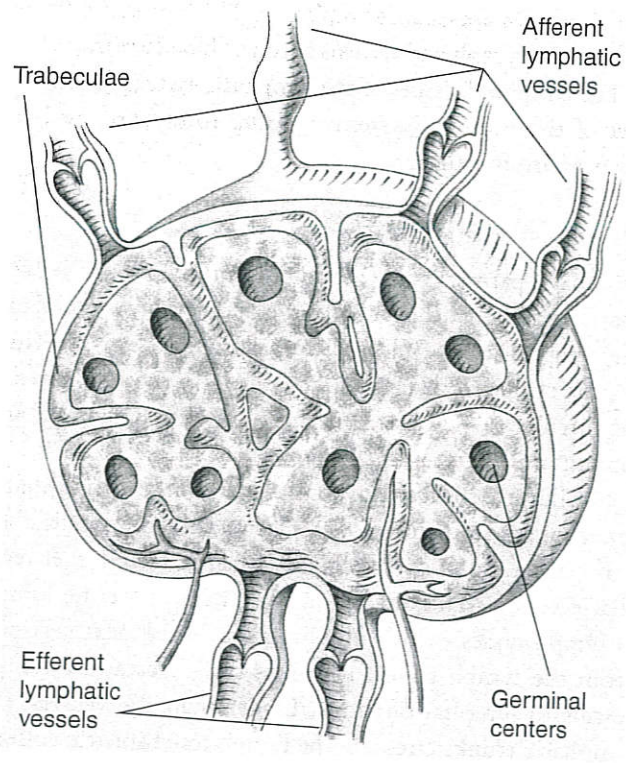

FIGURE 27-3 A cross section of a lymph node.

nodes have multiple (sometimes four or five) **afferent vessels**—vessels that bring lymph into the node. Lymph is circulated out of the node through **efferent vessels**—vessels that carry it away from the node to the rest of the body (Figure 27-3). Each node has two basic parts, an outer **cortex** and an inner **medulla**.

The cortex of the lymph node is populated mainly with lymphocytes, cells that help to initiate the immune response against pathogens (disease-causing organisms). The **germinal centers** in the cortex are the primary locations where B lymphocytes reproduce quite prolifically.

B lymphocytes, also called B cells, are responsible for production of **antibodies**, specialized proteins that lock onto specific **antigens** (receptors on the cells of foreign substances that invade the body). Once an antibody binds with an antigen, it will work to impede the disease-causing process of the antigen or will help to destroy it.

Each unique type of B cell produces only one type of antibody. For example, one B cell will make an antibody that blocks a common-cold virus; another B cell will make an antibody that targets a pneumonia bacterium. When an antigen enters the body, the B cells that produce antibodies against that particular antigen rapidly undergo mitosis and divide, thereby producing large quantities of a specific antibody that will seek out and help destroy the antigen. The antibody may disable the antigen by interfering with its chemical processes or it may cause the antigen's destruction by attracting scavenger cells that will envelop and actually eat (digest) the enemy antigen. This process is called **antibody-mediated response** *or humoral immunity*.

In addition to the part of the lymph node cortex that contains B lymphocytes, the rest of the lymph node cortex contains **T lymphocytes**, also called T cells, which are cells that circulate through the lymph nodes, lymphatic ducts, and bloodstream to seek out any infection. T lymphocytes promote immunity through a **cell-mediated response**. This means that, instead of producing antibodies to attack the antigen as B lymphocytes do, T lymphocytes attack directly by binding themselves to the antigens on the cells of the foreign substance.

After their encounter with a pathogen and its antigens, some B and T lymphocytes become memory cells, whose function is to "remember" the pathogen, which enables them to identify and attack quickly if that same pathogen enters the body again. The working partnership of B and T lymphocytes is further discussed in later parts of this chapter.

The medulla of the lymph node is primarily made up of macrophages attached to reticular fibers that are part of the inner structure of the node. The purpose of the macrophages is to engulf and digest pathogens in the lymph.

Spleen

Located in the upper-left quadrant of the abdomen, the spleen is the largest lymphatic organ.

The tissue of the spleen is either of two types: red pulp or white pulp. The majority of the spleen is made up of red pulp, which is composed of special tissues made up of red and white cells and blood-filled cavities, which are also known as sinuses. The red pulp removes damaged red blood cells and also acts as a storage site for platelets. In fact, the spleen stores about 30 percent of the body's platelets. The white pulp of the spleen is where the immune function occurs. The white pulp is composed of both T and B lymphocytes. As the blood enters the spleen, it is monitored by both T and B cells for infectious antigens, creating antibodies, as needed, to fight potentially harmful substances that could cause illness.

Tonsils

The **tonsils** are located in the depressions of the mucous membranes of the throat and pharynx (Figure 27-4). There are three sets: the palatine, the pharyngeal (**adenoids**), and the lingual. The function of the tonsils is to filter bacteria and aid in the formation of white blood cells. When the tonsils are unable to properly filter bacteria and pathogens, they can become enlarged and infected. This often occurs with the streptococcal bacteria and accompanies strep throat.

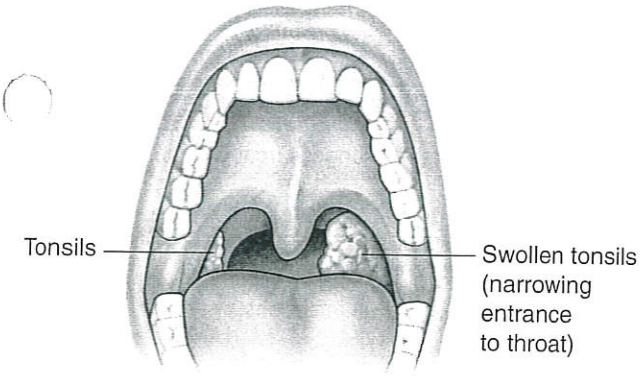

FIGURE 27-4 Tonsils—normal and enlarged.

Professionalism The Life Span

The Child

At birth, infants are incredibly vulnerable to disease and infection because they have not developed immunity. Their small bodies are susceptible to many infections and harmful microorganisms. Immunizations start immediately at birth with a newborn receiving its first hepatitis B vaccination before leaving the hospital. Vaccinations continue on a specific, age-based schedule through 18 to 23 months.

Another important aspect of the immune response is the growth of the thymus gland. This small gland weighs only approximately 0.3 to 0.5 ounces at birth, but it continues to grow and develop throughout puberty. When a child reaches puberty, the thymus gland weighs approximately 1.5 ounces, almost triple its size at birth. During this important time between birth and puberty, the thymus gland is responsible for producing and maturing T cells for the body's defense. After puberty, the thymus gland begins to decrease in size and replace functioning tissue with fatty and connective tissues.

The Older Adult

As the body ages, the immune system slowly changes in various ways. Once increasingly active bone marrow becomes less productive. The thymus gland continues to shrink. In fact, by age 75, the thymus gland is practically completely reduced in size and is composed only of fatty tissue. Lymphatic and circulatory vessels of the arms and legs begin to stiffen as they age, which makes transportation of blood and fluids more challenging. The overall response to invading microorganisms and pathogens begins to slow as both the body and its immune system age. Those advanced in age are much more susceptible to harmful viruses and bacteria than those much younger. Aging also increases the likelihood of developing autoimmune diseases, in which the body begins to attack itself because it perceives its own bodily cells and tissues as harmful substances. Immunizations for older adults are encouraged to protect them from harmful diseases that could wreak havoc on weakened immune systems.

Professionalism The Workplace

As a medical assistant, you work under the license of the physician. You and the physician are both team members, but you are still subordinate to physicians and their levels of education. Always address physicians by their title and name (e.g., "Dr. Morales"). Even if the physician has invited you to call her by a first name, never do so in front of a patient. This can undermine the doctor–patient relationship. Physicians refer to each other as "Dr. So-and-So" when talking to their patients, and the staff should take their cue from the physicians. They have earned the right to be called "Dr.," and the medical assistant should honor that right.

Bone Marrow and Thymus

Bone marrow and the thymus gland are considered to be the primary lymphatic organs because they are where the majority of the body's lymphocytes are produced. Bone marrow contains stem cells that develop into all the cells of the body, including blood cells and the cells of the immune system, in a process called hematopoiesis. The immune system cells produced in the bone marrow either become mature cells of the immune system (B cells and special lymphocytes known as natural killer cells) or they become precursors of cells that will mature in a part of the body other than the bone marrow.

The **thymus gland** is located behind the sternum, in the anterior mediastinum (front of the center section of the chest cavity). The thymus is an endocrine gland, a type of gland that secretes substances into the bloodstream that will be carried throughout the body. The thymus is divided into two distinct compartments, an outer cortex and an internal medulla. Immature lymphoid cells that were created in the bone marrow enter the cortex of the thymus, reproduce and mature, and then move to the medulla, from which they reenter the circulation of the body. The thymus manufactures infection-fighting T cells and helps distinguish normal T cells from those that attack the body's own tissues.

THE IMMUNE RESPONSE AND THE BODY'S DEFENSES

As previously noted, the immune system is the body's defense against infectious organisms and other pathogenic invaders. Through a series of steps called the **immune response**, the cells, tissues, and organs that make up the immune system work together to attack organisms and substances that invade body systems and cause illness and disease.

TABLE 27-1 | Types of Immunoglobulins

Type	Location	Function
IgA	Nose, mouth, digestive tract, ears, eyes, and vagina	Protects external body surfaces from external pathogens.
IgD	Tissue linings of the stomach and chest	Unknown.
IgE	Lungs, skin, and mucous membranes	Triggers allergic reactions and causes the body to react to foreign substances.
IgG	Found in all body fluids, can pass the placenta from mother to fetus, and is the most abundant immunoglobulin in the body	Fights bacterial and viral infections.
IgM	Found in blood and lymph fluid and is the largest immunoglobulin in size	Works in response to infection because it is the first antibody made in a response and initiates other immune system cells to destroy pathogens.

Leukocytes, or white blood cells (WBCs), seek out and destroy harmful organisms. The two types of WBCs are lymphocytes and phagocytes.

Lymphocytes, as already described, enable the body to recognize previous invading organisms/antigens and to produce antibodies in response to the invaders to protect the body.

Phagocytes attack and ingest (engulf, or eat) the invading organism. **Neutrophils** are the most common type of phagocyte. They primarily attack bacteria.

How Immunity Works: Antigens Versus Antibodies

When an antigen is detected, several types of proteins—antibodies/immunoglobulins—work together to recognize and respond to it.

The terms *antibody* and *immunoglobulin* (glycoproteins that function as antibodies) are often used interchangeably. They are found in blood, tissue fluids, and many secretions. Table 27-1 lists common types of immunoglobulins (Ig), their locations within the body, and their purposes.

Once antibodies have been produced by B lymphocytes, they remain in the body, ready to attack and neutralize if the same antigen is presented to the immune system again. Once antibodies have been created to attack a specific antigen (for instance the chicken pox virus), the person cannot get sick from the same antigen again. This is also the reason immunizations, or vaccinations, are given to protect against specific diseases. A vaccine contains either fragments of a disease organism or small amounts of a weakened disease organism. This small amount that is injected is not harmful to the individual receiving the vaccination. Rather, it is just the right amount to stimulate the immune system to develop antibodies that can subsequently recognize and attack the same organism if the body is exposed to it. Although an immunization may not always completely prevent the disease, it will significantly reduce its severity.

Antibodies are singular in their function. Although they are able to recognize an antigen, they are unable to destroy it. This is why they must work with T cells. The T cells destroy antigens that have been tagged by antibodies. T cells also directly destroy infected or abnormally changed cells. The major types of T cells are discussed in Table 27-2.

Antibodies can also activate a part of the immune system called the **complement**. Complement is a made up of a group of proteins that help to destroy infected cells or bacteria viruses.

Immunosuppressants and Immunity

The immune system provides the body with a powerful and necessary defense against invading organisms. However, there are times when the immune system must be overridden. **Immunosuppressants** are medications that suppress the

TABLE 27-2 | The Types and Functions of the T Cells

T Cell Type	Function
Helper T Cell	These cells encourage the formation and activation of B cells and killer T cells and become activated when they are presented with antigens.
Killer T Cell	Also called cytotoxic T cells, these cells lock onto the antigens that were targeted by helper T cells and destroy them.
Memory T Cell	These cells are able to recall antigens that previously invaded the body. They are able to provide a quicker immune response after a reinvasion.

immune system to keep it from working as efficiently and effectively as it normally would in defending the body. Immunosuppressants are usually given after an organ transplant to prevent rejection of the organ. Rejection of an organ occurs because the body recognizes the transplant as foreign tissue and considers it harmful. Thus, the immune system is activated and the body tries to defend itself by rejecting the transplanted tissue. Though immunosuppressants can help prevent organ rejection, these medications render the patient very vulnerable to illness, because the natural immune process is impeded. Extreme stress can also suppress the immune system.

Types of Immunity

There are three types of immunity: innate, active, and passive.

Innate Immunity

Everyone is born with **innate immunity**, sometimes called natural immunity. This immunity is passed down from parents to children. Part of innate of immunity are the physical barriers to foreign invaders. Examples include the skin, tears, and mucous membranes. As discussed in the chapter titled "The Integumentary System," these work together to protect the body as the first line of defense against pathogens.

Innate immunity also renders many of the viruses and bacteria that affect other species incapable of harming human beings. For example, most viruses that are harmful to pets, such as dogs and cats, are not harmful to humans, and vice versa.

Active Immunity

Active immunity, unlike innate immunity, is not present at birth but rather develops after birth. Active immunity is permanent, meaning that it gives the individual lifelong protection against the disease.

Active immunity occurs in one of two ways: as acquired active immunity or as artificially acquired active immunity. Take a moment and consider chicken pox again. When people are exposed to the chicken pox virus (varicella virus) and develop the disease, they become immune to subsequent exposures to the disease. This is an example of **acquired active immunity**, which develops after exposure to a live pathogen.

Artificially acquired active immunity is induced by a **vaccine**, a substance that contains the antigen and stimulates a primary response against the antigen without causing symptoms of the disease. With the chicken pox example, a child who receives the varicella vaccination has artificially acquired active immunity against chicken pox.

Passive Immunity

Passive immunity is not a permanent form of immunity; it lasts only for a little while. Passive immunity may be either natural or artificial. *Passive natural immunity*, for example, occurs when antibodies are passed to an infant through breast milk. The breastfeeding infant will be temporarily immune to antigens to which the mother has been exposed. This temporary form of immunity helps protect the infant against infection during the its early years. *Passive artificial immunity*, provided by an immunization or vaccine, also is effective for a limited time and then must be renewed. For example, a patient who had previously been vaccinated against tetanus needs a current tetanus shot because of a tetanus infection. This specific type of vaccination is considered to be a booster. Booster vaccinations are needed to maintain immunity after a period of many years has passed since the initial immunization.

COMMON PATHOLOGY ASSOCIATED WITH THE IMMUNE SYSTEM

Immune system disorders occur when the immune response is inappropriate, excessive, or absent. A lack of one or more components of the immune system can result in a number of immunodeficiency disorders.

Sometimes the body begins to attack its own healthy cells and tissue, because it begins to identify these cells as harmful foreign pathogens. This is what occurs with an **autoimmune disease**. Autoimmune diseases can affect different systems of the body. Etiology, signs and symptoms, and treatments vary with each disease. Here are some examples:

- Rheumatoid arthritis is an autoimmune disease that attacks the skeletal system.
- Multiple sclerosis is an autoimmune disease that attacks the nervous system.
- Crohn's disease is an autoimmune disease of the digestive system.
- Glomerulonephritis is an autoimmune disease of the urinary system.

Immune system disorders may occur as the result of an infection or illness. Unfortunately, they are also an unintentional side effects of certain medications (Table 27-3).

Acquired Immunodeficiency Syndrome (AIDS)

Acquired immunodeficiency syndrome (AIDS) is a severe disease of the immune system. It is caused by the human immunodeficiency virus (HIV). AIDS develops as a final stage to HIV infection; therefore, not everyone with HIV has AIDS.

TABLE 27-3 | **Disorders of or Associated with the Lymphatic System**

Disorder	Description
AIDS-Related Complex (ARC)	A complex of symptoms that appears in the early stages of AIDS. This is a positive test for the virus but has only mild symptoms of weight loss, fatigue, skin rash, and anorexia.
Elephantiasis	Inflammation, obstruction, and destruction of the lymph vessels, which results in enlarged tissues caused by edema.
Epstein-Barr Virus	Virus believed to be the cause of infectious mononucleosis.
Hodgkin's Disease	Lymphatic system disease that can result in solid tumors in any lymphoid tissue.
Lymphadenitis	Inflammation of the lymph glands. Referred to as swollen glands.
Lymphangioma	A benign mass of lymphatic vessels.
Lymphoma	Malignant tumor of the lymph nodes and tissue.
Lymphosarcoma	Malignant disease of the lymphatic tissue.
Mononucleosis	Acute infectious disease with a large number of atypical lymphocytes. Caused by the Epstein-Barr virus. There may be abnormal liver function and spleen enlargement.
Multiple Sclerosis	Autoimmune disorder of the central nervous system in which the myelin sheath of nerves is attacked.
Non-Hodgkin's Lymphoma	Malignant, solid tumors of lymphoid tissue.
Peritonsillar Abscess	Infection of the tissues between the tonsils and the pharynx. Also called quinsy sore throat.
Sarcoidosis	Inflammatory disease of the lymphatic system in which lesions may appear in the liver, skin, lungs, lymph nodes, spleen, eyes, and small bones of the hands and feet.
Splenomegaly	Enlargement of the spleen.
Thymoma	Malignant tumor of the thymus gland.

HIV compromises the immune system, leaving it highly vulnerable to infections and diseases. This occurs as the lymphocytes, mainly T lymphocytes, become destroyed. As a person's lymphocyte count continues to decline, the progression of the disease quickens.

Although the etiology of AIDS and HIV is the actual virus, sources of contracting the virus vary. HIV can be contracted through unprotected sexual intercourse with an infected partner and through blood contact as well as through shared blood circulation between mother and fetus. It can also be transmitted by a breastfeeding mother to her child through breast milk.

Signs and Symptoms. People stricken with HIV can be **asymptomatic** (without any symptoms) for up to 10 years after contracting the virus. Unfortunately, they are able unknowingly to pass along the virus during this time. The progression to full-blown AIDS is diagnosed when a T lymphocyte count is below 200. This is less than one-half of the normal T-cell count of over 400. Fever, weight loss, diarrhea, swollen lymph glands, and ulcers of the skin, mouth, and genitals are common symptoms of AIDS. Meningitis, encephalitis, and yeast infections afflicting the mouth, esophagus, and vagina are also common. Kaposi's sarcoma, which is a skin cancer marked by red lesions, is frequently seen in AIDS patients. The highly susceptible and deficient immune system makes AIDS patients targets for a multitude of diseases and disorders with varying signs and symptoms.

Treatment. There is currently no cure for HIV and AIDS. As with many autoimmune diseases, treatment is aimed at improving the quality and length of life through symptomatic treatment. Medical advances have included development of medicines that are able to suppress the replication of the virus. These medicines are called antiretroviral drugs. Often multiple forms of these drugs are used in conjunction to form a therapy called highly active antiretroviral therapy (HAART). This form of therapy varies from patient to patient, based on individual needs, and it is very effective if the patient is compliant with taking the medications. After a period of time, some patients become immune to the effects of HAART, and their drug therapy combination must be modified. Scientific research for advanced treatments of HIV continues to increase in hopes that a cure will be found.

Allergies

An **allergy** is an abnormal reaction, or hypersensitivity, t substance that doesn't normally cause a reaction in m

people. An **allergen** is any substance capable of causing an allergic reaction. Most allergic reactions are immune system responses to a "false alarm." When a harmless substance such as dust, mold, pollen, or cat dander is encountered by a person who is allergic to that substance, the immune system overreacts by producing antibodies to attack the allergen.

Allergens enter the body through inhalation, injection, swallowing, or contact with the skin. Almost any substance in the environment can cause an allergic reaction in a sensitive person. Allergic reactions may be localized, such as the red bump caused by a mosquito bite, or may be systemic, such as the red eyes, runny nose, and all-over itchiness of hay fever.

An increase in blood eosinophil levels may occur with allergies. An eosinophil is a granular white blood cell that captures invading microorganisms that cause antibody–antigen reactions and destroys them through phagocytosis (engulfing, or eating).

Anaphylaxis is an extreme, rapidly progressing, and often life-threatening allergic response. For some people this is the response to a bee sting, eating shellfish, or a severe asthma attack. It is sometimes seen in a physician's office after a vaccine or when a medication is first introduced into the patient. For this reason, it is prudent to observe patients for 15 to 30 minutes after any injection.

Signs and Symptoms. The allergic-response interaction of an antigen and antibody causes the release of histamine, which is the substance that produces signs and symptoms of allergies. The symptoms of allergies consist of a local or systemic inflammatory reaction characterized by redness, edema, and heat. Respiratory symptoms include wheezing, sneezing, coughing, and nasal congestion. Allergic conditions include eczema (skin inflammation), allergic rhinitis (irritation of the nasal passages), hay fever, bronchial asthma, urticaria (hives), and food allergies.

During anaphylaxis, the most severe form of allergic response, blood pressure drops, which causes multiple issues, including impeded function of bodily organs. Anaphylaxis also involves swelling in the neck and throat that can cause breathing difficulties. The swelling narrows the airway and can lead to hypoxia (decreased oxygen in the blood) and death. Therefore, it is vital to react quickly to any complaint of swelling or tickling of the throat.

Treatment. Allergies are rarely cured, but many medications, supplements, and other treatment options are available to help relieve symptoms. The treatment for allergies consists of medications, such as the antihistamine diphenhydramine (Benadryl), allergy testing to determine the exact allergen, and desensitization. Desensitizing injections involve administering minute amounts of the allergen into the patient's system over an extended period of time to build and develop a tolerance for the allergen in the patient. Desensitization is necessary if the allergic reactions significantly interfere with the patient's lifestyle or are life threatening. The best strategy for a person with an allergy is to avoid the offending allergen. Reactions to certain airborne allergens may be treated by the use of air filters and dehumidifiers.

Epinephrine is used in the event of anaphylaxis. Epinephrine is a form of adrenaline that surges through the body, causing an increase in blood pressure that counteracts the effects of the allergic reaction. Most patients who suffer from severe allergic reactions are prescribed an EpiPen (containing a single dose of epinephrine) or similar device, which the patient can use to self-administer an injection in the event of an exposure to the harmful allergen (Figure 27-5).

Cancer

Cancer is a collective term for multiple diseases that develop from abnormal cellular activity. Normal body cells grow and, through mitosis, divide. Normal cells automatically stop growing and dividing; eventually they die. Cancer cells are abnormal in form and function. They grow rapidly and keep on growing. Cancer cells do not work on behalf of the body. Instead, they make use of the body's resources at the expense of healthy cells through their uncontrolled growth and reproduction. Cancer cells do not die on their own.

Similar to the way normal cells with the same function come together to form tissues, cancer cells join together to form tumors or masses. Tumors that are cancerous are called malignant tumors. A growing tumor can destroy the normal cells around it and damage the body's healthy tissues. Sometimes cancer cells break away from the original tumor and travel via the bloodstream or lymphatic system to other areas of the body, where they keep growing and form new tumors. This process is called **metastasis**.

Whereas the causes of cancer are relatively unknown, certain risk factors may predispose a person to cancer. These

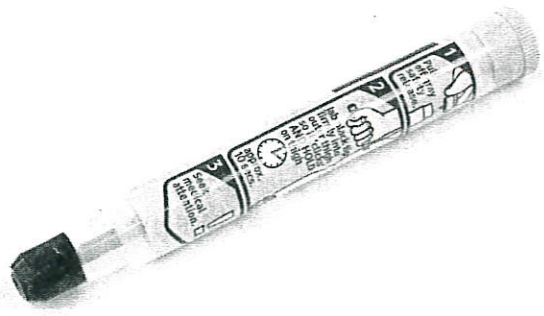

FIGURE 27-5 An EpiPen is used in cases of anaphylactic shock.

include a suppressed immune system; exposure to radiation, tobacco, toxins, or environmental stressors; and some viruses.

Cancer and the Immune System

The immune response is critical to eliminating or controlling cancer. An immune system that is operating at its highest level is alert to destructive cancerous cells and will attack them before the cells have the chance to grow and multiply uncontrollably. A suppressed or impaired immune response fails to respond in a timely manner and becomes overwhelmed by a massive number of corrupted cancer cells that have multiplied rapidly and undetected.

Carcinogens are cancer-causing agents that can transform oncogenes. Examples of carcinogens include tobacco smoke, various chemicals, radiation, and asbestos, to name a few. **Oncogenes** are genes that control cell growth and multiplication and that can produce cancer cells when they come into contact with carcinogens.

Signs and Symptoms. Cancer signs and symptoms are vast and depend on the site of the tumor. Some signs and symptoms common, but not limited, to cancer, include tissues that change color and shape (melanoma), lumps that form (breast cancer, uterine cancer, prostate cancer), shortness of breath (lung cancer), hoarse speech (throat cancer), and depressed organ function (thyroid). Generalized symptoms that often occur with most forms of cancer include extreme fatigue, decreased appetite, unintentional and often rapid weight loss, and fever and chills.

Treatment. Cancer may be treated with surgery, chemotherapy, radiation, or a combination of all three. The choice of treatment generally depends on the type of cancer and the stage of the tumor. Staging of a cancerous tumor indicates the extent of the disease based on the size of the tumor, surrounding lymph node involvement, and if (and how far) it has metastasized throughout the body. These three criteria—tumor, lymph node involvement, and metastasis—are known as the TNM system of staging, or evaluating the extent of a cancer. As a cancer progresses, the stage assigned to the cancer increases. The stages of cancer are as follows:

- Stage 0—Early detection indicated by localized cancer cells that are only a few layers deep. This is termed *carcinoma in situ*.
- Stage I—Deeper cell layers have been invaded by cancer cells, and some cells may have spread to surrounding tissues.
- Stage II—Surrounding tissue has been affected by cancer cells, but the cancer is contained at the primary site of cancer.
- Stage III—Cancer cells have spread beyond the primary site to nearby sites.
- Stage IV—Cancer cells have metastasized to or body organs, other than the primary site.

Cancer surgery is performed to remove cancerous tissue and perhaps some surrounding tissue. It is commonly used for breast cancer, prostate cancer, colon cancer, and some others. If the cancer has not metastasized, surgery may provide a cure.

In **chemotherapy**, anticancer drugs are used to treat the cancerous growth or tumor. The drugs may be intended to keep the cancer from spreading, slow its growth, kill cancer cells, or relieve symptoms. These medicines are sometimes taken in pill form but more often are given intravenously. Chemotherapy usually is given over a prescribed number of weeks or months. Often, a port-a-cath, a permanent intravenous (IV) catheter, is placed under the skin into one of the larger blood vessels of the upper chest. This method allows the administration of several courses of chemotherapy and other medicines through the catheter without the need to insert a new IV needle each time. The catheter remains under the skin until the cancer treatment is completed. The side effects of chemotherapy can be very intense and include severe nausea, vomiting, diarrhea, hair loss (all over the body), and weight loss.

Chemotherapy may cure some cancers.

Radiation therapy uses high-energy waves, such as X-rays, to damage and destroy cancer cells. This form of treatment causes tumors to shrink and, in some cases, disappear completely. Radiation therapy is one of the most common treatments for cancer. It is often prescribed in the earlier stages of cancer when the chance of cure is greatest.

The most modern form of cancer therapy involves creating mutated defense cells that are "programmed" to specifically target cancer cells. This empowers the body's own immune system to target only cancer cells, rather than also destroying healthy cells. This process is known as immunotherapy.

Professionalism

Patients receiving chemotherapy sometimes notice changes with their sense of smell. Smells can also trigger allergic reactions in patients who have heightened sensitivities. For these reasons as well as others, it is important that the medical assistant not wear strong-smelling perfume, scented body lotions, or aftershave lotio

Professionalism The Law

Some immunodeficiency disorders, such as chronic fatigue syndrome, may be associated with a person's age and emotional life. As a member of the health care profession, if you suspect a person may be dealing with emotional issues that may have some relevance or underlying health implication, it is important to notify the physician immediately and not to take it on yourself to "diagnose" that person's emotional health. The medical assistant's role is to provide assistance in the care and treatment of such disorders and, when required, to provide the patient with education.

Professionalism

Although long, painted fingernails may be attractive, there is no place for them in the medical office. Patients may be harmed by microbes that can flourish under false nails or long nails, and chipped nail polish may also support the growth of bacteria on nails. The Centers for Disease Control has published a *Guideline for Hand Hygiene in Health-Care Settings* that recommends health care workers "not wear artificial fingernails or extenders when having direct contact with patients at high risk." The practice where you work may have even stricter policies about fingernails. A good guideline for everyone who works in a medical practice is to keep nails natural and short.

JUDGMENT CALL

Although most patients at the family practice office get better, a friendly and much-loved patient has been diagnosed with incurable cancer. How should the medical assistant respond to his questions about death?

Chronic Fatigue Syndrome

Chronic fatigue syndrome (CFS) is a continual sense of tired- that is not helped by periods of rest or sleep. There is not a definitive etiology of CFS. Many physicians consider CFS to be a shared condition of many preexisting and possibly undiagnosed diseases. Some believe that a defective immune system is the culprit. Other possible conditions that are commonly found in those with CFS include low hormone levels, hypotension (low blood pressure), viral infections, yeast infections, food allergies, and exposure to hazardous chemicals.

Signs and Symptoms. Symptoms include intense and continual fatigue lasting for at least 6 months that is not relieved with rest, lack of energy, depression and anxiety, and sleep disorders. Flulike symptoms including muscle aches, low grade fevers, tender lymph nodes, and headaches may also be associated with CFS.

Treatment. Any treatment regimen for CFS generally begins with a thorough evaluation of the patient's prior treatment history. Medications to treat depression and anxiety may be prescribed. Both the quality and quantity of sleep are important factors that are addressed by a treating physician. A healthy diet, incorporating exercise into daily life, and proper knowledge and implementation of sleep management tech- es are helpful. Rest, relaxation, and coping mechanisms for dealing with stress are also an important factor in the treatment of a patient with CFS. Educating the patient with emphasis on becoming an active participant in the treatment regimen is extremely important in the treatment of CFS.

Infectious Mononucleosis

Infectious mononucleosis is caused by the Epstein-Barr virus (EBV). This specific infection is in the same virus family as herpes. Mononuclear white blood cells multiply in number. The layman's term for this infection, *mono*, is derived from the increase of these mononuclear WBCs. Especially frequent in teens and young adults, this virus is commonly spread through saliva and is often called the *kissing disease*.

Signs and Symptoms. Common signs and symptoms develop after the 4- to 8-week incubation period (the time between exposure and when first symptoms develop). Afflicted patients experience fever, fatigue, sore throat, night sweats, muscle weakness, headaches, and swollen lymph glands.

Treatment. There is no treatment for this virus, so focus is placed on alleviating symptoms. Patients are advised to get plenty of rest. For sore throats, gargling with saltwater or using throat lozenges is helpful. Analgesics (pain relievers) and antipyretics (fever reducers) are also prescribed. Corticosteroids may be prescribed for severe swelling of the throat and/or tonsils. If neglected, mono can lead to liver inflammation (hepatitis) and enlargement of the spleen. Recovery from mono generally takes several weeks. However, for some individuals, it may be several months before they regain their normal energy levels.

Lymphedema

Lymphedema is a condition that derives from a damaged or dysfunctional lymphatic system that results in an accumulation of lymphatic fluid, which causes swelling (Figure 27-6). There are two types of lymphedema; the type is determined

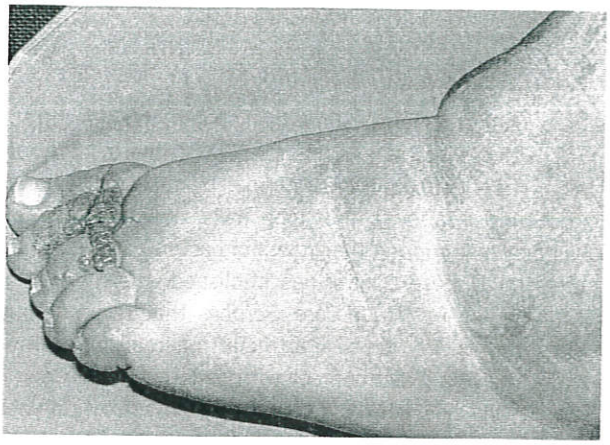

FIGURE 27-6 Chronic lymphedema.

by the specific etiology. The first, primary lymphedema, can be hereditary. It is marked by a developmental disorder of the lymphatic vessels that carry lymph. A fetus's exposure to an infection or injury may cause primary lymphedema; however, more likely causes of this congenital disorder center around difficulties that occur during childbirth.

The other form of lymphedema is termed secondary lymphedema, and its etiology is an interruption of lymphatic flow caused by an obstruction or damage to the lymphatic system.

Causes of secondary lymphedema are multiple as they can stem from anything that could damage or destroy lymphatics, such as surgery, infections, burns, and serious wounds or injuries. Cancer treatments, including surgical removal of lymph nodes and radiation, may also be implicated in this secondary form.

Signs and Symptoms. Swelling at the lymph nodes is the primary sign. Generally, swelling is limited to one arm or one leg as the lymphatic fluid pools in the affected extremity.

Treatment. There are multiple options for increasing the flow of lymphatic fluid; however, curing lymphedema is not possible. Exercises may be encouraged to help with movement and directing the accumulated fluid away from the extremity. Compression stockings and bandages are also used to put pressure on the extremity with the idea of moving the lymph fluid toward the trunk of the body. A specialized massage, called manual lymph drainage, is available for some patients. The massage therapist uses special strokes and movements to circulate the lymph fluid toward healthier lymph nodes. Employing several of these treatments is known as complete decongestive therapy (CDT). However, a patient's overall health must be taken into consideration when employing some of these methods. Those with a history of blood clots, diabetes, and other diseases need specialized consideration for the treatment of lymphedema. Additionally, blood pressure should not be taken in an extremity with lymphedema.

Rheumatoid Arthritis

Rheumatoid arthritis (RA) is a chronic autoimmune disease. It occurs when the body's immune defenses attack tissue in the joints, leading to pain and degeneration of the articular (joint) cartilage. The disease and its treatment also increase mortality, and patients often have a shorter life expectancy than their healthy peers.

RA causes a great deal of suffering and reduced quality of life, and can pose a major financial burden. Individuals with a family history of RA are four times more likely to develop the disease than others.

Signs and Symptoms. Symptoms include pain, warmth, and stiffness in the joints of the wrists, fingers, knees, feet, and ankles. Pain and stiffness gradually increase as the disease progresses. Morning joint stiffness is a common sign. Over time, the affected joints will have decreased range of motion and may become deformed. Numbness, tingling, and burning sensations may also be felt near the affected joint. Fatigue, poor sleep patterns, and anemia are also common with RA.

Treatment. The treatment of RA is based on medication regimens and educating the patient on how to facilitate d activities. Drugs are used to treat and reduce the symptoms and to help the patient to function at a more productive level and have a better quality of life. However, because drugs are only effective symptomatically, they do not actually treat or cure the disease. Antiinflammatory medications, rest, and exercises to promote joint strengthening and mobility are used to treat RA. On initial diagnosis, disease-modifying antirheumatic drugs (DMARDs) are often prescribed to patients. Because these drugs have severe side effects, routine blood work to monitor the patient is required for patients taking DMARDs.

Systemic Lupus Erythematosus

Systemic lupus erythematosus (SLE) is another autoimmune disorder. Patients suffering from SLE produce abnormal antibodies in their blood that target tissues within their own body rather than foreign infectious agents. SLE is called a systemic disorder because its effects may appear in many parts of the body—in other words, it is system wide. In addition to the signs and symptoms listed, Figure 27-7 depicts systemic effects, signs, and symptoms of this disease.

Women constitute 90 percent of patients with SLE and are generally diagnosed before menopause. There is a ge component as well; the risk of developing SLE rises if a close

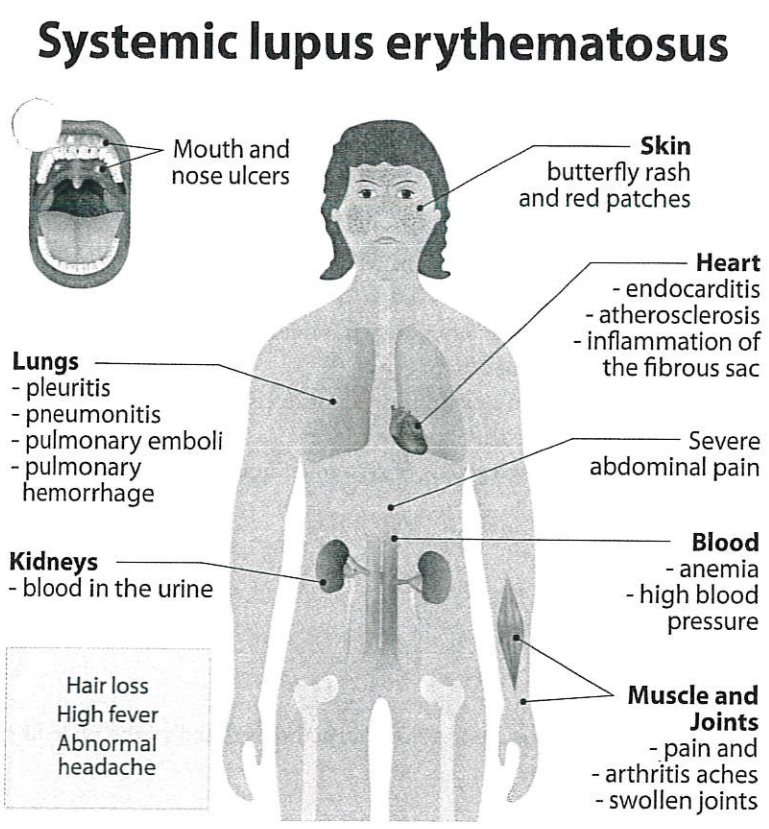

FIGURE 27-7 Systemic effects of SLE.

ily member has it. As the exact cause is unknown with this autoimmune disorder, the disease may develop after it has been triggered by a certain incident. Incidents that have been linked to triggering lupus include surgery, illness resulting from infection, pregnancy, and even exposure to sunlight.

Signs and Symptoms. SLE can produce many different signs and symptoms and imitate many other diseases. This can make it difficult to initially diagnose. Many patients with SLE have pain and swelling in the joints. They may also suffer from general fatigue, fever, chills, weight changes (both loss and gain), and headache. Hair loss, mouth sores, and sensitivity to light are also attributed to this disease. One of the most common signs seen in one half of those diagnosed with SLE is the "butterfly" rash. This is a rash that covers the bridge of the nose and the cheeks and it worsens in sunlight.

Round (discoid) lesions that are raised and scaly affect about 20 percent of patients with SLE. This condition is known as discoid lupus erythematosus. If left untreated, these scaly lesions expand and can cause severe scarring.

A condition that may be present with lupus is vasculitis, or inflamed blood vessels, characterized by red marks in any area of the body. Sometimes deep red lumps appear, especially on the leg, where they may develop into ulcers. In some people, the tips of the fingers and toes may develop reddish-purple lesions.

Treatment. Unfortunately, cures are not available for most autoimmune diseases, and SLE is no exception. Treatment is usually aimed at reducing the immune response and controlling symptoms by using drugs such as corticosteroids. SLE is a chronic, lifelong condition with periods of remission and relapse. Antiinflammatory drugs may also be prescribed to alleviate other symptoms.

SUMMARY

The immune system is the body's defense against infectious organisms and other pathogenic invaders. The lymphatic system and other organs, including the spleen, thymus, tonsils, and bone marrow, function together in the immune system. There are three types of immunity: innate, active, and passive. When the immune system is functioning properly, it attacks antigens by forming antibodies. Immune system disorders occur when the immune response is compromised, exaggerated, or absent.

Disorders of the immune system may be inherited, acquired through infection or other illness, or produced as an inadvertent side effect of certain drug treatments. An allergy is an overreaction of the immune system to an allergen. Many cancers appear to have a genetic component, but cancer production is usually a combination of predisposing genetic makeup and environmental carcinogenic factors that trigger the inappropriate immune response. Treatment for cancer includes surgery, radiation, chemotherapy, and measures that boost the correct immune response.

Viral infections can cause infectious mononucleosis. Chronic fatigue syndrome has many possible causes. A dysfunctional immune system may lead to lymphedema. When the immune system inappropriately attacks joints, rheumatoid arthritis results. Systemic lupus erythematosus is an autoimmune disease that causes systemic problems.