some of which are found in lymphocytes and are required for lymphocyte function. Zinc deficiency also may result from inadequate absorption in the GI tract or excessive losses in urine, feces, or through the skin with such disorders as chronic renal disease, chronic diarrhea, burns, or severe psoriasis. Vitamin deficiencies may also depress T- and B- cell function because several (eg, A, E, folic acid, pantothenic acid, and pyridoxine) also are enzyme cofactors in lymphocytes.

Stress

There is evidence that stress depresses immune function and therefore increases risks for development of infection and cancer. The connection between the stress response and the immune response is thought to involve neuroendocrine mechanisms. The stress response is characterized by increased activity of catecholamine neurotransmitters in the central and autonomic nervous systems (eg, norepinephrine, epinephrine) and increased secretion of cortisol from the adrenal cortex. Cortisol and other corticosteroids are well known to suppress immune function and are used therapeutically for that purpose. The immune response is affected by these neuroendocrine influences on lymphoid organs and lymphocyte functions because lymphocytes have receptors for many neurotransmitters and hormones.

IMMUNE DISORDERS

Dysfunction of the immune system is related to many different disease processes, including allergic, autoimmune, immunodeficiency, and neoplastic disorders. Each of these is described in the following list to assist in understanding the use of drugs to alter immune functions:

- In *allergic disorders*, the body erroneously perceives normally harmless substances (eg, foods, pollens) as antigens and mounts an immune response. More specifically, IgE binds to antigen on the surface of mast cells and causes the release of chemical mediators (eg, histamine) that produce the allergic manifestations. This reaction may cause tissue damage ranging from mild skin rashes to life-threatening anaphylaxis.
- In *autoimmune disorders*, the body erroneously perceives its own tissues as antigens and elicits an immune response, often inflammatory in nature. Hashimoto's thyroiditis, multiple sclerosis, myasthenia gravis, rheumatoid arthritis, scleroderma, systemic lupus erythematosus (SLE), and type 1 diabetes mellitus are considered autoimmune disorders. Most of these disorders occur more often in women than men, possibly because of hormonal differences.

  Autoimmune processes may damage virtually every body tissue, and various mechanisms have been proposed to explain their development. Some evidence exists for different mechanisms, and it is probable that autoimmunity develops from several events rather than a single one
- In *immunodeficiency disorders*, the body is especially susceptible to infections and neoplastic diseases. AIDS is a major immunodeficiency disorder that decreases the numbers and almost all functions of T lymphocytes and several functions of B lymphocytes and monocytes. Immunodeficiency also is induced by severe malnutrition, cancer, and immunosuppressant drugs.
- In *neoplastic disease*, immune cells lose their ability to destroy mutant cells or early malignant cells. This effect could result from immunodeficiency states or from cancer cells that are overwhelming in number or highly malignant. Mutant cells constantly occur during cell division, but few survive or lead to cancer. Most mutant cells simply die; some survive but retain the normal controls that prevent excessive growth; and some are destroyed by immune processes activated by abnormal proteins found in most mutant cells.

DRUGS THAT ALTER HEMATOPOIETIC AND IMMUNE RESPONSES

Several hematopoietic and immune cytokines have been synthesized for therapeutic purposes. Hematopoietic agents are used to prevent or treat symptoms (eg, anemia, neutropenia) caused by disease processes or their treatments.

Drugs that modify the immune system are used to prevent or treat infections, treat immunodeficiency disorders and cancer, and to prevent or treat rejection of transplanted tissues or organs.

Methods include administering exogenous antigens (eg, immunizations and desensitization procedures), strengthening antigens (eg, an antigen that is too weak to elicit an immune response), or suppressing the normal response to an antigen. In desensitization procedures, weak extracts of antigenic substances (eg, foods, plant pollens, penicillin) are prepared as drugs and administered in small, increasing amounts so the patient develops a tolerance for the substances and avoids serious allergic reactions.

Overall, drugs can be given to stimulate immune responses (immunizing agents [see Chap. 43]; stimulate hematopoiesis and immune responses [see Chap. 44]); or suppress normal immune responses (immunosuppressants [see Chap. 45]).

Review and Application Exercises

1. What is the difference between innate and acquired immunity?
2. What are methods of producing active acquired immunity?
3. Which WBCs are phagocytes?
4. Describe phagocytosis.