physical barriers and produce mucus that traps foreign substances so they may be expelled from the body. Mucous membranes also produce other secretions (eg, gastric acid) that kill ingested microorganisms. Additional internal mechanisms include the normal microbial population, which is usually nonpathogenic and controls potential pathogens, and secretions (eg, perspiration, tears, and saliva) that contain lysozyme, an enzyme that destroys the cell walls of gram-positive bacteria.

If a foreign substance gets through the aforementioned defenses to penetrate body tissues and cause cellular injury, an inflammatory response begins immediately. Cellular injury may be caused by chemicals, hypoxia, ischemia, microorganisms, excessive heat or cold, radiation, and nutritional deficiencies or excesses. The cellular response to injury involves inflammation, a generalized reaction to any tissue damage. Inflammation is an attempt to remove the damaging agent and repair the damaged tissue. The hemodynamic aspect of inflammation includes vasodilation, which increases blood supply to the injured area, and increased capillary permeability, which allows fluid to leak into tissue spaces. The cellular aspect involves the movement of white blood cells (WBCs) into the area of injury. WBCs are attracted to the injured area by bacteria, tissue debris, plasma protein fractions (complement), and other substances in a process called *chemotaxis*. Once they reach the area, they phagocytize causative agents and tissue debris.

The final defense mechanism is the immune response, and development of an effective response involves lymphoid cells, inflammatory cells, and hematopoietic cells. Immune responses, which occur more slowly than inflammatory responses, stimulate production of antibodies and activated lymphocytes to destroy foreign invaders and mutant body cells.

Inflammatory and immune responses interact in complex ways and share a number of processes, including phagocytosis. They produce their effects indirectly, through interactions among cytokines and other chemical mediators. Cytokines induce WBC replication, phagocytosis, antibody production, fever, inflammation, and tissue repair. Other chemical mediators (eg, histamine, prostaglandins) are synthesized or released by mast cells, basophils, and other cells. Once activated, mediators may exert their effects on tissues locally or at distant target sites. They also may induce or enhance other mediators. Little information is available about the chemical mediators of chronic inflammation, but immunologic mechanisms are thought to play an important role.

IMMUNITY

Immunity indicates protection from a disease, and the major function of the immune system is to detect and eliminate foreign substances that may cause tissue injury or disease. To perform this function, the immune system must be able to differentiate body tissues (self) from foreign substances (nonself). Self tissues are recognized by distinctive protein molecules on the surface membranes of body cells. These molecules or markers are encoded by a group of genes called the major histocompatibility complex (MHC). MHC markers are essential to immune system function because they regulate the antigens to which a person responds and allow immune cells (eg, lymphocytes and macrophages) to recognize and communicate with each other. Nonself or foreign antigens are also recognized by distinctive molecules, called epitopes, on their surfaces. Epitopes vary widely in type, number, and ability to elicit an immune response.

A normally functioning immune system does not attack body tissues labeled as self but attacks nonself substances. In most instances, a normally functioning immune system is highly desirable. With organ or tissue transplants, however, the system responds appropriately but undesirably when it attacks the nonself grafts. An abnormally functioning immune system causes numerous diseases. When the system is hypoactive, immunodeficiency disorders develop in which the person is highly susceptible to infectious and neoplastic diseases. When the system is hyperactive, it perceives ordinarily harmless environmental substances (eg, foods, plant pollens) as harmful and induces allergic reactions. When the system is inappropriately activated (it loses its ability to distinguish between self and nonself, so an immune response is aroused against the host's own body tissues), the result is autoimmune disorders, such as systemic lupus erythematosus and rheumatoid arthritis. Many other disorders, including diabetes mellitus, myasthenia gravis, and inflammatory bowel diseases, are thought to involve autoimmune mechanisms. To aid understanding of the immune response and drugs used to alter immune response, more specific characteristics, processes, and functions of the immune system are described.

Types of Immunity

Innate immunity, which is not produced by the immune system, includes the general protective mechanisms described.

Acquired immunity develops during gestation or after birth and may be active or passive. *Active immunity* is produced by the person's own immune system in response to a disease caused by a specific antigen or administration of an antigen (eg, a vaccine) from a source outside the body, usually by injection. The immune response stimulated by the antigen produces activated lymphocytes and antibodies against the antigen. When an antigen is present for the first time, production of antibodies requires several days. As a result, the serum concentration of antibodies does not reach protective levels for approximately 7 to 10 days, and the disease develops in the host. When the antigen is eliminated, the antibody concentration gradually decreases over several weeks.

The duration of active immunity may be brief (eg, to influenza viruses), or it may last for years or a lifetime. Long-term active immunity has a unique characteristic called *memory*. When the host is re-exposed to the antigen, lymphocytes are activated and antibodies are produced rapidly, and the host does not contract the disease. This characteristic