allows "booster" doses of antigen to increase antibody levels and maintain active immunity against some diseases.

Passive immunity occurs when antibodies are formed by the immune system of another person or animal and transferred to the host. For example, an infant is normally protected for several months by maternal antibodies received through the placenta during gestation. Also, antibodies previously formed by a donor can be transferred to the host by an injection of immune serum. These antibodies act against antigens immediately. Passive immunity is short-term, lasting only a few weeks or months.

Cellular and Humoral Immunity

Types of acquired immunity have traditionally been separated into cellular immunity (mainly involving activated T lymphocytes in body tissues) and humoral immunity (mainly involving B lymphocytes and antibodies in the blood). However, it is now known that the two types are closely connected, that virtually all antigens elicit both cellular and humoral responses, and that most humoral (B cell) responses require cellular (T cell) stimulation.

Although most humoral immune responses occur when antibodies or B cells encounter antigens in blood, some occur when antibodies or B cells encounter antigens in other body fluids (eg, tears, sweat, saliva, mucus, and breast milk). The antibodies in body fluids other than blood are produced by a part of humoral immunity sometimes called the secretory or mucosal immune system. The B cells of the mucosal system migrate through lymphoid tissues of tear ducts, salivary glands, breasts, bronchi, intestines, and genitourinary structures. The antibodies (mostly immunoglobulin A [IgA], some IgM and IgG) secreted at these sites act locally rather than systemically. This local protection combats foreign substances, especially pathogenic microorganisms, that are inhaled, swallowed, or otherwise come in contact with external body surfaces. When the foreign substances bind to local antibodies, they are unable to attach to and invade mucosal tissue.

Antigens

Antigens are the foreign (nonself) substances (eg, microorganisms, other proteins, or polysaccharides) that initiate immune responses. Antigens have specific sites that interact with immune cells to induce the immune response. The number of antigenic sites on a molecule depends largely on its molecular weight. Large protein and polysaccharide molecules are complete antigens because of their complex chemical structures and multiple antigenic sites. Smaller molecules (eg, animal danders, plant pollens, and most drugs) are incomplete antigens (called haptens) and cannot act as antigens by themselves. However, they have antigenic sites and can combine with carrier substances to become antigenic. Antigens also may be called *immunogens.* In discussions of allergic conditions, antigens are often called *allergens.*

Immune Responses to Antigens

The immune response involves antigens that induce the formation of antibodies or activated T lymphocytes. The initial response occurs when an antigen is first introduced into the body. B lymphocytes recognize the antigen as foreign and develop antibodies against it. Antibodies are proteins called immunoglobulins that interact with specific antigens.

Antigen–antibody interactions may result in formation of antigen–antibody complexes, agglutination or clumping of cells, neutralization of bacterial toxins, destruction of pathogens or cells, attachment of antigen to immune cells, coating of the antigen so that it is more readily phagocytized (opsonization), or activation of complement (a group of plasma proteins activated by recognition of an antigen–antibody complex, bacteria, or viruses and essential to normal inflammatory and immunologic responses). Activated complement stimulates chemotaxis (of monocytes, neutrophils, basophils, and eosinophils) and the release of hydrolytic enzymes, actions that result in the destruction or inactivation of the invading antigen. With a later exposure to the antigen, antibody is rapidly produced. The number of exposures required to produce enough antibodies to bind a significant amount of antigen is unknown. Thus, an allergic reaction may occur with the second exposure or after several exposures, when sufficient antibodies have been produced.

Antigen–T lymphocyte interactions stimulate production and function of other T lymphocytes and help to regulate antibody production by B lymphocytes. T cells are involved in delayed hypersensitivity reactions, rejection of tissue or organ transplantats, and responses to neoplasms and some infections.

IMMUNE CELLS

Immune cells (Fig. 42–1) are WBCs found throughout the body in lymphoid tissues (bone marrow, spleen, thymus, tonsils and adenoids, Peyer's patches in the small intestine, lymph nodes, and blood and lymphatic vessels that transport the cells). When exposure to an antigen occurs and an immune response is aroused, WBCs move toward the antigen in a process called *chemotaxis.* Once WBCs reach the area, they phagocytize the antigen. Specific WBCs are granulocytes (neutrophils, eosinophils, basophils), and nongranulocytes (monocytes and lymphocytes). Although all WBCs play a role, neutrophils, monocytes, and lymphocytes are especially important in phagocytic and immune processes. Granulocytes often contain inflammatory mediators or digestive enzymes in their cytoplasm.

Neutrophils, the body's main defense against pathogenic bacteria, are the major leukocytes in the bloodstream. Substances (eg, complement) released from infected or inflamed tissue cause neutrophils to migrate to the affected tissue. These WBCs arrive first, usually within 90 minutes of injury. They localize the area of injury and phagocytize organisms or particles by releasing digestive enzymes and oxidative metabolites that kill engulfed pathogens or destroy other types of foreign particles. The number of neutrophils increases greatly during