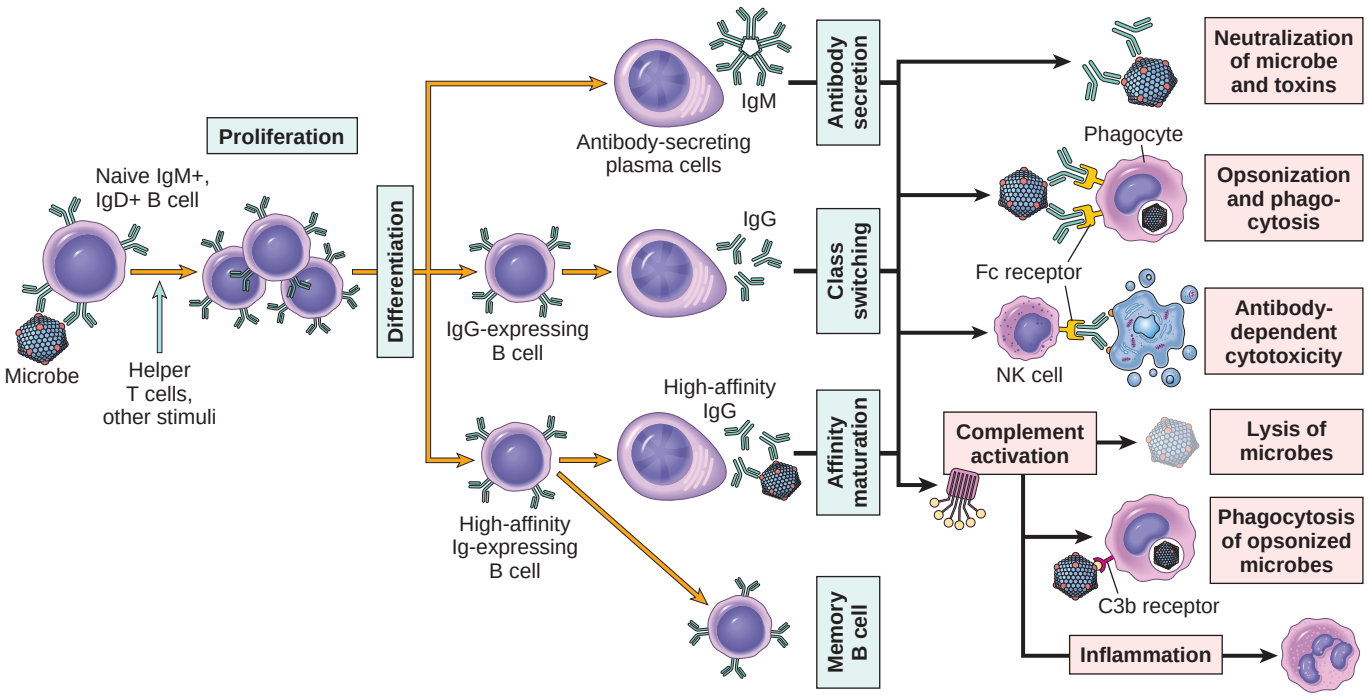

Figure 6-12 Humoral immunity. Naive B lymphocytes recognize antigens, and under the influence of T_H cells and other stimuli (not shown), the B cells are activated to proliferate and to differentiate into antibody-secreting plasma cells. Some of the activated B cells undergo heavy-chain class switching and affinity maturation, and some become long-lived memory cells. Antibodies of different heavy-chain classes (isotypes) perform different effector functions, shown on the right. Note that the antibodies shown are IgG; these and IgM activate complement; and the specialized functions of IgA (mucosal immunity) and IgE (mast cell and eosinophil activation) are not shown.

microbes. IgG antibodies coat (*opsonize*) microbes and target them for phagocytosis, since phagocytes (neutrophils and macrophages) express receptors for the Fc tails of IgG. IgG and IgM activate the complement system by the classical pathway, and complement products promote phagocytosis and destruction of microbes. Some antibodies serve special roles at particular anatomic sites. IgA is secreted from mucosal epithelia and neutralizes microbes in the lumens of the respiratory and gastrointestinal tracts (and other mucosal tissues). IgG is actively transported across the placenta and protects the newborn until the immune system becomes mature. IgE and eosinophils cooperate to kill parasites, mainly by release of eosinophil granule contents that are toxic to the worms. As mentioned above, T_H2 cytokines stimulate the production of IgE and activate eosinophils, and thus the response to helminths is orchestrated by T_H2 cells.

Most circulating IgG antibodies have half-lives of about 3 weeks. Some antibody-secreting plasma cells, particularly those that are generated in germinal centers, migrate to the bone marrow and live for months or even years, continuously producing antibodies during this time.

Decline of Immune Responses and Immunologic Memory

The majority of effector lymphocytes induced by an infectious pathogen die by apoptosis after the microbe is eliminated, thus returning the immune system to its resting state. The initial activation of lymphocytes also generates long-lived *memory cells*, which may survive for years after the infection. Memory cells are an expanded pool of antigen-specific lymphocytes (more numerous than the naive cells specific for any antigen that are present before encounter with that antigen), and they respond faster and more effectively when reexposed to the antigen than do naive cells. This is why the generation of memory cells is an important goal of vaccination.

KEY CONCEPTS

The Normal Immune Response: Cells, Tissues, Receptors, Mediators, and Overview

- The innate immune system uses several families of receptors, notably the Toll-like receptors, to recognize molecules present in various types of microbes and produced by damaged cells.
- Lymphocytes are the mediators of adaptive immunity and the only cells that produce specific and diverse receptors for antigens.
- T (thymus-derived) lymphocytes express antigen receptors called T cell receptors (TCRs) that recognize peptide fragments of protein antigens that are displayed by MHC molecules on the surface of antigen-presenting cells.
- B (bone marrow–derived) lymphocytes express membrane-bound antibodies that recognize a wide variety of antigens. B cells are activated to become plasma cells, which secrete antibodies.
- Natural killer (NK) cells kill cells that are infected by some microbes, or are stressed and damaged beyond repair. NK cells express inhibitory receptors that recognize MHC molecules that are normally expressed on healthy cells, and are thus prevented from killing normal cells.
- Antigen-presenting cells (APCs) capture microbes and other antigens, transport them to lymphoid organs, and