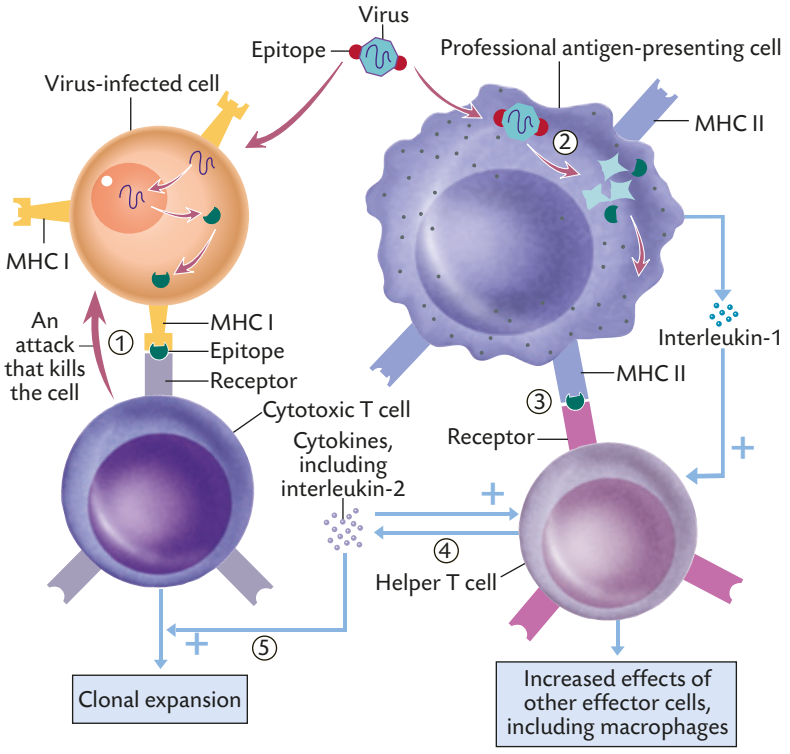

Figure 10.20 Immune reactions in T lymphocytes. In common body cells infected by a virus, cell-produced fragments of viral proteins (viral epitopes) are presented on the cell surface bound to MHC class I molecules (**1**). In this form, the viral epitopes are recognized by cytotoxic T cells. Expansion of this particular clone of cytotoxic T cells also requires activation of helper T cells. This is achieved by phagocytosis of the virus by a professional antigen-presenting cell (**2**), for example, a dendritic cell. In antigen-presenting cells, the viral epitopes are presented on the cell surface together with MHC class I proteins (not shown) as well as MHC class II proteins (**3**). When the epitopes are presented together with MHC class II molecules, they are recognized by the helper T cells. The activated helper T cells produce cytokines (**4**) that stimulate differentiation and proliferation of both the helper T cells themselves (not shown) and the activated clone of cytotoxic T cells (**5**). The co-receptors are not shown in this figure.

genicity, but retain their antigenic properties. After injection, the body launches an immune response directed against the epitopes in the vaccine. The clone of lymphocytes that recognize the epitopes in the vaccine expands. Memory cells are also formed, and they enable the immune system to recognize these epitopes and mount a faster and stronger immune response should the same microorganism infect the vaccinated individual later. Thus, vaccination leads to *active immunization*.

There are four major types of vaccines, consisting of either:

- living, non-pathogenic microorganisms
- complete, dead pathogenic microorganisms
- components of pathogenic microorganisms
- inactivated (modified) microbial toxins

In addition, most vaccines also contain an *immunological adjuvant*. This is an agent that enhances the immune response to the antigen. The most commonly used adjuvants act by counteracting rapid clearance and degradation of free antigen. Other adjuvants activate the professional antigen-presenting cells, which then activate the helper T cells. The activated helper T cells, in turn, release cytokines that accelerate antibody production in the B lymphocytes.

Active immunity is self-generated

In human medicine, vaccination has played a decisive role in the efforts to combat infectious diseases. For example, an international vaccination program against smallpox has completely eradicated this disease. In veterinary medicine, vaccination is used increasingly to prevent a number of infectious diseases, thereby enabling a reduction in the use of antibiotics. However, it is easier to verify introduction of a pathogen in an "unprotected" animal population than in one that has been protected through vaccination. Therefore, for some particularly serious infectious animal diseases, many countries do not utilize vaccination routinely.

Vaccination is a form of active immunization

An animal may acquire temporary immunity by receiving serum that contains antibodies from another individual. This is called *passive immunization*, because the body's own immune system has not been stimulated. The serum used to transfer specific antibodies is called *antiserum*. Animals receiving antiserum gain immediate protection against the particular disease. However, this protection only lasts for a couple of months, as the transferred antibodies (IgG antibodies) are gradually broken down. Transfer of antibodies from mother to offspring is a natural form of passive immunization (see below). Passive immunization is occasionally used to

Adjuvant enhances the immune response

Passive immunity is based on transfer of antibodies from another individual