aged 6 months or more with certain risk factors, including but not limited to asthma, cardiac disease, sickle cell disease, HIV, and diabetes. However, as of 2006, all children aged 6 to 59 months, and their household contacts and out-of-home caregivers should be vaccinated against influenza.

In June 2003, the live intranasal influenza virus vaccine (FluMist, Wyeth; MedImmune) was approved for active immunization against influenza A and B viruses in healthy children aged 5 to 17 and adults 18 to 49 years of age. It is the first vaccine approved in the United States for administration as a nasal mist. The introduction of a nasal vaccine has much implication to help overcome barriers to immunization (fear of side effects, the need for yearly immunizations, perception of low vaccine effectiveness). Widespread use of the nasal vaccine in high-risk children may, therefore, be more easily achievable than use of injected vaccines. This would be a very effective way to reduce the incidence of influenza in this population. The only downside is its expense (ranging from $50 to $70 per patient) and that the cold chain, discussed earlier in this chapter, must be maintained to guarantee adequate stability.

The strength of viral vaccines can be provided in tissue culture infectious doses, the quantity of virus estimated to infect 50% of inoculated cultures. Also, micrograms of immunogen, international units, D-antigen units, and plaque-forming units for yellow fever vaccine are employed for these products.

## Cancer Vaccines

For more than a century, the role of the immune system and its relationship to cancer has been researched. Recently, however, the immune response is being clinically explored as a mode to prevent and treat cancer. Cancer vaccines in development are intended to increase recognition of cancer cells by the immune system.

This approach to cancer treatment is exciting, as it offers another modality to complement surgery, radiation therapy, and chemotherapy. Another cause for guarded optimism is that the development of these vaccines may play a role in preventing cancer in patients at high risk because of familial diseases.

For the immune system to recognize and kill a tumor cell, immune cells must recognize antigens on the tumor cell as foreign to the body and receive costimulatory signals. Otherwise, tumor cells go undetected by the immune system and proliferate. Thus, a goal of cancer vaccine development is to increase antigen awareness of the immune cells or increase costimulatory signals that induce an immune response.

*T cells, lymphokine-activated killer cells,* and *natural killer cells* have antitumor activity. Thus, tumor vaccine development is to stimulate these immune cells instead of antibody-producing cells, the operational model used to protect one from an infection. Tumor-killing cells recognize tumor-associated antigens (TAAs) on the surface of the tumor cells. These antigens have peptide fragments that appear on the cell surface either by the cancer cell or taken up by a phagocytic cell.

TAAs fall into one of three categories. These are patient specific, tumor specific, and shared. Antigens unique to a specific patient are patient specific, such as an antigen expressed on the surface of a B-cell malignancy. A tumor-specific TAA is unique to a particular tumor. Most notable is prostate-specific antigen, found in prostate tumors. Shared TAAs are created by tumor cells with a common histology. A notable example of this is the carcinoembryonic antigen on adenocarcinoma cells found in colon, ovarian, and lung tumors.

Four types of cancer vaccines are under investigation, and a thorough explanation of each is beyond the scope of this book. Nonetheless, these types are important. They are autologous, allogeneic, anti-idiotypic, and gene therapy–derived vaccines.

*Autologous tumor vaccines* are developed from antigenic material procured from the tumor of the patient. Tumor cells are isolated from tissue procured during biopsy or surgery. These cells are killed or attenuated and reinfused into the patient. Typically, to enhance immunogenicity, they are combined with an adjuvant, such as