bacille Calmette-Guérin (BCG) or *C. parvum*. A major problem with this approach is the work and cost associated with the production of vaccine for the individual patient. Also, some tumors escape the immune system because their antigens are not expressed on the tumor surface.

Allogeneic tumor vaccines use the concept of shared or tumor-specific antigens. These vaccines are produced from cell lines that express tumor-specific or shared TAAs. To induce an immune response, either the fragment of the allogeneic tumor cell or the whole cell is injected. The beneficial aspect of this vaccine is that it can be used in a wide population of patients.

Anti-idiotypic vaccines are three-dimensional immunogenic regions on the antibody that binds antigen. Antibodies that bind TAAs are isolated and injected into mice. The resulting antibodies are harvested and used to vaccinate another mouse. The resulting antibodies have a three-dimensional binding site that mimics the original structure of the TAA. These antibodies are combined with an adjuvant and given as a vaccine. Because the anti-idiotypic antibody closely resembles the antigen, these can be used to induce immune responses (cellular, antibody–antigen) to a given antigen.

Gene therapy allows a DNA template to be placed within a cell, transcribed into messenger RNA, and expressed as a costimulatory protein. One can then induce a cell to synthesize this protein as part of its normal function. A gene that encodes for interleukins or other costimulatory proteins can be placed in cells expressing TAAs. This stimulates the immune response. In June 2006, the FDA approved the first quadrivalent human papillomavirus (HPV) (Types 6, 11, 16, 18) recombinant vaccine (Gardasil by Merck). Approximately 70% of cervical cancer is caused by infection with HPV types 16 and 18, and approximately 90% of genital warts are caused by HPV types 6 and 11. As this is a prophylactic measure, at present, this vaccine is only indicated for women 9 to 26 years of age. Subsequently, in September 2008, this vaccine was approved to prevent vulvar and vaginal cancers. To test the vaccine, 15,000 women from earlier cervical cancer studies were evaluated for a 2-year period. In the group which did not receive the vaccine, 10 women developed precancerous vulvar lesions, and nine developed similar vaginal lesions. No women in the Gardasil-treated group developed such lesions.

Clinical trials are being undertaken for cancer vaccines for melanoma, colorectal cancer, renal cell carcinoma, breast and ovarian cancers, prostate cancer, and lung cancer.

Toxoids

In similar fashion to bacterial vaccines, bacteria are propagated, and after the required growth is achieved, the culture is filtered through a sterilizing membrane filter. The filtrate that contains the toxin (exotoxin) is then processed. Processing involves addition of a concentrated salt solution to precipitate the toxin from the filtrate. After the precipitated toxin is washed and dialyzed to purify it, the toxin is detoxified with formaldehyde.

The detoxified toxin (toxoid) may be plain or contain an adjuvant (e.g., alum, aluminum hydroxide, aluminum sulfate). The product may also contain single, multiple, or mixed immunogens (e.g., tetanus and diphtheria toxoids adsorbed for adult use, which contains two toxoids for active immunization against different toxins). A mixed biologic, such as diphtheria and tetanus toxoids and pertussis vaccine adsorbed for pediatric use, has two toxoids and a vaccine in a single-dosage form for active immunization against different toxicities and infection. Their advantage is broad immunization coverage and minimum number of injections.

These mixtures or types of biologics differ from polyvalent products, which are used for different strains of the same toxicity or infection (e.g., influenza virus vaccine, pneumococcal vaccine polyvalent).

The strength of a toxoid is in flocculating (Lf) units (e.g., tetanus toxoid, 4 to 5 Lf U/0.5 mL dose). A flocculating unit is the smallest amount of toxin that flocculates most rapidly one unit of standard antitoxin in a series of mixtures containing fixed amounts of antitoxin and varying amounts of toxin.