



How Are Vaccines Made?

Vaccines are made in several ways. However, all vaccines have the same general goal — weaken the virus or bacteria in a way that allows the child to develop an immune response without developing any symptoms of infection. Vaccines are made using the same components that are found in the natural virus or bacteria.

Several basic strategies are used to make vaccines. The strengths and limitations of each approach are listed below.

Weaken the virus

Using this strategy, viruses are weakened so that they reproduce themselves very poorly once inside the body. The measles, mumps, German measles (rubella) and chickenpox (varicella) vaccines are made this way. Viruses usually cause disease by reproducing themselves many times in the body. Whereas natural viruses reproduce themselves thousands of times, vaccine viruses usually reproduce themselves fewer than 20 times. Because vaccine viruses don't reproduce themselves very much, they don't cause disease, but vaccine viruses replicate well enough to induce "memory B cells" that protect against infection in the future.

The advantage of live, "weakened" vaccines is that one or two doses provide immunity that is life long. The limitation of this approach is that these vaccines usually cannot be given to people with weakened immune systems (like people with cancer or AIDS).

Inactivate the virus

Using this strategy, viruses are completely inactivated (or killed) with a chemical. By killing the virus, it cannot possibly reproduce itself or cause disease. The inactivated polio, hepatitis A, influenza, and rabies vaccines are made this way. Because the virus is still "seen" by the body, cells of the immune system that protect against disease are generated.

The strength of this approach is that the vaccine cannot possibly cause even a mild form of the disease that it prevents and can be given to people with weakened immune systems. The limitation of this approach is that several doses must be given to achieve immunity.

Use part of the virus

Using this strategy, just one part of the virus is removed and used as a vaccine. The hepatitis B vaccine is the only vaccine that is made this way. The vaccine is composed of a protein that resides on the surface of the virus. This strategy can be used when an immune response to one part of the virus (or bacteria) is responsible for protection against disease.

The hepatitis B vaccine can be given even to people with weakened immunity and the vaccine appears to induce long-lived immunity after three doses.

Use part of the bacteria

Some bacteria cause disease by making a harmful protein called a toxin. Several vaccines are made by taking toxins and inactivating them with a chemical (the toxin, once inactivated, is called a toxoid). By inactivating the toxin, it no longer causes harm. The diphtheria, tetanus and pertussis vaccines are made this way.

Another strategy to make a bacterial vaccine is to use part of the sugar coating (or polysaccharide) of the bacteria. Protection against infection by certain bacteria is based on immunity to this sugar coating (and not the whole bacteria). However, because young children don't make a very good immune response to the sugar coating alone, the coating is linked to a harmless protein (this is called a "conjugated polysaccharide" vaccine). The *Haemophilus influenzae* B (or Hib) and pneumococcal vaccines are made this way. A

conjugate vaccine to prevent meningococcal infections should be available soon.

Just like for inactivated viral vaccines, bacterial vaccines can be given to people with weakened immune systems, but often require several doses to induce adequate immunity.

