VACCINE STRATEGIES

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

Weaken the virus

Using this strategy, viruses are weakened so they reproduce very poorly once inside the body. The vaccines for measles, mumps, German measles (rubella), rotavirus, oral polio (not used in the U.S.), chickenpox (varicella), and influenza (intranasal version) vaccines are made this way. Viruses usually cause disease by reproducing themselves many times in the body. Whereas natural viruses reproduce thousands of times during an infection, vaccine viruses usually reproduce fewer than 20 times. Because vaccine viruses don't reproduce 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 usually 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 (shot), 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.

There are two benefits to this approach:

- The vaccine cannot cause even a mild form of the disease that it prevents
- The vaccine can be given to people with weakened immune systems

However, the limitation of this approach is that it typically requires several doses 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, one shingles vaccine (Shingrix®) and the human papillomavirus (HPV) vaccines are 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.

These vaccines can be given to people with weakened immunity and appear to induce long-lived immunity after two 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 disease. 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* type B (or Hib), pneumococcal, and some meningococcal vaccines are made this way.

Two meningococcal vaccines, which prevent against one particular type of the bacterium (type B) not contained in the other meningococcal vaccines, are made using two or more proteins from the bacteria, not the bacterial polysaccharide.

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.