Background Information on

How Vaccines Work

When a person is exposed to a disease-causing germ, the immune system attempts to mount a defense against it. When the defense is successful, immunity results. When the defense is not successful, an encounter with the bacteria or virus can result in disease and its consequences. In the process of developing immunity, the body produces substances known as antibodies against a specific germ and creates a "memory" of this experience that can be called upon for protection, when needed, many months or years later. The next time the person encounters that germ, the antibodies that circulate in the bloodstream prevent it from causing disease, or decrease the disease's severity, and eliminate the germ from the body.

This is why a child who has had measles, for example, is unlikely to develop the disease again. The immune system has memory. The next time the child encounters the measles virus, the antibodies created during the previous infection are ready to neutralize and destroy the virus before it has a chance to cause sickness again. Medical experts estimate that the immune system can recognize and effectively combat hundreds of thousands, if not millions, of different organisms.[1]

A vaccine works in a similar way. However, instead of suffering the natural infection and risking its consequences in order to develop this protective immunity, a vaccine creates a similar immune protection without the recipient experiencing the disease. Regardless of the way that a vaccine is made—whether it contains an inactivated (killed) germ, a greatly weakened form of the germ, or a purified component of the virus or bacteria—it engages the immune system to create immunity and to prepare to fight off an infection whenever it is encountered.

Types of Vaccines

Vaccines can be developed in four different ways by using:

- Live bacteria or viruses that have been altered so that they cannot cause disease
- Killed bacteria or inactivated viruses
- Toxoids (bacterial toxins that have been made harmless)
- Purified parts of bacteria or viruses

Live attenuated vaccines are derived from the naturally occurring germ. They can sometimes cause a mild infection, but most people do not get the disease or its symptoms. In very rare instances, people can become sick from the weakened germ, although the illness is usually milder than what would occur if that person caught the natural disease. Because people with weakened immune systems are not able to fight off bacteria and viruses, live attenuated vaccines are not given to them.

How Vaccines Work (continued)

Live attenuated vaccines are made by growing the virus in a sequence of cell cultures over time until its disease-causing ability has deteriorated. Live attenuated vaccines include:

- Measles vaccine
- Mumps vaccine
- German measles (rubella) vaccine
- Oral polio vaccine (OPV)
- Varicella (chickenpox) vaccine

Immunization with a vaccine made from live, weakened (attenuated) bacteria or virus mimics a normal infection most closely. These vaccines offer protection that may last longer than would a killed vaccine or a vaccine made with toxoid.

Inactivated (killed) vaccines cannot cause an infection because the germ used to create the vaccine is dead. These vaccines still stimulate antibody production, but often times require more doses over a longer period of time to create adequate protection from the infection. Viruses are inactivated with chemicals such as formaldehyde. The inactivated polio vaccine (IPV) and the influenza vaccine are made this way.

Some bacteria cause disease by manufacturing harmful proteins called toxins. To make vaccines against these diseases, toxins are purified and killed with chemicals, and the resulting vaccine helps the body block the effects of the bacteria that cause disease. Toxoid vaccines cannot cause the disease. The diphtheria and tetanus vaccines are made this way.

Vaccines are also made by using only part of the virus or bacteria, which cannot cause disease. The immune system can mount a response against the partial virus or bacteria. Four of the newest vaccines are made this way:

- *Haemophilus influenzae* type b (Hib) vaccine
- Hepatitis B vaccine
- Hepatitis A vaccine
- Pneumoccocal conjugate vaccine

Because the immune response may diminish over time, vaccine doses known as “boosters” are sometimes given to restore the immune response against that particular germ. Protective immunity lasts longer when booster doses are given.

How Vaccines Work (continued)

Community Immunity – Enhancing the Vaccine's Inherent Effectiveness

Community immunity or "herd immunity" is an important part of protecting the community against disease. Because vaccinated people have antibodies that neutralize a germ, they are much less likely to become infected and transmit that germ to other people. Thus, even people who have not been vaccinated (and those whose immune response has declined or whose vaccines aren't fully effective) often can be protected by the immunity of the "herd" because vaccinated people around them are not getting sick and do not, therefore, transmit the infection to other members of the community. Herd immunity is more effective as the percentage of people vaccinated increases. The more people in a community who are not immunized, the more likely that they and others will get the disease.

For some diseases, however, herd immunity offers little or no protection. For example, tetanus is not contagious from person to person. It is contracted when a wound comes in contact with soil contaminated with the tetanus bacterium.

It is important to keep in mind that some people may not be protected from the disease even though they have been vaccinated. About 1 or 2 of every 20 people immunized will not have an adequate immune response to a vaccine and may not be fully protected. People with weakened immune systems, in particular, may not develop protective antibodies from the immunizations they receive. But if the majority of the population is immunized, then the unprotected people are not as likely to be exposed to vaccine preventable diseases, so they have a lesser chance of becoming infected.