How Vaccines Work

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Years ago, scientists learned that by injecting a ***virus*** or virus particles into an individual, an immune response could be stimulated. This immune response would protect the individual, for a period of time, against whichever virus was used in the injection. This knowledge is the basis for our vaccines today. The principles and steps of vaccination are discussed below. (To make the discussion easier, we will use a viral disease as an example; the same would be true of bacterial diseases.)

Disease-causing agent is altered

We do not want to inject actual disease-causing viruses into healthy animals. (The pathogenic (disease-causing) form of a virus is often called the 'wild' strain or 'field strain.') We alter the pathogenic virus so it will no longer cause disease. In some cases, the virus is killed, in others it is modified through various processes until it becomes ***nonpathogenic***, or 'attenuated.' There is a fine line, however, between altering the virus and making it ineffective. Even though we want to alter the virus to make it nonpathogenic, we need to keep it in a form which will still cause the body to react against it.

The portions of a virus that cause the body to react to it are called antigens. Antigens are often large protein molecules on the surface of the virus. We need to keep these antigens intact for the immune system (the body's defense system) to react to them.

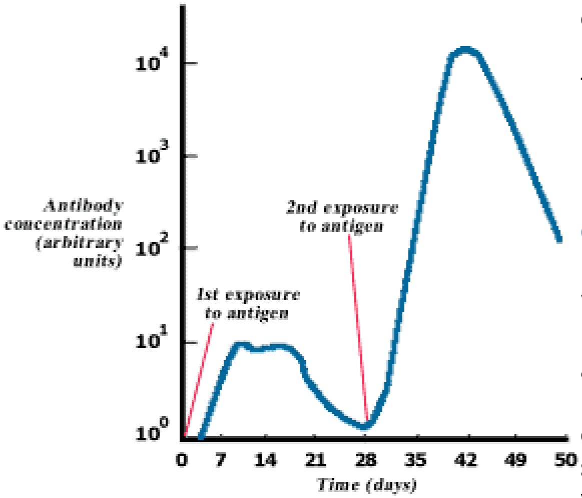
Altered agent is introduced into the body

Once altered, the virus must be introduced into the body. Depending upon the vaccine, it can be injected, given into the nose or eye, or actually be eaten (e.g., polio vaccine in people, and rabies vaccine for wildlife). (Each vaccine is labeled as to the correct route of administration. NEVER inject a vaccine developed for ***intranasal*** use, and NEVER administer a vaccine by the nasal route, if it was developed to be given by injection.)

Vaccines which are injected or eaten, usually produce a more systemic (whole body) response. Those given in the eyes and nose, produce a more localized immune response. In the case of viruses which may be inhaled, e.g., parainfluenza in dogs and rhinotracheitis in cats, the use of intranasal vaccines and this local response in the nasal passages is advantageous. The immune system will become ready to kill any new virus before it can get any further into the body. Local nasal ***immunity*** would not be very helpful, however, for a virus that is ingested and causes intestinal disease such as parvovirus in dogs and panleukopenia in cats. For that type of virus, we would want a vaccine which would produce a more ***systemic*** response.

Immune system reacts

When the body's immune system recognizes the foreign antigens on the virus, it is stimulated to make a response. Part of the immune response includes making antibodies (small disease-fighting proteins), which bind to the antigens and deactivate or kill the virus. This is called humoral immunity. Other cells produce certain chemicals which either kill the virus directly or help the other



cells called macrophages (literally, 'big eaters') to devour and thus kill the virus. This portion of the immune response is called 'cell-mediated.'

Immunologic memory is created

Whether the body's response is primarily humoral (through antibodies) or cell-mediated, certain 'memory cells' are created. These cells remember their exposure to the specific antigens which were on the virus. If a dog, for instance, receives a combination vaccine containing canine distemper, parvovirus, and canine hepatitis, 3 different groups of memory cells will be produced: one group will remember the distemper antigens, another will remember parvovirus antigens, and the third group will remember the hepatitis antigens.

These memory cells are not produced instantly. The time period between vaccination and the creation of memory cells is 2-3 weeks, if the vaccine is injected and several days, if given intranasally.

Subsequent exposures stimulate larger and faster responses

The production of memory cells is the goal of vaccination. These memory cells help the body respond much faster and with a larger response, if they are ever again exposed to the antigens for which they have memory. For example, if the dog above was vaccinated against parvovirus, and then 3-4 weeks later vaccinated against parvovirus again, the body's response to the second vaccination will be greater and much faster than after the first vaccination. High amounts of antibody will be rapidly produced. This faster and higher response is scientifically termed a '***secondary response***' or an '***anamnestic response***.'

The second vaccination will produce more memory cells against parvovirus, and the body could be considered 'primed.' We have all heard of priming the pump. An unprimed pump will take a lot of strokes of the pump handle before it produces any water. A primed pump, however, may produce a good deal of water on the first stroke. A 'primed' immune system will react more swiftly, just like a primed pump.

Now if the dog is exposed to another dog with parvovirus and the pathogenic virus enters its body, its 'primed' immune system would respond very efficiently and kill the virus before it can do any harm. This dog would be termed 'immunized' against parvovirus because its immune system is able to protect it from parvovirus.

The memory cells created against some diseases live a long time, while those for other diseases may have a relatively shorter life span. Since memory cells do not live forever, at some point, we need to revaccinate an animal to produce a new generation of memory cells. For some diseases, revaccination must occur every year, for others 3 years or longer. When we talk about duration of immunity (length of time an animal is protected), we are really talking about how long a sufficient number of memory cells live, and how long the antibodies remain so that the animal is still protected.

Summary

A vaccine helps 'prime' an animal against a specific disease. It does this by stimulating the immune system with a nonpathogenic virus or bacteria. If the animal responds adequately, it develops memory cells which will help it to quickly and efficiently fight off the pathogenic form of the agent, if it is later encountered.

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