

Immunology
And Vaccines —
Where We Are
And Where We
Are Going

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The immune system is the focus of intense current research in both veterinary and human medicine. This research spans the realms of possibilities from cancer treatments to AIDS vaccines. Many of the advances in future treatments of diseases will come from chemicals with their derivatives in the immune system. In order to be a good manager of the large dairy herd, you must be able to discuss vaccination programs and make informed decisions with your veterinarian. A basic understanding of the immune system and how vaccines work is necessary. A knowledge of the limitations of vaccines is essential when we access large herd disease dynamics.

There are some important concepts to consider when making these decisions. These concepts often change as we look at the different organisms that can attack the cow. Different diseases are handled differently by the immune system.

What does immunity really mean? For all practical purposes; if a cow is healthy and is exposed to a disease agent, the animal gets rid of the organism with a minimal disruption of body functions. The immune system often moderates disease rather than preventing infection.

As we look at the immune system, it is divided into two distinct parts. The innate immune system is composed of cells and chemicals that cannot be enhanced by exposure or vaccination. It is the first line of defense and includes the mucous membranes and cells of the skin. The adaptive part of the immune system can be improved by vaccination or exposure. This part of the immune system does have indirect effects on the innate immune system.

The adaptive part of the immune system is likewise divided into two sections. The cell mediated wing (CMI) and the humoral wing. They are governed by T cells and B cells respectively. Both B cells and T cells belong to a group of cells called lymphocytes. They look identical since they come from a common precursor. Special tests are required to differentiate between the two cell types. However, both wings have dramatic differences in how they function.

CMI is the part of the immune system receiving the most research today. CMI is integrally involved in the protection and clearing of most viral infections. For some viruses, such as IBR, it is the primary source of protection as antibody levels do not indicate protection. CMI is also a primary source of cancer control.

As stated previously, CMI is regulated by T cells. There are basically three T cells involved in the immune response:

Helper and suppresser T cells act as primary mediators of the entire immune system including antibody production. This is done through the release of chemicals by these cells. These chemical messengers have effects on other cells in the immune system, attracting them and making them more efficient. These chemicals can also have an effect on virus replication and the ability of viruses to infect a cell.

Killer (cytotoxic) T cells are also driven by antigens invading a cell. They have the ability to recognize infected or cancerous cells and destroy them.

CMI is a powerful regulator of the entire immune system including the humoral wing. CMI is difficult to stimulate with killed vaccines and killer T cells cannot be primed with a killed vaccine. In veterinary medicine measurement of CMI stimulation is a recent advance. Although available for human testing in veterinary medicine, these are only used in research at this time.

The humoral wing of the immune system is concerned with antibody production. This part of the immune system is easy to check and is often called serology or titers. When the veterinarian pulls blood to look for diseases he is often checking antibody levels. The problem is that antibody levels have been associated with protection which is often not true. The humoral wing is run by B cells. When the B cells are stimulated by antigens and chemicals from helper T cells they can become a memory cell or a plasma cell. Plasma cells then make antibodies. These antibodies can be manufactured at the rate of 300 per second by a plasma cell. When we measure titers we are determining the amount of a specific antibody in the bloodstream. There are four basic classes of antibodies found in the bloodstream of cattle. They are:

- IgG: the predominant antibody in the bloodstream. It is small and can easily leave the bloodstream to reach infected areas.
- IgM: the largest antibody and the first antibody made in the immune response. Its large size makes it more difficult to move out of the bloodstream.
- IgA: the predominant antibody of the mucous membranes. It is a secretory antibody and is the first line of defense against many diseases. It is difficult to stimulate with killed vaccines and easily stimulated by orally and intranasal vaccines.
- IgE: the antibody involved in allergic reactions.

It is possible to stimulate antibodies that are not protective or, in some instances, are harmful to the animal. One of the goals of vaccination is to have an animal recognize a virus or bacteria and make the protective antibodies. Then we can neutralize the effects of the disease.

There are several factors that can affect the immune system. We need to be constantly aware of the factors that add stress onto the cow if we are to maximize a vaccine's potential. Two important stressors are calving and heat. Vaccination should be avoided until seven days post calving to avoid calving related stress on the fresh cow. In temperatures over 78 degrees Fahrenheit the Holstein breed will begin to show some mild heat stress. At temperatures above 90 degrees Fahrenheit vaccination should be performed in the cooler hours of the day.

The area getting most of the research now is micro-minerals. Deficiencies in micro-minerals not only affect the immune system by not allowing it to respond properly to a challenge of vaccination but may increase the likelihood of reactions to vaccines. The primary micro-minerals involved are Copper, Iron, Zinc, and Selenium. We also see Vitamin A and Vitamin E involved in this scenario.

One thing to keep in mind is that challenge and protection are not constant steady state items. We like to think that when we vaccinate an animal, it has a certain level of protection. However, the cycles of the animal affect the level of protection. The same is true with the amount of exposure to a pathogen. What we try to do with vaccination is to widen the gap between challenge and protection, thereby making it more difficult to get disease. It does not mean that when you vaccinate you will never get the disease.

It is important to follow the label directions for administering vaccines. This brings us into a discussion of modified live versus killed vaccines. Killed vaccines and modified live BRSV act as a killed vaccine, require a booster shot before protection is complete. The first time we give a vaccination we get what is termed the primary response. This response is fairly short lived and is not very strong. It is also composed mainly of IgM. The response seen after a booster shot is called the secondary response or anamnestic response. This response is much stronger and long lived and is primarily IgG. Also, there is much more memory made in response to the booster shot. If we give our booster too early, we won't get the anamnestic response; and if we wait too long to give it, we go back to it acting as a primary shot not as a booster. With modified live vaccines, since the virus or bacteria is growing in the animal, it goes from the primary into the secondary response without needing a booster.

What are we doing with vaccination? We are tricking the immune system to think that it has been attacked by that disease. The closer a vaccine approaches the natural, wild virus, the stronger the immune response is and your animal has better protection.