

Basic Bovine Immunology

Brief Immunology Primer

Immunity / Immune Response

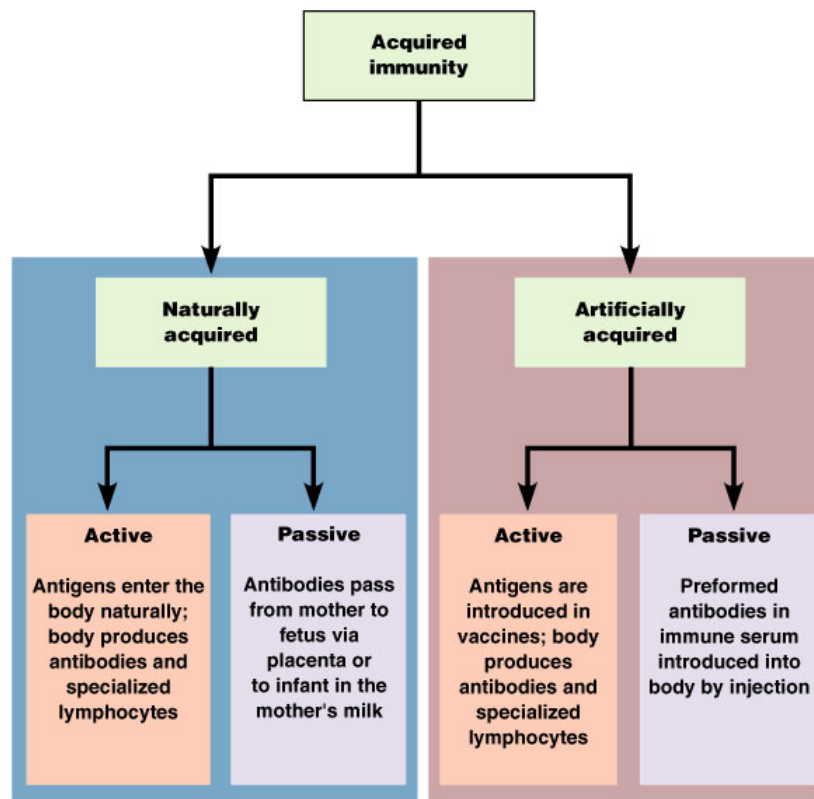
- Refers to actions by an animal's body to foreign substances such as microbes and various macromolecules (Allergens)
- Innate (Natural)
- Acquired (Specific)
 - Immunization or vaccination

Innate Immunity

- Innate Immunity (non-specific, naive) (born with)
 - Physical or chemical barriers (skin, saliva, stomach acids, enzymes, body temperature)
- Humoral
 - Complement System lyses microorganisms or enhances Phagocytosis.
 - Lysozyme: enzyme destructive to cell walls of bacteria
 - Present in tears and other body fluids
 - Interferon
 - Produced by T cells in response to viral infections
 - Bind to specific receptors and
 - Induce enzymes
 - Suppress cell proliferation ie. viral replication
 - Enhance phagocytic activity of macrophages
 - Augments the Cytotoxic activity of T cells
 - 5 major classes (alpha, beta, gamma, tau, and omega)
 - Tumor Necrosis factor
- Inflammatory barriers
 - Leakage of vascular fluid, with serum proteins and antibacterial activity
 - Cellular
 - White Blood cells
 - Macrophages
 - Neutrophils,
 - Natural killer cells

Acquired Immunity

- Acquired Immunity (Developed or Obtained Immunity)
 - Induced by natural exposure or vaccination
 - Includes
 - Antibodies
 - Lymphocytes T&B
 - Cytokines / lymphokines
 - Interleukin 1
 - Interleukin 4



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Acquired Immunity 2 components

- **Humoral Immunity**
 - B-Lymphocytes and Antibody production
 - Provides defense against extracellular microbial infections
 - Many bacterial infections are extracellular
- **Cell Mediated Immunity**
 - T-Lymphocytes and associated cytokines
 - Provide defense against intracellular pathogens and tumor cells.
 - Viral infections intracellular
 - Graft rejection
 - Delayed hypersensitivity

Definitions

- Lymphocytes
 - White blood cells
- Cytokines
 - Proteins that mediate cellular interactions and regulate cell growth and secretions. As a result they regulate many aspects of the immune system.

- For example IL-1 and Tumor Necrosis Factor
 - These two work in concert or together.
- Tumor Necrosis Factor
 - Locally causes the cardinal signs of inflammation
Heat, redness, swelling, pain,
 - Decrease in cardiac output, capillary leakage, microvascular thrombosis,
 - Works on Neutrophils to enhance their ability to kill microbes

■ Cytotoxic cell

- A cell that can injure or kill other cells.
 - macrophages

Humoral and Cell Mediated Immunity

■ T Lymphocytes: Cell mediated immunity

- Migrate to the thymus from the bone marrow where they undergo a “education” within the thymus
- Will undergo 8-10 cell divisions with a lot of these cells dying before leaving the thymus (90%)
- Development in the fetus probably in the liver

■ B Lymphocytes: Humoral immunity

- Develop initially in the fetal liver but later production shifts to the bone marrow.
- Develop into immunoglobulin producing Plasma cells

T-lymphocytes (T-cells)

- Mediate cellular immunity, which protects individual against microorganisms, tumor cells, and viruses
- Are long lived (months to years)
- There are 3 different types of T-lymphocytes
 1. Cytotoxic T-cells (CD8) They typically cause lysis of foreign cells
 2. Helper T-cells (CD4) activate the humoral response
 3. Suppressor T-cells suppress or shut down the immune response
 - Suppress the activity of B-cells
 - play a role to suppressing immune response to one's own (self) antigens
- Originate in Bone Marrow and mature in the Thymus

B-lymphocytes or B-cells

- Mediate humoral immunity, which protects individuals against microorganisms, tumor cells, and viruses.
- Are short lived
- When come into contact with antigen, transform into activated B-cells which then become plasma cells secrete antibodies or immunoglobulins
 - (5 types)
 1. IgG found in colostrum, circulating blood

2. IgA Respiratory and Intestinal Secretions
 3. IgM First one produced in response to a new antigen
 4. IgE Associated with Allergies and degranulation of Mast cells to release vasoactive amines
 5. IgD?????
- A small percentage of activated B-cells transform into B memory cells which are pre-programmed to respond rapidly to a second exposure to the antigen.
 - When a animal is revaccinated and we see a rapid rise in serum immunoglobulin's this is termed an anamnestic response.

Role of the Immune Response

- Prevent pathogens for disease causing organisms from entering the tissues of the body
- Eliminate those pathogens that are successful in entering tissues

Definitions

- Antigen: a substance the immune system can see (recognize as foreign) and elicits a response (humoral and or cell mediated response)
- Antibody: Molecules formed by the immune system in response to an antigen that aid in elimination of the pathogen.
- Antibiotics: synthetic molecules that interfere with metabolism and growth of bacteria. Have nothing to do with the immune system, (a functional immune system is required to get a favorable antibiotic response) usually derived from a mold or bacteria.
- Vaccination: attempt to present an antigen to the calf,
 - MLV virus injected sub-Q to a calf.
 - Vaccine: Selected antigens that are important to cattle producers
- Immunization: the process of initiating a successful or functionally protective immune response
- Pathogen: a disease causing organism.
 - i.e.. Virus, Bacteria, Fungi, Mycoplasma

Three components for an effective immune response

1. Effective Vaccine
 - UV light destroys vaccine
 - Mfg flaw
 - Disinfectants used in cleaning syringes
2. Calf must have a functional immune system
 - Stressors such as transportation, weaning, surgeries, commingling poor nutrition all inhibit immune response
3. Properly administering the vaccine
 - Handling
 - Dose
 - Route of administration

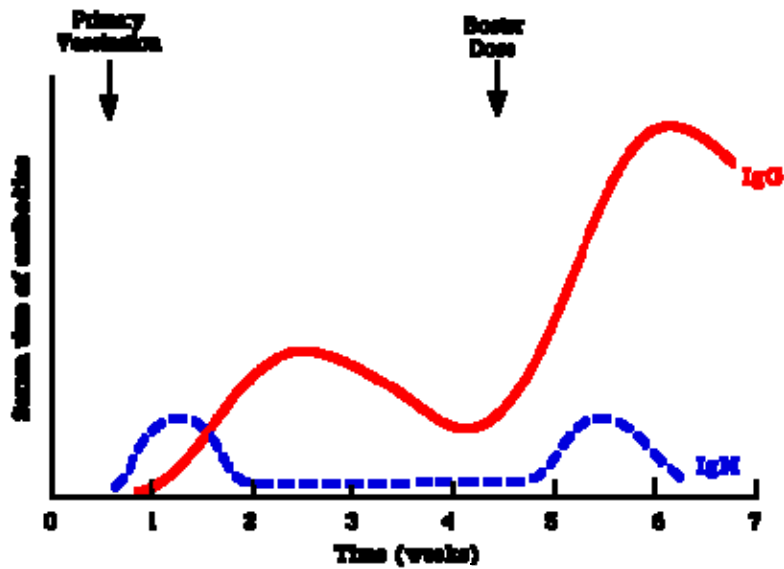
Administer the Vaccine and what happens regarding the antibody response

1. Primary Response

- Slow in Onset
- Low in Magnitude
- Short Lived
- IgM

2. Secondary Response

- Rapid in Onset
- High in Magnitude
- Long Lived
- IgG (Or IgA, or IgE)



Serology utilized to diagnose or identify individuals.

Notes:

Neonatal Considerations and Colostral Immunity

- #1 Ingestion of colostrum within the first 6 hrs after birth
 - Colostral immunity, passive transfer can be improved with the use of a maternal vaccination program
- At Birth Tag calf in conjunction with cows ID for records and pairing up.
 - With the NAID program this is an area to start the identification.
- Record
 - birth date
 - weight
 - gender
 - BCS for the cow
 - Any calving problems
- Calving Score
 - Normal deliver to a caesarean section

The bovine Immune system

- At birth calves are completely immunocompetent.
 - Neonates are often though of as immunonaive
 - Their immune system has not been stimulated
- The immunological assistance that neonates receive is through the colostrum.
 - Immunoglobulins
 - Lymphocytes T (33%) & B (24%)
 - Neutrophils, Macrophages
 - Cytokines
 - Lactoferon
- At birth the # circulating B lymphocytes is approximately 30% of that found in an adult.
 - Reach adult levels approx 20 days post partum
- Local and Cell mediated immunity is deficient in calves at birth
 - Local gut immunity begins in the first week of life producing IgM for the first 3- weeks
 - Later IgA appears and dominates throughout life
- Cell mediated immunity is deficient at birth, but by 2 weeks of age reach levels similar to adults.
- The half life of colostral derived antibody in the neonate system is between 11.5 and 16 days.
- As a general rule the best time to immunize a neonate is when the maternal Ab has waned and the immune system is mature enough to respond
- Old school thoughts were that immunoglobulins acquired via colostrum interfered with the immune response
- In calves by 1 month of age immune system is mature
- IgG1 is the major immunoglobulin (80% in colostrum)
 - 97% catabolized after 80 days

- Practically speaking if multiple immunizations are given, can start at 2 to 4 months of age to develop adequate protection against specific antigens.