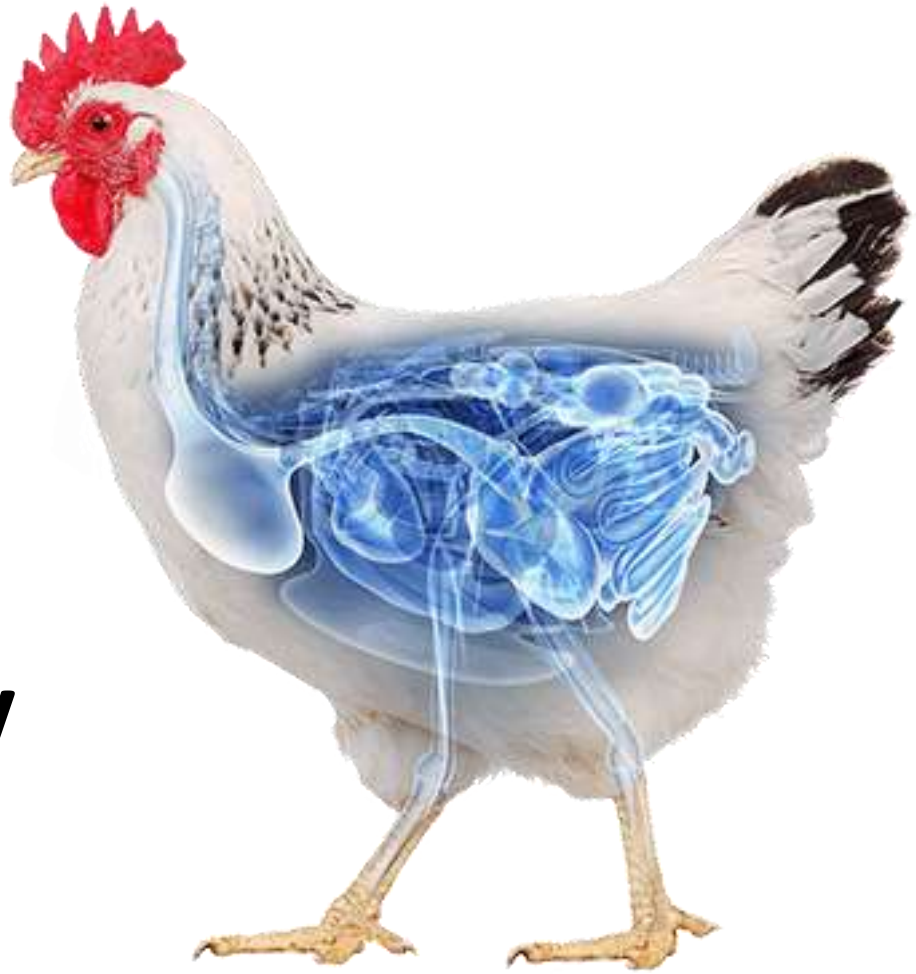
Avian Immunity



Plan Of Talk

- Description of avian immune system
- Types of immunity
  - Innate immunity
  - Acquired immunity
- Vaccine and Immune Response to Vaccination

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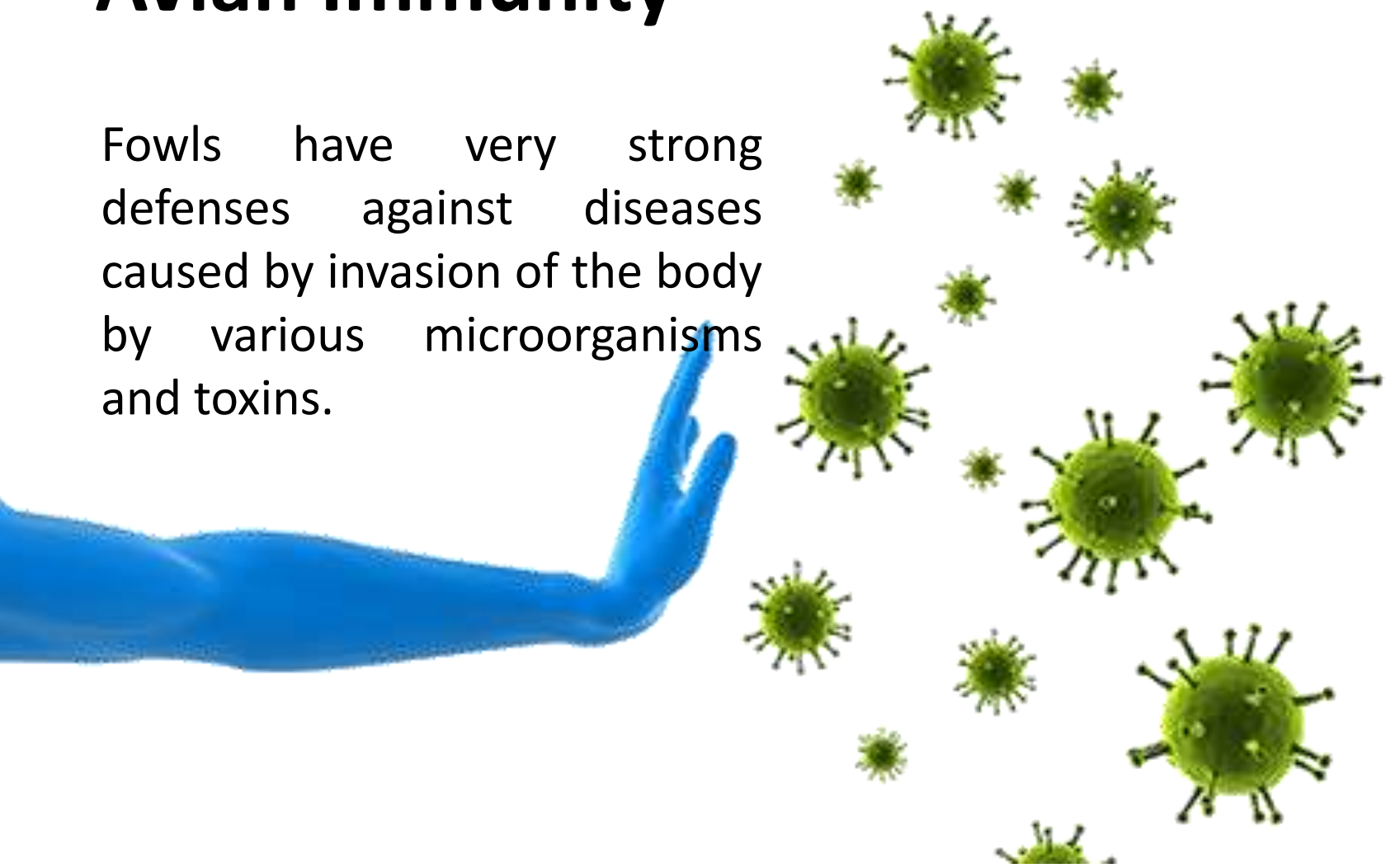
Avian Immunity

Fowls have very strong defenses against diseases caused by invasion of the body by various microorganisms and toxins.



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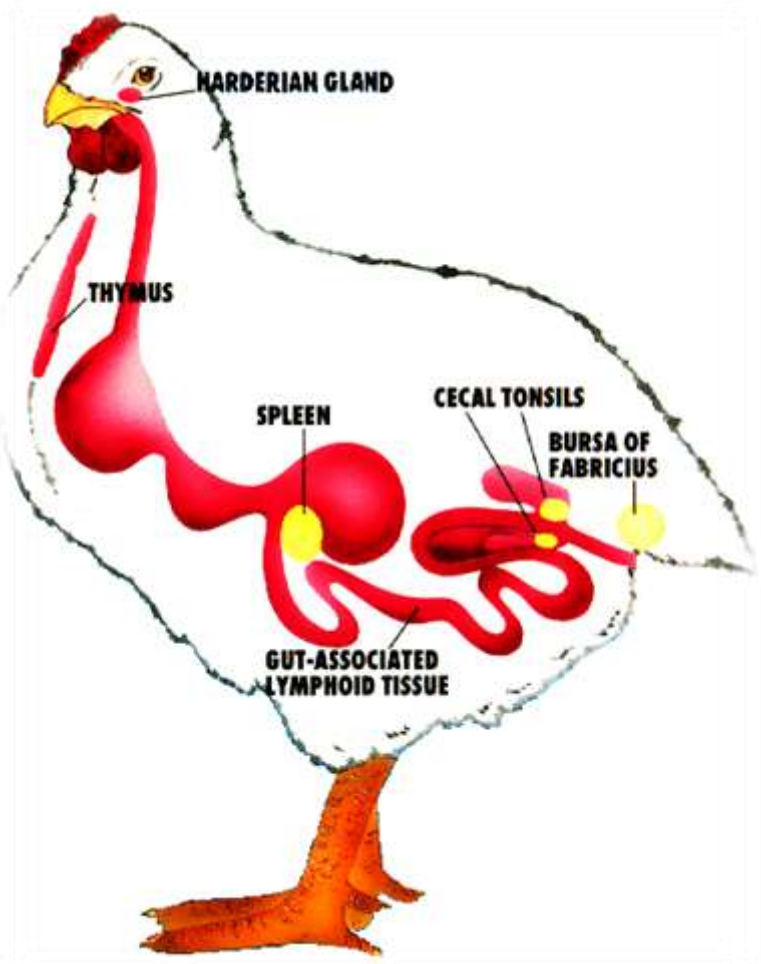
HARDERIAN GLAND
THYMUS
SPLEEN
CECAL TONSILS
BURSA OF FABRICIUS
GUT-ASSOCIATED LYMPHOID TISSUE

Cont. …

Primary Organs

1) **Thymus gland**
   - T-cell system
   - Cell-mediated immunity
2) **Bursa of Fabricius**
   - B-cell system
   - Humoral immunity
3) **Bone marrow**
   - Precursor blood cells
4) **Yolk sac**
   - Maternal immunity

Peripheral Lymphoid Tissue

1) Harderian gland
2) Caecal tonsilles
3) Spleen
4) GALT

Components of Avian Immunity

Generally, the immune defense is compose of:

1. The skin
2. Mucous membrane
3. Immune system

Cont. …

1. **The skin:**
   - The skin is a barrier against invasion of the body by microorganisms.
   - When the skin barrier is broken, invasion through the skin can occur.

Cont. …

2. **Mucous membranes:**
   - These linings of the digestive tract, respiratory tract and other body systems provide a good barrier against invasion by microorganisms.
   - If anything harm the mucous membranes, invasion may occur.
   - An example is when diets deficient in vitamin A cause damage to the mucous membranes resulting in an increase in the incidence of infectious disease.

Cont. …

3. **The immune system:**
   - Notwithstanding the efficiency of the skin and the mucous membranes as defense mechanisms, microorganisms often find their way into the body.
   - Many of these are harmless, while others cause disease, usually specific diseases caused by specific organisms.

The Immune System

The primary role of the immune system is to:

1. Recognize foreign organisms that have managed to enter the body.
2. Initiate and manage the appropriate physiological responses to neutralize or eliminate them.

Mechanisms of Defense

1. Inactivation of biological agents.
2. Lysis of foreign cells.
3. Agglutination (clumping).
4. Precipitation of molecules or cells.
5. Phagocytosis (engulfing and inactivating) of foreign agents.

For an immune response to be effective, the right mechanism or combination of mechanisms must be activated.

Defense Success

Whether or not a bird develops a disease after such an invasion will depend on “how well it fights the invasion” which in turn depends on:

1. The bird’s condition, state of wellbeing and level of immunity.
2. The number of the invading organisms “challenge”
3. The virulence of the invading organisms.

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Innate Immunity
Description

- Innate immunity is the natural or inherited ability to resist disease.
- It is non-specific host defenses.
- It recognizes the invading pathogen through its outer surface protein (antigens) and entail a series of actions that start immediately after recognizing the invading pathogen.
- All multi-cellular organisms have some kind of innate defense; roughly 98% of all multi-cellular organisms possess only an innate immune system for protection against infections.

Innate Immunity
Cost of Building and Developing

- The costs of building the innate immunity have not been definitively measured, its is inherited.
- The cost of developing the innate immunity is thought to be comparatively lower than building.

Innate Immunity
Cost of Stimulation

- After stimulating the constitutive components of the innate immune system, these components induce local inflammation via the production of inflammatory cytokines.

Cont. …

- If they are highly stimulated, would induce the highly costly systemic inflammatory response, which is characterized by:
  1. Increased production of acute phase proteins by the liver.
  2. Changes in energy and nutrient metabolism.
  3. Anorexia and fever.

  leading to localized tissue damage and potentially sepsis.

Innate Immunity

There are number of non-specific disease response mechanisms included in this type of immunity:

1. Genetic factor
2. Body temperature
3. Anatomic feature
4. Normal microflora
5. Respiratory cilia

Innate Immunity
1- Genetic Factors

- Birds may lack the receptors required by disease organisms in order to be able to infect.

E.g.

- some strains of chickens are genetically resistant to the lymphoid leukosis virus.

Innate Immunity
2- Body Temperature

- The high body temperature of the chicken precludes many diseases.

E.g.

- Blackleg disease of cattle is not normally a problem in poultry because poultry have a higher body temperature at which the disease-causing bacteria cannot survive. If the body temperature of the chicken is lowered, this disease may occur.

Innate Immunity
3- Anatomic Features

- Many disease organisms cannot penetrate intact body coverings (skin and mucous membranes) or are trapped in the mucus secretions.

E.g.

- Some nutritional deficiencies (such as biotin deficiency), injury or infectious diseases compromise the integrity of the body coverings, allowing penetration by disease organisms.

Innate Immunity
4- Normal Microflora

- The skin and gut normally maintain a dense, stable microbial population.
- This stable microflora prevents invading disease organisms from gaining a foothold.
- Improper use of antibiotics or poor sanitation can disrupt the balance of the microflora.

Innate Immunity
5- Respiratory Tract Cilia

- Parts of the respiratory tract are lined with fine hair-like protrusions, called cilia, which remove disease organisms and debris.
- If the air in the poultry house is of poor quality due to high levels of dust or ammonia, the ciliary system may be overwhelmed and become ineffective.

Innate Immunity
Other Factors

Other factors involved in the effectiveness of innate resistance include:

1. Nutrition
2. Stress
3. Age
4. Inflammatory processes
5. Metabolic factors.

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Acquired Immunity

- It is a specific immune defenses.
- It utilizes receptors on T and B lymphocytes that recognize specific antigens on pathogens with great precision.
- They are characterized by an enormous range of diversity in antigen-binding receptors and have the ability to recognize and respond more quickly to antigens upon second exposure through immunological memory.

Cont. …

This refers to immunity provided by:

1. Immune cells.
2. Antibodies that are produced in response to exposure to an antigen.

Immune Cells

- The blood consists of a number of different cell types including red and white blood cells and serum.
- The white blood cells are called leucocytes and some of these destroy foreign bodies by engulfing and digesting them.
- There are two types of leucocytes called lymphocytes (B and T) that are involved in the production of antibodies for the immune system.

Antibodies

- Antibodies are very small bodies of a very special protein (globulin protein) that animals release into their circulatory system to fight invading viruses and bacteria.
- Antibodies are short lived.
- They are specific for the antigen to which they attach.
  - For example, the antibody against Newcastle disease virus will attach only to the Newcastle disease virus, not to the infectious bronchitis virus.

Forms of Acquired Immunity

There are two forms of acquired immunity:

1. Passive
2. Active

Types of Acquired Immunity

Passive Immunity

- This is achieved when antibodies are transferred to the individual either;
  1. From the hen (during egg formation)
  2. By provision of antiserum (blood serum containing antibodies) through injections.

Importance of Passive immunity

The newly hatched chicken is unable to use its own immune system to fight invasion during the first few days to a week of its life.

Cont. …

To overcome this problem, newly hatched chick receives antibodies from its mother via the egg;

- These antibodies are specific for all of the disease causing organisms that the mother has experienced or has been vaccinated against.
- These antibodies are usually short lived but survive long enough to provide a defense system for the first few days of life while the chickens' own defense system becomes operative.

Level of Passive immunity

- The level of immunity passed on by the mother is about the same as she carries herself.
- However, by the time the egg hatches, it is dropped to about half.

Increasing Level of Passive immunity

- It is important that the antibody level of the breeder hen be boosted frequently regarding some diseases to ensure that her antibody levels do not decline too much, leading to a reduction in her offspring's ability to fight invasion at this critical time.

Passive Immunity and Chick Vaccination

- The flock manager must be aware of the maternal antibody levels in the chick in order to appropriately schedule vaccinations.

Cont. …

- If young chickens are vaccinated when maternal antibody levels are still high, the vaccine may be neutralized excessively by the maternal antibodies, resulting in a reduced immune response.
- Conversely, if vaccinations are delayed and maternal antibody levels drop too low, a severe vaccine reaction may result and the chick will be left vulnerable to disease prior to vaccination.

Types of Acquired Immunity

Active Immunity

- This is the immunity which the chicken obtains from its own immune system.
- This system must be activated or triggered to produce the antibodies.
- This defense mechanism has the ability to remember specific invaders, resulting in quicker and more effective responses to a repeated exposure of the same antigen, and produces defenses that are specific for that invader i.e. they will fight that particular invader only.

Acquired Immunity

The acquired immunity is generally divided into:

1. Cellular immunity
2. Humoral immunity

Cellular Immune Response

- The cellular system was first identified when it was shown that chickens with damaged BF (who were unable to produce specific antibodies) could respond to and eliminate many disease organisms.

Cont. …

- The cellular component of the immune response includes all the cells that react with specificity to antigens, except those associated with antibody production.

- The cells associated with this system, the T-lymphocytes (T-cells).

Cont. …

- A range of T-cells are produced to perform various roles:
    1. Some T-cells act by producing chemicals called lymphokines.
    2. Others directly destroy disease organisms (T-Killer)
    3. Some T-cells act to enhance the response of B-cells, macrophages, or other T-cells (called helper T-cells); while still others have the opposite effect and act to inhibit the activity of these cells (suppressors).

Cont. …

- Cell-mediated responses are accompanied by the secretion of pro-inflammatory cytokines and are sometimes associated with the nutritionally expensive systemic inflammatory response.

- The rapid expansion of T-cells during development and later diversification require substantial time and nutrients.

Cont. …

- An estimated 95% of maturing T cells are destroyed in the thymus as a result of rigorous selection procedures, making this a very expensive process

Humoral Immune Response

1
- A disease organism enters the body.
- It is engulfed by a phagocytic-type cell, the macrophage.

2
- The macrophage transports the disease organism and exposes it to the B-lymphocytes (B-cells).

3
- B-cells move to the bursa of Fabricius (BF), the BF programs these cells to attach to the antigen.

Cont. …

4
- The programmed cells then move to the blood, spleen, cecal tonsils, bone marrow, Harderian gland and thymus.

5
- The B-cells then respond by producing antibodies specific to the disease organism.

6
- A five-day lag period occurs because the B-cells must be programmed and undergo clonal expansion to increase their numbers.

Cont. …

- The B-cell system also produces ‘memory’ cells that remember infections.
- These have a relatively long life and stimulate the antibody producing cells to quickly release large amounts of antibodies specific for particular disease organisms previously experienced by the bird, resulting in a quicker and more effective immune response than the initial response.

Humoral Immunity
Cost of Stimulation

- The costs of using humoral component (B-cells and type two T-helper cells) are thought to be small compared with those of innate and cell-mediated immunity because humoral immunity is associated with the production of anti-inflammatory cytokines.
- At the same time, lymphocyte proliferation and diversification during the developmental period require substantial energy and nutrients.

Immune Suppression

Note

- Destruction of the BF in a chicken at a young age by Gumboro (infectious bursal disease) or Marek's disease prevents programming of B-cells for life, thus, the affected chicken will not be able to respond to diseases or vaccinations by producing specific antibodies.

How Do Antibodies Fight Infection?

- Antibodies do not have the capability to kill disease organisms directly.
- Antibodies perform their function by attaching to disease organisms and blocking their receptors and prevent them from attaching to their target cell receptors in the chicken.

Cont. …

For example:

1. An infectious bronchitis virus which has its receptors covered with antibodies will not be able to attach to and penetrate its target cells, the cells lining the trachea.
2. The attached antibodies also immobilize the disease organism which assists their destruction by macrophages.

Immune System
Cost Comparison

Immune System
Cost Comparison

- Activation of the innate response is generally considered to be more costly than activation of the acquired response.

Immune System
Cost Comparison

- However, during re-exposure of the host to pathogens, there may still be activation of innate immune pathways such that acquired immunity may not be able to circumvent all the costs of innate immune responses.

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Basis for Vaccination

If the chicken is exposed a second time to the same antigen, the response is quicker and a much higher level of immune cell and antibody production occurs.

This is the basis for vaccinating.

Types Of Vaccines

- There are a number of types of vaccines, with advances in technology resulting in the continuing development of new vaccine types.
- Some types of vaccines include:
  1. Live attenuated
  2. Killed
  3. Sub-unit
  4. Recombinant
  5. DNA
  6. Conjugated

1- Live Attenuated Vaccines

- They contain living disease organisms that have been treated in some way to reduce their ability to cause disease while still causing an immune response.
- These living organisms are able to infect and multiply in the host and this enhances the strength and duration of the immune response.

2- Killed (Inactivated) Vaccines

- Inactivated vaccine contains high doses of the killed disease organism.
- Killed vaccines generally result in a weaker and shorter immune response compared to live vaccines due to their inability to infect and multiply in the host.

3- Sub-unit Vaccines

These vaccines contain doses of purified antigens extracted from the disease organism.

4- Recombinant Vaccines

These vaccines are produced by incorporating the DNA for the antigens that stimulate a disease response to a disease organism into a vector (or carrier), such as a harmless virus, which is then used as a live vaccine.

5- DNA Vaccines

These vaccines contain purified DNA for the antigens that stimulate an immune response to a disease organism.

6- Conjugate Vaccines

- These vaccines are used to elicit an immune response to an antigen that is normally able to evade detection by the immune system.
- They contain the antigen bound to a compound, such as a protein, to form a complex that is detectable by the immune system.