



# PRINCIPLES OF VETERINARY IMMUNOLOGY

VERSION 3

## POWERPOINTS

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VETERINARY  
BIOLOGICS  
TRAINING  
PROGRAM





# Principles of Veterinary Immunology

## Long Course

### Lecture Checklist

#### **Lecture Title (approximate length)**

PPT Book Page #

<input type="checkbox"/> Introduction to the Course (5 min)	
<b>Overview of the Immune System</b>	
<input type="checkbox"/> Overview of Immunology (7.5 min)	pg. 5
<input type="checkbox"/> Overview of Innate Defenses (8 min)	pg. 7
<input type="checkbox"/> Overview of Adaptive Defenses (9.5 min)	pg. 8
<input type="checkbox"/> Overview of the Cells of the Immune System ( 16.5 min)	pg. 11
<input type="checkbox"/> Overview of Antigen Binding Molecules (10 min)	pg. 14
<b>Innate Immune System</b>	
<input type="checkbox"/> Complement, Part 1 (19.5 min)	pg. 16
<input type="checkbox"/> Complement, Part 2 (8.5 min)	pg. 19
<input type="checkbox"/> Neutrophils (34 min)	pg. 21
<input type="checkbox"/> Eosinophils (8 min)	pg. 26
<input type="checkbox"/> Macrophages (17.5 min)	pg. 28
<input type="checkbox"/> Early Detection and Response to Microbial Invasion (13.5 min)	pg. 32
<input type="checkbox"/> Response Following Detection of Microbe (10.5 min)	pg. 34
<input type="checkbox"/> Macrophage Activation and Types of Inflammation (9.5 min)	pg. 36
<input type="checkbox"/> Cytokines(27.5 min)	pg. 39
<b>Adaptive Immune System</b>	
<input type="checkbox"/> Antigens and Antibodies (16 min)	pg. 43
<input type="checkbox"/> Antigen-Antibody Binding (18 min)	pg. 46
<input type="checkbox"/> Properties that Make Antigens Strong Immunogens (16.5 min)	pg. 49
<input type="checkbox"/> Antibody Isotype Structure and Function (14.5 min)	pg. 52
<input type="checkbox"/> Understanding the Primary and Secondary Immune Response (11.5 min)	pg. 56
<input type="checkbox"/> Major Histocompatibility Complex (MHC) (17 min)	pg. 58
<input type="checkbox"/> Pathways of Antigen Presentation (13 min)	pg. 62
<input type="checkbox"/> MHC and Transplantation (12 min)	pg. 64
<input type="checkbox"/> Generation of Antigen Receptors (26 min)	pg. 67
<input type="checkbox"/> Lymphocyte Identification (16 min)	pg. 74
<input type="checkbox"/> Understanding B cell Response to Antigen and Development of Memory(10 min)	pg. 77

<input type="checkbox"/> Monoclonal Antibodies (7.5 min)	pg. 80
<input type="checkbox"/> Development of Tolerance- Part 1 (6.5 min)	pg. 81
<input type="checkbox"/> Development of Tolerance- Part 2 (9 min)	pg. 83
<input type="checkbox"/> Lymphocyte Circulation (16.5 min)	pg. 85
<input type="checkbox"/> Understanding T <sub>H</sub> cells and $\gamma\delta$ T cells (20 min)	pg. 90
<input type="checkbox"/> T cell Help for B cells (12 min)	pg. 95
<input type="checkbox"/> Antigen Trapping and Presentation (7.5 min)	pg. 97
<input type="checkbox"/> Cell Interactions and Response to Microbes (16 min)	pg. 100
<input type="checkbox"/> Cytotoxic T Cells and Natural Killer Cells (16 min)	pg. 105
<b>Clinical Immunology Topics</b>	
<input type="checkbox"/> Immune Response to Viruses (20 min)	pg. 110
<input type="checkbox"/> Immune Response to Tumors and Immunotherapies (27 min)	pg. 113
<input type="checkbox"/> Mucosal Immunology, Part 1 (19.5 min)	pg. 121
<input type="checkbox"/> Mucosal Immunology, Part 2 (19 min)	pg. 126
<input type="checkbox"/> Fetal and Neonatal Immunology, Part 1 (11 min)	pg. 131
<input type="checkbox"/> Fetal and Neonatal Immunology, Part 2 (19 min)	pg. 132
<input type="checkbox"/> Fetal and Neonatal Immunology, Part 3 (12 min)	pg. 136
<input type="checkbox"/> Introduction to Hypersensitivities (7 min)	pg. 138
<input type="checkbox"/> Type I (Immediate, IgE-mediated) Hypersensitivity, Part 1 (11.5 min)	pg. 140
<input type="checkbox"/> Type I (Immediate, IgE-mediated) Hypersensitivity, Part 2 (14.5 min)	pg. 142
<input type="checkbox"/> Type I (Immediate, IgE-mediated) Hypersensitivity, Part 3 (6.5 min)	pg. 145
<input type="checkbox"/> Type II and Type III Hypersensitivities (19 min)	pg. 146
<input type="checkbox"/> Type IV Hypersensitivity (14.5 min)	pg. 150
<input type="checkbox"/> <b>Comparative Immunology: Avian and Aquatic (26.5 min)</b>	<b>pg. 152</b>

# Principles of Veterinary Immunology

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## Topic Areas

- Basic immunology: Protection from infectious agents and neoplasia
- Systemic vs. mucosal immunity
- Immunity in the neonate
- Immune mediated diseases
- Introduction to immunotherapeutics
- Comparative immunology

### Innate Defense Mechanisms

- Protects naïve animal
- Protects immediately
- Not antigen specific
- Activated by "danger signals" from pathogens and tissue damage
- More effective in presence of adaptive immunity

### Adaptive Defense Mechanisms

- Develop after antigen exposure in presence of danger signals from innate system
- Require several days to weeks
- Antigen specific
- Memory and tolerance
- Activate innate defense mechanisms to be more effective



## Overview of Innate Defenses

## Innate Defense Mechanisms

- Anatomical and physiological barriers
  - Skin
  - Mucus
  - Normal flora
  - Acid in stomach
  - Antimicrobial peptides: e.g. defensins

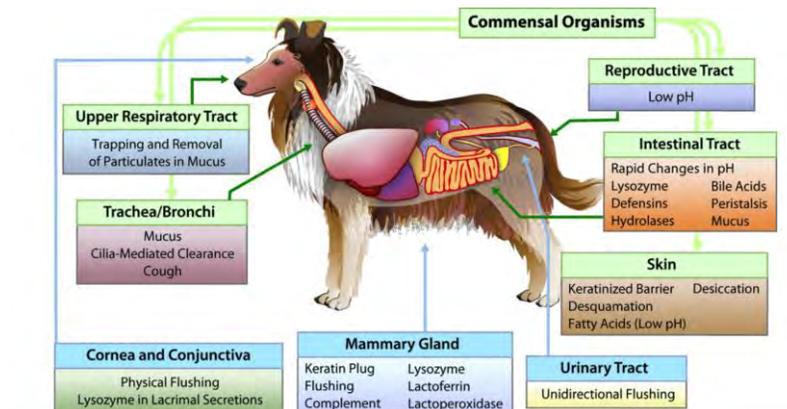
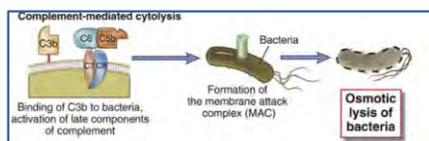


Illustration: Tamara Rees, Basic Veterinary Immunology, Callahan & Yates, 2014, Fig 2.2

## Innate Defense Mechanisms

- Soluble factors include:
  - Complement system (C')
    - > 20 serum and membrane proteins
    - Powerful and rapid enzyme cascade system
    - Induces acute inflammation
    - Multiple mechanisms for controlling microbial infection



Abbas, A.K., 2018. Cellular and Molecular Immunology, 9e, 2018, Fig 13-17

## Innate Defense Mechanisms

- Soluble factors continued
  - Innate defense cytokines
    - Cytokines: protein messenger molecules produced by stimulated cells
    - Sentinel cells produce in response to danger signals
    - Pro-inflammatory cytokines
    - Chemokines
    - Interferons
  - Defensins
    - Antimicrobial molecules associated with epithelium and phagocytes

## Innate Defense Mechanisms

- Cellular components include:
  - Phagocytic cells: Neutrophils, macrophages
  - Sentinel cells: Dendritic cells, macrophages, mast cells
  - Cytokine secreting innate lymphoid cells (ILCs)
  - Cytotoxic innate lymphoid cells (Natural Killer (NK) cells)

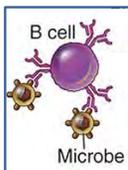
## Overview of Adaptive Defenses

# Adaptive Defense Mechanisms

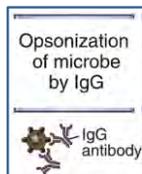
- Humoral Immunity/Antibody
  - B cells/plasma cells
  - IgM, IgG, IgA, IgE, IgD
- Cell Mediated Immunity (CMI)
  - T cells – alpha/beta ( $\alpha\beta$ ) TCR
    - CD4+:  $T_{\text{Helper}1}$ ,  $T_{\text{H}2}$ ,  $T_{\text{H}17}$ ,  $T_{\text{FH}}$ ,  $T_{\text{reg}}$
    - CD8+: Cytotoxic T cells (CTLs)
  - T cells – gamma/delta ( $\gamma\delta$ ) TCR

# Antigen Recognition

- B cells/Antibody
  - B cells recognize intact antigens
  - Antibodies recognize a small portion of a molecule (epitope)
  - Very specific ~  $10^9$  different epitopes



B cell receptor is membrane bound antibody

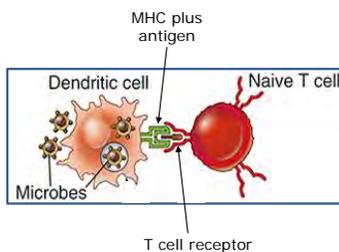


Free antibody recognizes an epitope on a microbe

Abbas, A.K., 2018. Cellular and Molecular Immunology, 9e. Fig. 13.1 and 13.4

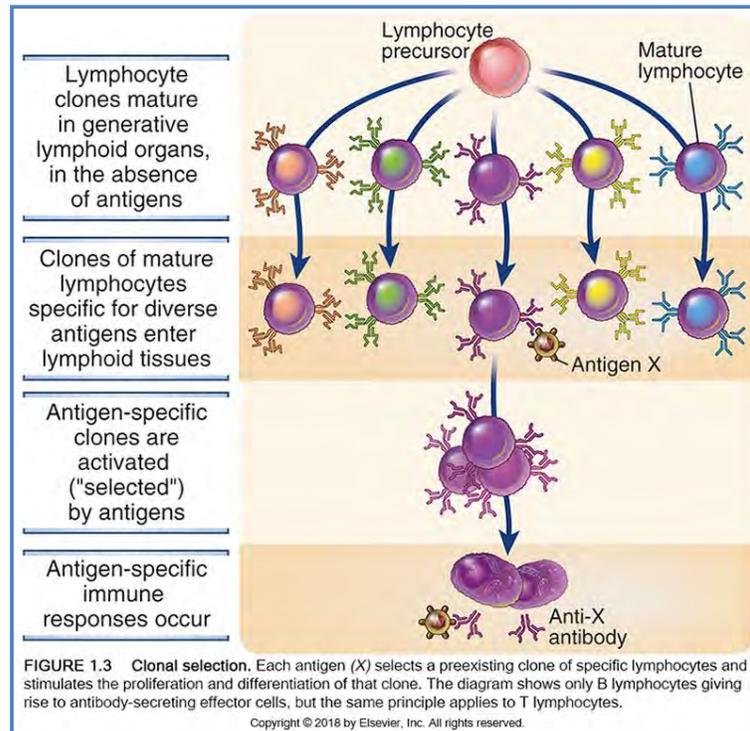
# Antigen Recognition

- T cells
  - $T_{\text{H}}$  (CD4) and CTLs (CD8) recognize only peptides processed and presented on MHC molecules
  - Gamma delta ( $\gamma\delta$ ) T cells recognize cell surface molecules



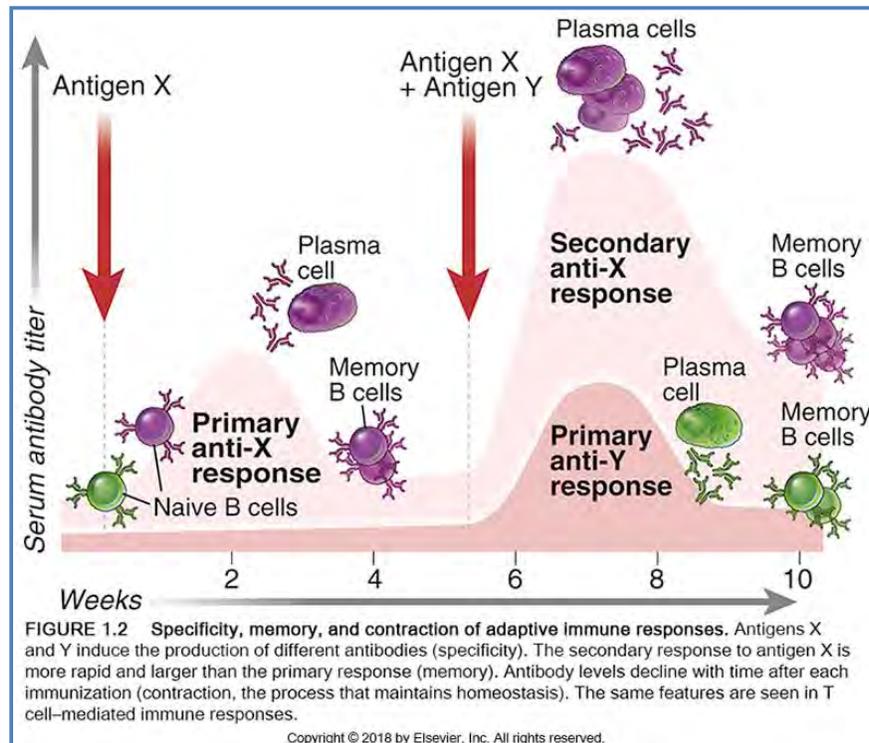
Abbas, A.K., 2018. Cellular and Molecular Immunology, 9e. Fig. 10.5

# Clonal Selection of Lymphocytes



Abbas, A.K., 2018. Cellular and Molecular Immunology, 9e. Fig. 1.3

# Immunologic Memory



Abbas, A.K., 2018. Cellular and Molecular Immunology, 9e. Fig. 10.5