VETERINARY/ANIMAL PHYSIOLOGY

Chapter 9: Physiology of immune system

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Introduction

Immunophysiology in veterinary medicine encompasses the intricate study of the immune system's structure, function, and interactions within the realm of animal health and disease.

Components of the Immune System:

1. **Innate Immunity**: First line of defense against pathogens, offering immediate protection:
    - Innate Active Immunity: Natural resistance acquired from environmental exposure (e.g., skin barrier).
    - Innate Passive Immunity: Temporary immunity passed from mother to offspring (e.g., maternal antibodies in breast milk).
2. **Adaptive Immunity**: Tailored response to specific pathogens, with memory and specificity:
    - Acquired Active Immunity: Developed from exposure to antigens, leading to antibody production and memory cells (e.g., vaccination).
    - Acquired Passive Immunity: Temporary immunity from transfer of pre-formed antibodies (e.g., antivenom administration).

Key Elements:

Immunoglobulins (Antibodies):

These glycoprotein molecules are produced by B cells in response to foreign antigens, playing a vital role in humoral immunity:

- **IgG:** Abundant in blood, provides long-term immunity, crosses placenta, aids opsonization, complement activation, and toxin neutralization.
- **IgM:** Initial immune response, exists as a pentamer, effective in agglutination, complement activation, and pathogen clearance.
- **IgA:** Found in mucosal secretions, provides localized immunity, prevents pathogen adherence, and neutralizes toxins and viruses in mucosal surfaces.
- **IgD:** Found in low concentrations, on B cell surfaces, role in B cell activation and differentiation not fully understood.
- **IgE:** Involved in allergies and defense against parasites, binds to mast cells and basophils, triggers release of histamine and inflammatory mediators.

MHC (Major Histocompatibility Complex):

MHC molecules play a crucial role in the immune system by presenting antigens to T cells, thereby initiating immune responses. They are divided into two classes: MHC class I molecules, which present intracellular antigens to CD8+ T cells, and MHC class II molecules, which present extracellular antigens to CD4+ T cells. MHC diversity is essential for antigen presentation and immune recognition, influencing immune responses and susceptibility to diseases.

Complement System:

The complement system, a group of proteins, enhances immune responses by promoting inflammation and aiding in pathogen destruction. It has three activation pathways: classical (triggered by antigen-antibody complexes), alternative (activated independently of antibodies), and lectin (initiated by lectin binding to microbial surfaces).

Its effector functions include opsonization (enhancing phagocytosis), inflammation (recruiting immune cells), membrane attack complex formation (causing cell lysis), and immune complex clearance.

Mechanisms of Immune Response:

- **Tissue Macrophage System**: Tissue-resident macrophages, derived from circulating monocytes, maintain tissue health by engulfing pathogens and debris.
- **Inflammatory Response**: Triggered by pathogens or tissue damage, inflammation aims to eliminate threats and initiate repair. Features include immune cell recruitment and cytokine release, with tissue macrophages amplifying the response.
- **Phagocytic Mechanism**: Phagocytic cells recognize pathogens through pattern recognition receptors and engulf them, leading to their digestion or presentation to other immune cells.
- **Immunomodulation:** Immunomodulin is a protein that regulates immune responses by modulating the activity of immune cells. It has anti-inflammatory properties and can enhance the function of regulatory T cells, which helps maintain immune balance and prevent excessive inflammation. Immunomodulin shows promise in various therapeutic applications, including autoimmune diseases and transplantation, due to its ability to regulate immune tolerance and reduce inflammatory responses.

Ontogeny and Phylogeny of the Immune System:

Ontogeny: The development of an individual's immune system, from embryonic stages to adulthood, involves the maturation of immune cells in organs like the thymus and bone marrow, leading to a functional immune system capable of defending against pathogens and maintaining health.

Phylogeny: Across different species, immune systems have evolved diverse mechanisms for detecting and responding to pathogens, shaped by evolutionary pressures and interactions with the environment, allowing organisms to adapt and survive in their respective ecological niches.

Hypersensitivity:

Hypersensitivity is an exaggerated immune response to harmless substances, resulting in tissue damage or clinical symptoms.

a) **Type I Hypersensitivity (Immediate Hypersensitivity):** Immediate allergy; IgE antibodies trigger histamine release causing reactions like hay fever, asthma, and anaphylaxis.
b) **Type II Hypersensitivity (Cytotoxic Hypersensitivity):** Antibodies (IgG or IgM) bind to host cells, leading to cell destruction; examples include autoimmune hemolytic anemia and some drug reactions.
c) **Type III Hypersensitivity (Immune Complex-Mediated Hypersensitivity):** Immune complexes form between antigens and antibodies, causing tissue damage; examples include systemic lupus erythematosus (SLE) and serum sickness.
d) **TypeIV Hypersensitivity (Delayed-Type Hypersensitivity):**Delayed hypersensitivity involving T cell activation and cytokine release, leading to tissue damage; examples include contact dermatitis and certain drug reactions.

Diseases related to immune system:

- **Canine Atopic Dermatitis:** Similar to human allergies, dogs can develop atopic dermatitis, an allergic skin disease triggered by environmental allergens such as pollen, dust mites, and mold. It leads to itching, redness, and skin lesions due to an abnormal immune response.
- **Feline Immunodeficiency Virus (FIV):** FIV is a viral infection in cats that compromises the immune system, similar to HIV in humans. It weakens the cat's ability to fight off infections and can lead to various secondary infections and illnesses.
- **Equine Infectious Anemia (EIA):** Also known as swamp fever, EIA is a viral disease affecting horses, mules, and donkeys. It attacks the immune system, causing recurrent fever, anemia, weight loss, and weakness. EIA can be fatal and is spread primarily through blood-sucking insects.
- **Bovine Respiratory Disease (BRD):** BRD is a complex respiratory disease affecting cattle, caused by a combination of viral and bacterial pathogens. It compromises the animal's immune response, leading to pneumonia, fever, coughing, and reduced weight gain.

Advances in Immunophysiology:

- **Immunotherapy:** Breakthroughs in cancer treatment through immune checkpoint inhibitors and CAR T-cell therapy.
- **Microbiota-Immune System:** Understanding how gut bacteria influence immune responses, leading to new therapeutic approaches.
- **Vaccine Innovation:** Rapid development of mRNA and viral vector vaccines, along with research into novel adjuvants and delivery systems.
- **Single-Cell Technologies:** Providing insights into immune cell dynamics at the single-cell level.
- **Innate Immunity:** Recognition of the critical role of innate immune cells in shaping responses and potential targets for disease therapy.

Multiple Choice Questions

1. Which cells are primarily responsible for the adaptive immune response?
    a) Neutrophils
    b) Macrophages
    c) B cells and T cells
    d) Eosinophil
2. Which of the following is not a primary lymphoid organ?
    a) Thymus
    b) Bone marrow
    c) Spleen
    d) Liver
3. What is the main function of dendritic cells in the immune system?
    a) Phagocytosis of pathogens
    b) Production of antibodies
    c) Antigen presentation to T cells
    d) Activation of B cells
4. Which type of immunity is mediated by antibodies produced by B cells?
    a) Cell-mediated immunity
    b) Innate immunity
    c) Humoral immunity
    d) Adaptive immunity
5. What is the role of helper T cells in the immune response?
    a) Directly kill infected cells
    b) Produce antibodies
    c) Activate other immune cells
    d) Phagocytose pathogens
6. Which class of antibodies is involved in mucosal immunity?
    a) IgA
    b) IgG
    c) IgE
    d) IgM
7. Which cells are responsible for producing antibodies?
    a) B cells
    b) T cells
    c) Natural killer cells
    d) Macrophages
8. What is the primary function of cytotoxic T cells?
    a) Secretion of cytokines
    b) Phagocytosis of pathogens
    c) Killing of virus-infected cells
    d) Activation of B cells
9. Which type of immunity provides immediate, nonspecific protection against pathogens?
    a) Passive immunity
    b) Active immunity
    c) Innate immunity
    d) Adaptive immunity
10. Which cytokine is involved in promoting inflammation and attracting immune cells to the site of infection?
    a) Interleukin-10

b) Interferon-gamma
c) Tumor necrosis factor-alpha
d) Transforming growth factor-beta

11. Which type of cell is responsible for presenting antigens to T cells?
a) B cells
b) Macrophages
c) Dendritic cells
d) Natural killer cells

12. What is the function of memory B cells?
a) Produce antibodies during a primary immune response
b) Phagocytose pathogens
c) Provide long-term immunity upon re-exposure to an antigen
d) Kill virus-infected cells

13. Which of the following is not a characteristic of the adaptive immune response?
a) Specificity
b) Memory
c) Rapid response to infection
d) Diversity

14. Which type of cell is responsible for antibody class switching?
a) Helper T cells
b) Memory B cells
c) Plasma cells
d) Regulatory T cells

15. Which class of antibodies can cross the placenta to provide passive immunity to the fetus?
a) IgA
b) IgG
c) IgE
d) IgM

16. What is the role of regulatory T cells in the immune system?
a) Activate other immune cells
b) Produce antibodies
c) Suppress excessive immune responses
d) Phagocytose pathogens

17. Which type of cell secretes antibodies?
a) Plasma cells
b) Helper T cells
c) Cytotoxic T cells
d) Memory B cells

18. Which type of immunity is acquired through vaccination?
a) Passive immunity
b) Active immunity
c) Innate immunity
d) Humoral immunity

19. What is the primary function of the complement system?
a) Phagocytosis of pathogens
b) Activation of B cells
c) Killing of virus-infected cells
d) Enhancement of the immune response

20. Which cells are responsible for granulomatous inflammation?

a) **Macrophages**
b) Neutrophils
c) Eosinophils
d) Basophils

21. Which type of cell produces histamine during allergic reactions?
    a) Basophils
    b) Neutrophils
    c) Eosinophils
    d) **Mast cells**
22. Which cytokine is involved in promoting the differentiation of B cells into plasma cells?
    a) Interleukin-2
    b) **Interleukin-4**
    c) Interferon-gamma
    d) Tumor necrosis factor-alpha
23. Which type of cell mediates antibody-dependent cell-mediated cytotoxicity (ADCC)?
    a) **Natural killer cells**
    b) Helper T cells
    c) Cytotoxic T cells
    d) Memory B cells
24. Which type of immunity is provided by the transfer of antibodies from one individual to another?
    a) **Passive immunity**
    b) Active immunity
    c) Innate immunity
    d) Humoral immunity
25. What is the main function of Toll-like receptors (TLRs) in the immune system?
    a) Phagocytosis of pathogens
    b) Activation of the complement system
    c) **Recognition of pathogen-associated molecular patterns (PAMPs)**
    d) Production of antibodies
26. Which type of cell is responsible for secreting cytokines to recruit and activate immune cells?
    a) Plasma cells
    b) Mast cells
    c) Eosinophils
    d) **Macrophages**
27. Which class of antibodies is involved in allergic reactions?
    a) IgA
    b) IgG
    c) **IgE**
    d) IgM
28. What is the role of MHC molecules in the immune response?
    a) **Present antigens to T cells**
    b) Produce antibodies
    c) Kill virus-infected cells
    d) Mediate phagocytosis of pathogens
29. Which cells are primarily responsible for producing antibodies during a secondary immune response?
    a) **Plasma cells**
    b) Memory B cells

c) Dendritic cells
d) Natural killer cells

30. Which type of cell is responsible for phagocytosing pathogens and presenting antigens to T cells?
    a) B cells
    b) Mast cells
    c) **Macrophages**
    d) Eosinophils
31. Which of the following is not a function of antibodies?
    a) Opsonization
    b) Neutralization
    c) **Phagocytosis**
    d) Complement activation
32. Which type of immunity is mediated by cytotoxic T cells?
    a) Passive immunity
    b) Active immunity
    c) **Cell-mediated immunity**
    d) Humoral immunity
33. Which cytokine is primarily produced by Th1 cells and is involved in activating macrophages?
    a) Interleukin-2
    b) Interleukin-4
    c) **Interferon-gamma**
    d) Tumor necrosis factor-alpha
34. Which type of cell is responsible for antibody-mediated immune responses against parasitic infections?
    a) Mast cells
    b) Basophils
    c) Eosinophils
    d) Neutrophils
35. Which type of hypersensitivity reaction involves the formation of immune complexes and subsequent tissue damage?
    a) Type I
    b) Type II
    c) **Type III**
    d) Type IV
36. Which class of antibodies can activate the classical pathway of the complement system?
    a) IgA
    b) IgG
    c) IgE
    d) IgM
37. What is the main function of the thymus gland in the immune system?
    a) Production of antibodies
    b) **Maturation of T cells**
    c) Phagocytosis of pathogens
    d) Activation of B cells
38. Which type of cell is responsible for maintaining self-tolerance and preventing autoimmune reactions?
    a) **Regulatory T cells**
    b) Helper T cells

c) Cytotoxic T cells
d) Memory T cells

39. Which molecule is expressed on the surface of cytotoxic T cells and is involved in recognizing antigen-presenting cells?
    a) CD4
    b) **CD8**
    c) CD19
    d) CD20
40. Which type of hypersensitivity reaction involves the formation of immune complexes in the lungs, leading to inflammation and tissue damage?
    a) Type I
    b) Type II
    c) **Type III**
    d) Type IV**
41. Which molecule is involved in the activation of complement by the alternative pathway?
    a) **Properdin****
    b) Mannose-binding lectin (MBL)
    c) C1q
    d) Factor B
42. Which type of cell is responsible for producing cytokines that promote inflammation and recruit immune cells to the site of infection?
    a) Natural killer cells
    b) **Helper T cells**
    c) Plasma cells
    d) Regulatory T cells
43. Which cell-surface molecule is required for T cell activation and is known as the co-receptor for the T cell receptor?
    a) MHC class I
    b) MHC class II
    c) **CD4**
    d) CD8
44. Which type of immunity is primarily mediated by T cells and does not involve antibodies?
    a) Passive immunity
    b) Active immunity
    c) **Cell-mediated immunity**
    d) Humoral immunity
45. Which type of cell is responsible for secreting antibodies into the bloodstream?
    a) **Plasma cells**
    b) Memory B cells
    c) Dendritic cells
    d) Natural killer cells
46. Which type of cell expresses high levels of CD14 and Toll-like receptors and is involved in recognizing and phagocytosing bacteria?
    a) **Macrophages**
    b) Neutrophils
    c) Mast cells
    d) Eosinophils
47. Which type of cell is responsible for presenting exogenous antigens to helper T cells?
    a) Macrophages

b) **Dendritic cells**
c) B cells
d) Neutrophils

48. Which class of antibodies is the first to be produced during an immune response?
    a) IgA
    b) IgG
    c) IgE
    d) **IgM**
49. Which type of immunity is provided by memory T cells?
    a) Passive immunity
    b) Active immunity
    c) Innate immunity
    d) **Cell-mediated immunity**
50. Which type of cell is responsible for producing antibodies with high affinity and specificity during the secondary immune response?
    a) Memory B cells
    b) **Plasma cells**
    c) Dendritic cells
    d) Natural killer cells
51. Which type of hypersensitivity reaction is mediated by IgE antibodies and mast cells?
    a) **Type I**
    b) Type II
    c) Type III
    d) Type IV
52. Which type of cell is responsible for producing antibodies with different effector functions, such as IgG, IgA, and IgE?
    a) Memory B cells
    b) **Plasma cells**
    c) Dendritic cells
    d) Natural killer cells
53. Which type of cell expresses high levels of Fc receptors and is involved in antibody-dependent cellular cytotoxicity (ADCC)?
    a) Macrophages
    b) Neutrophils
    c) **Natural killer cells**
    d) Eosinophils
54. Which cytokine is primarily produced by Th2 cells and is involved in promoting the production of IgE antibodies?
    a) Interleukin-2
    b) **Interleukin-4**
    c) Interferon-gamma
    d) Tumor necrosis factor-alpha
55. Which type of cell is responsible for suppressing immune responses and maintaining peripheral tolerance?
    a) **Regulatory T cells**
    b) Helper T cells
    c) Cytotoxic T cells
    d) Memory T cells
56. Which molecule is involved in the formation of the immunological synapse between T cells and antigen-presenting cells?

a) CD4
b) CD8
c) **CD28**
d) CTLA-4

57. Which type of cell is primarily responsible for producing antibodies against viral infections?
    a) **Plasma cells**
    b) Memory B cells
    c) Dendritic cells
    d) Natural killer cells
58. Which type of hypersensitivity reaction involves the activation of complement and the formation of membrane attack complexes?
    a) Type I
    b) **Type II**
    c) Type III
    d) Type IV
59. Which class of antibodies is primarily found in secretions such as tears, saliva, and breast milk?
    a) **IgA**
    b) IgG
    c) IgE
    d) IgM
60. Which type of cell expresses high levels of Toll-like receptors and is involved in innate immune responses to bacterial infections?
    a) **Macrophages**
    b) Neutrophils
    c) Mast cells
    d) Eosinophils
61. Which type of cell is responsible for presenting endogenous antigens to cytotoxic T cells?
    a) Macrophages
    b) Dendritic cells
    c) B cells
    d) **Infected cells**
62. Which class of antibodies is the first to be produced during fetal development?
    a) **IgM**
    b) IgG
    c) IgE
    d) IgA
63. Which cytokine is primarily produced by Th17 cells and is involved in promoting inflammation and neutrophil recruitment?
    a) Interleukin-2
    b) Interleukin-4
    c) **Interleukin-17**
    d) Interferon-gamma
64. Which type of hypersensitivity reaction involves the formation of granulomas and is associated with delayed-type hypersensitivity?
    a) Type I
    b) Type II
    c) Type III

d) **Type IV**

65. Which molecule is involved in the activation of complement by the classical pathway?
    a) Mannose-binding lectin
    b) **C1q**
    c) Factor B
    d) Properdin
66. Which type of cell is responsible for producing antibodies against blood-borne pathogens?
    a) **Plasma cells**
    b) Memory B cells**
    c) Dendritic cells
    d) Natural killer cells
67. Which class of antibodies is primarily involved in protecting mucosal surfaces?
    a) **IgA**
    b) IgG
    c) IgE
    d) IgM
68. Which cytokine is primarily produced by regulatory T cells and is involved in suppressing immune responses?
    a) Interleukin-2
    b) Interleukin-4
    c) **Interleukin-10**
    d) Transforming growth factor-beta (TGF-β)**
69. Which type of hypersensitivity reaction is mediated by cytotoxic T cells and involves tissue destruction?
    a) Type I
    b) Type II
    c) Type III
    d) **Type IV**
70. Which molecule is involved in the recognition of pathogen-associated molecular patterns (PAMPs) by immune cells?
    a) **Toll-like receptors (TLRs)**
    b) Major histocompatibility complex (MHC)
    c) CD4
    d) CD8
71. Which type of cell is primarily responsible for killing virus-infected cells?
    a) Plasma cells
    b) Memory B cells
    c) **Cytotoxic T cells**
    d) Natural killer cells
72. Which class of antibodies is involved in activating eosinophils and mediating allergic reactions?
    a) IgA
    b) IgG
    c) **IgE**
    d) IgM
73. Which cytokine is primarily produced by mast cells and is involved in promoting inflammation and smooth muscle contraction?
    a) Interleukin-2
    b) Interleukin-4

c) **Histamine**
d) Interferon-gamma

74. Which type of hypersensitivity reaction involves the formation of immune complexes in blood vessels and subsequent tissue damage?
    a) Type I
    b) Type II
    c) **Type III**
    d) Type IV
75. Which molecule is involved in the activation of complement by the alternative pathway?
    a) Mannose-binding lectin
    b) C1q
    c) **Factor B**
    d) Properdin
76. Which type of cell is primarily responsible for presenting antigens to helper T cells in lymph nodes?
    a) Macrophages
    b) **Dendritic cells**
    c) B cells
    d) Follicular dendritic cells**
77. Which class of antibodies is the first to be produced during an infant's immune response to infection?
    a) **IgM**
    b) IgG
    c) IgE
    d) IgA
78. Which cytokine is primarily produced by Th2 cells and is involved in promoting B cell proliferation and class switching to IgE?
    a) Interleukin-2
    b) **Interleukin-4**
    c) Interleukin-17
    d) Interferon-gamma
79. Which type of hypersensitivity reaction involves the release of preformed mediators such as histamine from mast cells and basophils?
    a) **Type I**
    b) Type II
    c) Type III
    d) Type IV
80. Which molecule is involved in the recognition of self-antigens by autoreactive T cells in the thymus?
    a) **Toll-like receptors (TLRs)**
    b) Major histocompatibility complex (MHC)
    c) CD4
    d) CD8
81. Which type of cell is primarily responsible for producing antibodies against extracellular bacteria?
    a) Plasma cells
    b) Memory B cells
    c) **Follicular B cells**
    d) Natural killer cells

82. Which class of antibodies is primarily involved in neutralizing toxins produced by bacteria?
    a) IgA
    b) IgG
    c) **IgM**
    d) IgE
83. Which cytokine is primarily produced by Th1 cells and is involved in activating cytotoxic T cells?
    a) Interleukin-2
    b) Interleukin-4
    c) Interleukin-10
    d) **Interferon-gamma**
84. Which type of hypersensitivity reaction involves the formation of granulomas and is associated with tuberculosis?
    a) Type I
    b) Type II
    c) Type III
    d) **Type IV**
85. Which molecule is involved in the recognition of viral peptides presented by infected cells to cytotoxic T cells?
    a) Toll-like receptors (TLRs)
    b) Major histocompatibility complex (MHC)
    c) **T cell receptor (TCR)**
    d) CD8
86. Which type of cell is primarily responsible for producing antibodies against viruses in the respiratory tract?
    a) Plasma cells
    b) **IgA-producing plasma cells**
    c) Dendritic cells
    d) Natural killer cells
87. Which class of antibodies is primarily involved in allergic reactions, asthma, and anaphylaxis?
    a) IgA
    b) IgG
    c) **IgE**
    d) IgM
88. Which cytokine is primarily produced by regulatory T cells and is involved in suppressing immune responses?
    a) Interleukin-2
    b) Interleukin-4
    c) **Interleukin-10**
    d) Interferon-gamma
89. Which type of hypersensitivity reaction involves the formation of immune complexes in the glomeruli of the kidneys?
    a) Type I
    b) Type II
    c) **Type III**
    d) Type IV
90. Which molecule is involved in the activation of complement by the lectin pathway?
    a) **Mannose-binding lectin (MBL)**

b) C1q
c) Factor B
d) Properdin

91. Which type of cell is primarily responsible for presenting lipid antigens to T cells?
    a) Macrophages
    b) **Dendritic cells**
    c) B cells
    d) Natural killer cells
92. Which class of antibodies is the first to be produced during a primary immune response to an infection?
    a) **IgM**
    b) IgG
    c) IgE
    d) IgA
93. Which cytokine is primarily produced by Th17 cells and is involved in promoting neutrophil chemotaxis?
    a) Interleukin-2
    b) Interleukin-4
    c) **Interleukin-17**
    d) Interferon-gamma
94. Which type of hypersensitivity reaction is mediated by immune complexes deposited in blood vessel walls?
    a) Type I
    b) Type II
    c) **Type III**
    d) Type IV
95. Which molecule is involved in the recognition of lipopolysaccharide (LPS) from Gram-negative bacteria?
    a) T**oll-like receptor 4 (TLR4)**
    b) Major histocompatibility complex (MHC)
    c) CD4
    d) CD14
96. Which type of cell is primarily responsible for producing antibodies against pathogens in the bloodstream?
    a) Plasma cells
    b) Memory B cells
    c) **Follicular B cells**
    d) Natural killer cells
97. Which class of antibodies is primarily involved in crossing the placenta to provide passive immunity to the fetus?
    a) **IgG**
    b) IgM
    c) IgE
    d) IgA
98. Which cytokine is primarily produced by Th1 cells and is involved in activating macrophages?
    a) Interleukin-2
    b) Interleukin-4
    c) Interleukin-10
    d) **Interferon-gamma**

99. Which type of hypersensitivity reaction involves T cell-mediated destruction of host tissues?
    a) Type I
    b) Type II
    c) Type III
    d) **Type IV**
100. Which molecule is involved in the recognition of antigenic peptides presented by MHC class II molecules?
    a) Toll-like receptors (TLRs)
    b) Major histocompatibility complex (MHC)
    c) **T cell receptor (TCR)**
    d) CD8
101. Which type of cell is primarily responsible for producing antibodies against pathogens in the respiratory tract?
    a) **IgA-producing plasma cells**
    b) Memory B cells
    c) Dendritic cells
    d) Natural killer cells
102. Which class of antibodies is primarily involved in mediating allergic reactions, such as hay fever and eczema?
    a) IgA
    b) IgG
    c) **IgE**
    d) IgM
103. Which cytokine is primarily produced by regulatory T cells and is involved in suppressing immune responses?
    a) Interleukin-2
    b) Interleukin-4
    c) Interleukin-10
    d) Interferon-gamma
104. Which type of hypersensitivity reaction involves the formation of immune complexes in the basement membrane of epithelial tissues?
    a) Type I
    b) Type II
    c) Type III
    d) Type IV
105. Which molecule is involved in the activation of complement by the lectin pathway?
    a) Mannose-binding lectin (MBL)
    b) C1q
    c) Factor B
    d) Properdin
106. Which type of cell is primarily responsible for presenting antigens to CD8+ T cells?
    a) Macrophages
    b) Dendritic cells
    c) B cells
    d) Natural killer cells
107. Which class of antibodies is the most abundant in mucosal secretions such as saliva and tears?
    a) IgA
    b) IgG

c) IgE
d) IgM

108. Which cytokine is primarily produced by Th2 cells and is involved in promoting the growth and differentiation of eosinophils?
a) Interleukin-2
b) Interleukin-5
c) Interleukin-17
d) Interferon-gamma

109. Which type of hypersensitivity reaction involves the activation of complement by antibodies bound to the surface of host cells?
a) Type I
b) Type II
c) Type III
d) Type IV

110. Which molecule is involved in the recognition of double-stranded RNA (dsRNA) from viruses?
a) Toll-like receptor 3 (TLR3)
b) Major histocompatibility complex (MHC)
c) CD4
d) CD14

111. Which type of cell is primarily responsible for producing antibodies against extracellular parasites such as helminths?
a) Plasma cells
b) Memory B cells
c) **Follicular B cells**
d) Natural killer cells

112. Which class of antibodies is involved in defending against bacterial infections by promoting opsonization and phagocytosis?
a) IgA
b) IgG
c) **IgM**
d) IgE

113. Which cytokine is primarily produced by Th1 cells and is involved in activating natural killer (NK) cells?
a) Interleukin-2
b) Interleukin-4
c) Interleukin-10
d) **Interferon-gamma**

114. Which type of hypersensitivity reaction involves the formation of granulomas and is associated with chronic infections such as tuberculosis?
a) Type I
b) Type II
c) Type III
d) **Type IV**

115. Which molecule is involved in the recognition of viral peptides presented by MHC class I molecules?
a) Toll-like receptors (TLRs)
b) Major histocompatibility complex (MHC)
c) **T cell receptor (TCR)**
d) CD8

116. Which type of cell is primarily responsible for producing antibodies against pathogens in the gastrointestinal tract?
    a) **IgA-producing plasma cells**
    b) Memory B cells
    c) Dendritic cells
    d) Natural killer cells
117. Which class of antibodies is primarily involved in triggering immediate hypersensitivity reactions, such as anaphylaxis?
    a) IgA
    b) IgG
    c) **IgE**
    d) IgM
118. Which cytokine is primarily produced by regulatory T cells and is involved in suppressing immune responses?
    a) Interleukin-2
    b) Interleukin-4
    c) **Interleukin-10**
    d) Interferon-gamma
119. Which type of hypersensitivity reaction involves the formation of immune complexes in the alveoli of the lungs, leading to tissue damage?
    a) Type I
    b) Type II
    c) **Type III**
    d) Type IV
120. Which molecule is involved in the activation of complement by the alternative pathway?
    a) **Factor B**
    b) C1q
    c) Properdin
    d) Mannose-binding lectin (MBL)
121. Which type of cell is primarily responsible for presenting antigens to T cells in the skin and mucosal tissues?
    a) Macrophages
    b) **Langerhans cells**
    c) B cells
    d) Natural killer cells
122. Which class of antibodies is the first to be produced during a primary immune response to a bacterial infection?
    a) **IgM**
    b) IgG
    c) IgE
    d) IgA
123. Which cytokine is primarily produced by Th2 cells and is involved in promoting the activation and differentiation of eosinophils?
    a) Interleukin-2
    b) **Interleukin-5**
    c) Interleukin-17
    d) Interferon-gamma
124. Which type of hypersensitivity reaction involves the activation of complement by IgM or IgG antibodies bound to cell surfaces?

a) Type I
b) **Type II**
c) Type III
d) Type IV

125. Which molecule is involved in the recognition of single-stranded RNA (ssRNA) from viruses?
a) **Toll-like receptor 7 (TLR7)**
b) Major histocompatibility complex (MHC)
c) CD4
d) CD14

126. Which type of cell is primarily responsible for producing antibodies against toxins produced by bacteria?
a) Plasma cells
b) Memory B cells
c) **Follicular B cells**
d) Natural killer cells

127. Which class of antibodies is primarily involved in neutralizing bacterial toxins and preventing their binding to host cells?
a) IgA
b) IgG
c) **IgM**
d) IgE

128. Which cytokine is primarily produced by Th1 cells and is involved in activating macrophages and promoting inflammation?
a) Interleukin-2
b) Interleukin-4
c) Interleukin-10
d) **Interferon-gamma**

129. Which type of hypersensitivity reaction involves T cell-mediated destruction of pancreatic beta cells, leading to insulin deficiency?
a) Type I
b) Type II
c) Type III
d) **Type IV**

130. Which molecule is involved in the recognition of peptides derived from intracellular pathogens presented by MHC class I molecules?
a) Toll-like receptors (TLRs)
b) Major histocompatibility complex (MHC)
c) **T cell receptor (TCR)**
d) CD8

131. Which type of cell is primarily responsible for producing antibodies against pathogens in the genitourinary tract?
a) IgA-producing plasma cells
b) Memory B cells
c) **Plasma cells**
d) Natural killer cells

132. Which class of antibodies is primarily involved in defending against parasitic infections by activating eosinophils and mast cells?
a) IgA
b) IgG

c) IgE
d) IgM

133. Which cytokine is primarily produced by regulatory T cells and is involved in suppressing immune responses and promoting tolerance?
    a) Interleukin-2
    b) Interleukin-4
    c) **Interleukin-10**
    d) Interferon-gamma
134. Which type of hypersensitivity reaction involves the formation of immune complexes in the glomeruli of the kidneys, leading to glomerulonephritis?
    a) Type I
    b) Type II
    c) **Type III**
    d) Type IV
135. Which molecule is involved in the activation of complement by the lectin pathway?
    a) **Mannose-binding lectin (MBL)**
    b) C1q
    c) Factor B
    d) Properdin
136. Which type of cell is primarily responsible for presenting antigens to T cells in the lymph nodes?
    a) Macrophages
    b) **Dendritic cells**
    c) B cells
    d) Natural killer cells
137. Which class of antibodies is the first to be produced during a primary immune response to a viral infection?
    a) **IgM**
    b) IgG
    c) IgE
    d) IgA
138. Which cytokine is primarily produced by Th2 cells and is involved in promoting the proliferation and differentiation of B cells?
    a) Interleukin-2
    b) Interleukin-4
    c) Interleukin-17
    d) Interferon-gamma
139. Which type of hypersensitivity reaction involves the formation of immune complexes in tissues, leading to complement activation and inflammation?
    a) Type I
    b) Type II
    c) **Type III**
    d) Type IV
140. Which molecule is involved in the recognition of flagellin from bacteria?
    a) **Toll-like receptor 5 (TLR5)**
    b) Major histocompatibility complex (MHC)
    c) CD4
    d) CD14
141. Which type of cell is primarily responsible for producing antibodies against extracellular pathogens in the bloodstream?

a) Plasma cells
b) Memory B cells
c) **Follicular B cells**
d) Natural killer cells

142. Which class of antibodies is primarily involved in fixing complement and opsonizing pathogens for phagocytosis?
a) IgA
b) IgG
c) **IgM**
d) IgE

143. Which cytokine is primarily produced by Th1 cells and is involved in activating macrophages and enhancing phagocytosis?
a) Interleukin-2
b) Interleukin-4
c) Interleukin-10
d) **Interferon-gamma**

144. Which type of hypersensitivity reaction involves T cell-mediated destruction of insulin-producing beta cells in the pancreas?
a) Type I
b) Type II
c) Type III
d) **Type IV**

145. Which molecule is involved in the recognition of lipopeptides from bacteria?
a) Toll-like receptors (TLRs)
b) **CD14**
c) T cell receptor (TCR)
d) CD8

146. Which type of cell is primarily responsible for producing antibodies against pathogens in the respiratory tract?
a) **IgA-producing plasma cells**
b) Memory B cells
c) Dendritic cells
d) Natural killer cells

147. Which class of antibodies is primarily involved in triggering allergic reactions, such as hay fever and asthma?
a) IgA
b) IgG
c) **IgE**
d) IgM

148. Which cytokine is primarily produced by regulatory T cells and is involved in suppressing immune responses and promoting tolerance?
a) Interleukin-2
b) Interleukin-4
c) **Interleukin-10**
d) Interferon-gamma

149. Which type of T cell is responsible for suppressing immune responses?
a) Helper T cells
b) Cytotoxic T cells
c) Memory T cells
d) **Regulatory T cells**

150. Which type of cell is primarily responsible for secreting cytokines that regulate the immune response and coordinate the activities of other immune cells?
    a) Plasma cells
    b) **T helper cells**
    c) Natural killer cells
    d) Eosinophils
151. Which of the following techniques has revolutionized our understanding of immune cell interactions and signaling pathways?
    a) Electron microscopy
    b) X-ray crystallography
    c) **Single-cell analysis**
    d) Immunohistochemistry
152. Advances in immunophysiology have primarily focused on:
    a) Understanding the role of physical barriers in immunity
    b) Unraveling the molecular mechanisms of phagocytosis
    c) Investigating the function of TLR receptors
    d) **Exploring previously unknown aspects of immune function**
153. The ontogeny of the immune system refers to its:
    a) Evolutionary history
    b) **Development during embryonic stages**
    c) Response to external stimuli
    d) Interaction with other physiological systems
154. Which of the following is true regarding the phylogeny of the immune system?
    a) It remains unchanged across different species
    b) It primarily involves the study of human immune development
    c) **It refers to the evolutionary origins and diversification of immune mechanisms**
    d) It is solely influenced by genetic factors
155. Recent advancements in immunology have led to:
    a) A decrease in the complexity of immune responses
    b) A limited understanding of immune cell interactions
    c) Improved therapies for autoimmune disorders
    d) **New insights into immune cell function and regulation**
156. Which imaging technique allows visualization of immune cell interactions in real-time?
    a) Magnetic resonance imaging (MRI)
    b) Positron emission tomography (PET)
    c) **Fluorescence microscopy**
    d) Confocal microscopy
157. Ontogeny of the immune system involves the study of its development:
    a) Across different phylogenetic groups
    b) **During embryonic stages and throughout life**
    c) Only in adult organisms
    d) Exclusively in vertebrates
158. Phylogeny of the immune system encompasses:
    a) The study of immune response patterns in individual organisms
    b) **Comparisons of immune systems across species and evolutionary history**
    c) The interaction between the immune system and other bodily systems
    d) The influence of genetics on immune function
159. Single-cell analysis techniques allow researchers to:
    a) Study the entire immune system in a single experiment

b) Investigate interactions between immune cells and pathogens
c) **Analyze the heterogeneity of immune cell populations**
d) Identify specific immune cell types using imaging

160. The ontogeny of the immune system involves:
a) The study of immune responses in different tissues
b) **The development of immunity from birth to old age**
c) The comparison of immune systems between species
d) The role of genetics in immune function

161. What aspect of the immune system does ontogeny primarily focus on?
a) Immune cell interactions
b) Immune responses to pathogens
c) I**mmune development during embryonic stages and throughout life**
d) Immune regulation

162. Which of the following best describes phylogeny in the context of the immune system?
a) The study of immune responses within an individual organism
b) The examination of immune system development in vertebrates
c) **Comparisons of immune systems across species and evolutionary history**
d) The influence of environmental factors on immune function

163. Advances in immunophysiology have contributed to:
a) A decrease in the complexity of immune responses
b) **A better understanding of immune cell interactions and signaling pathways**
c) The elimination of autoimmune disorders
d) The restriction of immune responses to specific pathogens

164. Which of the following techniques has enabled researchers to study immune cell behavior at a single-cell level?
a) Flow cytometry
b) **Single-cell RNA sequencing**
c) Western blotting
d) Immunohistochemistry

165. The study of ontogeny and phylogeny of the immune system is essential for understanding:
a) Immune responses in adult organisms
b) Immune cell interactions in tissue microenvironments
c) **The development and evolutionary origins of immune mechanisms**
d) Immune modulation by external factors

166. Recent advancements in immunology have led to:
a) A decline in the complexity of immune responses
b) A narrow focus on innate immunity
c) **A deeper understanding of immune cell interactions and signaling pathways**
d) An increase in autoimmune disorders

167. Single-cell analysis techniques have allowed researchers to:
a) Study immune cell interactions in vivo
b) **Characterize the heterogeneity of immune cell populations**
c) Investigate immune responses in multicellular organisms
d) Visualize immune cells using electron microscopy

168. Ontogeny of the immune system refers to its:
a) Phylogenetic origins
b) Development during embryonic stages and throughout life
c) Response to environmental stimuli
d) Interactions with other physiological systems

169. Phylogeny of the immune system involves:
    a) The study of immune responses in individual organisms
    b) Comparisons of immune systems across species and evolutionary history**
    c) The development of immunity from birth to old age
    d) The regulation of immune responses by genetic factors
170. Autoimmune disorders result from:
    a) Overactive immune responses against foreign pathogens
    b) Underactive immune responses leading to immunodeficiency
    c) **Immune system dysfunction where the body attacks its tissues**
    d) Excessive immune cell proliferation
171. Which of the following is a common autoimmune disorder affecting livestock species?
    a) Feline leukemia
    b) Canine distemper
    c) Equine infectious anemia
    d) **Bovine autoimmune encephalitis**
172. Immunodeficiency in livestock species can result from:
    a) Overactive immune responses leading to tissue damage
    b) **Genetic mutations affecting immune cell function****
    c) Exposure to environmental toxins
    d) Improper diet and nutrition
173. Which of the following diseases is caused by an autoimmune response in livestock species?
    a) Brucellosis
    b) Johne's disease
    c) **Autoimmune hemolytic anemia**
    d) Bovine viral diarrhea
174. Immunodeficiency disorders in livestock can lead to:
    a) Excessive immune responses against pathogens
    b) Increased resistance to infections
    c) **Greater susceptibility to diseases**
    d) Enhanced immune surveillance
175. Which of the following is an example of an immunodeficiency disorder in livestock species?
    a) Bovine respiratory disease
    b) Porcine reproductive and respiratory syndrome
    c) Bovine leukosis
    d) **Severe combined immunodeficiency (SCID) in Arabian horses**

Fill-in-the-blank questions

1. The primary function of the immune system is to defend the body against **pathogens**
2. The process by which immune cells recognize and eliminate foreign substances is called **immunosurveillance**
3. **Lymphocytes** are specialized white blood cells that play a central role in the adaptive immune response.
4. The cells responsible for producing antibodies are called **plasma cells**.
5. The proteins that bind to specific antigens and mark them for destruction by immune cells are called **antibodies**.
6. The major histocompatibility complex (MHC) molecules present antigens to **T cells** for recognition.
7. The main function of cytotoxic T cells is to kill **infected or cancerous** cells.
8. The process of **antibody production** involves the production of antibodies by B cells.
9. Helper T cells release **cytokines** that stimulate other immune cells.
10. The molecule responsible for mediating the binding of T cells to antigen-presenting cells is called **CD4**.
11. The production of antibodies by B cells is stimulated by **helper T** cells.
12. **Tolerance** is the process by which immune cells learn to recognize self from non-self.
13. Immunoglobulins are another name for **antibodies**.
14. **Cytokines** are proteins secreted by cells that regulate the immune response.
15. The cells responsible for engulfing and digesting pathogens are called **phagocytes**.
16. The type of immunity that is acquired through vaccination is called **active** immunity.
17. The type of immunity that is passed from mother to offspring through breast milk is called **passive** immunity.
18. The first line of defence against pathogens is **innate** immunity.
19. The process by which phagocytes move toward the site of infection is called **chemotaxis**.
20. The molecule responsible for binding to the Fc region of antibodies and promoting phagocytosis is called **Fc receptors**.
21. Inflammation is characterized by redness, heat, swelling, and **pain** at the site of infection.
22. The cells responsible for releasing histamine during allergic reactions are called **mast** cells.
23. The cells responsible for destroying virus-infected cells and cancer cells are called **cytotoxic T** cells.
24. Autoimmune diseases occur when the immune system mistakenly attacks **self** tissues.
25. The cells responsible for coordinating the immune response and producing cytokines are called **helper T** cells.
26. The main function of memory T cells is to provide **long-lasting** immunity upon re-exposure to a pathogen.
27. The cells responsible for presenting antigens to T cells in the skin are called **Langerhans** cells.
28. The type of immune response that involves the production of antibodies is called **humoral** immunity**.**
29. The type of immune response that does not involve antibodies is called **cell-mediated** immunity.
30. The process by which immune cells eliminate cancerous cells is called **immunosurveillance**.

Matching type questions

1. Match the column and choose the correct combination

Column I	Column II
a. Natural active	p. Induced by vaccination
b. Artificial passive	q. From mother to foetus through placenta
c. Artificial active	r. Injection of antiserum to travellers
d. Natural passive	s. Fighting infections naturally

a-s, b-r, c-p, d-q

2. Match the column and choose the correct combination

Column I	Column II
a. Natural active	p. Induced by vaccination
b. Artificial passive	q. from mother to fetus through the placenta
c. Artificial active	r. Injection of antiserum to travelers
d. Natural passive	s. Fighting infection naturally

a-s, b-r, c-p, d-q

3. Match the column and choose the correct combination

Column I	Column II
a. Oviparous animals	p. Development of immunity after recovering from an illness
b. Endemic diseases	q. Transfer of antibodies through breast milk
c. Acquired immunity	r. Diseases constantly present in a particular region or population
d. Active immunity	s. Fighting infection naturally
e. Passive immunity	t. Immunity acquired through vaccination

a-s, b-r, c-p, d-t, e-q

4. Match the column and choose the correct combination

Column I	Column II
a. Natural active Epidemic diseases	p. Administration of antibodies to provide immediate protection
b. Zoonotic diseases	q. Outbreak of a disease affecting a large number of people within a short period
c. Hyperimmune serum	r. Diseases transmitted from animals to humans

d. Herd immunity	s. Collective immunity in a population due to a large portion being immune

a-q, b-r, c-p, d-s

5. Match the column and choose the correct combination

Column I	**Column II**
a. Carrier state	p. Immune response stimulated by exposure to an antigen
b. Autoimmune diseases	q. Individuals capable of transmitting a pathogen without showing symptoms
c. Active immunity	r. Immune system attacks the body's own cells
d. Immunocompromised	s. Condition where the immune system is weakened or suppressed
e. Immunization	t. Introduction of a vaccine to induce immunity

a-q, b-r, c-p, d-s, e-t

6. Match the column and choose the correct combination

Column I	**Column II**
a. Pandemic diseases	p. Rapid test detecting the presence of antibodies in blood
b. Antiserum	q. Global outbreak of a disease affecting multiple countries or continents
c. Seropositive	r. Blood serum containing specific antibodies
d. Serological test	s. Individuals tested positive for antibodies in their blood
e. Seroprevalence	t. Percentage of a population with a specific antibody

a-q, b-r, c-s , d-p, e-t

7. Match the column and choose the correct combination

Column I	**Column II**
a. Vector-borne diseases	p. Infection transmission through insect or animal carriers
b. Endemic diseases	q. Diseases consistently present in a particular geographical area
c. Reservoir host	r. Organism harboring a pathogen capable of infecting others

d. Emerging diseases	s. Newly identified or re-emerging diseases with increasing incidence
e. Enzootic diseases	t. Diseases affecting animals within a specific area or population

a-p, b-q, c-r, d-s, e-t

8. Match the column and choose the correct combination

Column I	**Column II**
a. Immunodeficiency	p. Rare diseases caused by genetic mutations affecting the immune system
b. Primary immunodeficiency	q. Weakened immune response due to malnutrition or certain medications
c. Secondary immunodeficiency	r. Inherited disorders impairing the immune system's function
d. Opportunistic infections	s. Diseases occurring in individuals with compromised immune systems
e. Inherited immunodeficiency	t. Infections caused by pathogens taking advantage of weakened immunity

a-q, b-r, c-s, d-t, e-p

9. Match the column and choose the correct combination

Column I	**Column II**
a. Active immunization	p. Immunity resulting from the presence of antibodies in a person's body
b. Passive immunization	q. Vaccination stimulating the immune system to produce antibodies
c. Antibody-mediated immunity	r. Transfer of preformed antibodies to provide immediate protection
d. Natural immunity	s. Immune response triggered by the presence of antibodies in the body
e. Artificial immunity	t. Immunity acquired through exposure to a pathogen or antigen

a-q, b-r, c-p, d-s, e-t