

IMMUNOLOGY

1. Introduction - Review of the immune system

Chapter Outline

- 1.1 Historical Review
- 1.2 Infection and Immunity
- 1.3 Innate and adaptive immunity
- 1.4 Humoral and cellular mediated immunity

LEARNING OBJECTIVES

On completion of the chapter the student will:

- Gain knowledge about the development of Immunology through early vaccination studies.
- Become familiar with the following terms: innate immunity, adaptive immunity, active response, memory response, immune system, antigen, antibody, T lymphocyte receptor, lymphocytes, humoral response, cell-mediated response.

2. Cells and organs of the immune system

Chapter Outline

- 2.1 Hematopoiesis
- 2.2 Apoptosis
- 2.3 Immune system cells
- 2.4 Immune system organs

LEARNING OBJECTIVES

On completion of the chapter the student will:

- Have learned about stem cells and branches of differentiation during hematopoiesis and the mechanism of homeostasis of programmed cell death (apoptosis).
- Know the main cell types of the immune system, their origin, their characteristics, their properties and their actions.
- Be familiarized with the primary and secondary organs of the immune system in terms of their topology, structure, and their role in the education / maturation of lymphocytes and in the immune response to the antigen.

3. Innate immunity

Chapter Outline

- 3.1 Anatomical barriers
- 3.2 Relationships of innate and adaptive immunity
- 3.3 Inflammation
- 3.4 Soluble molecules and membrane receptors
- 3.5 Toll Receptors
- 3.6 Cellular types of innate immunity
- 3.7 Signaling pathways

LEARNING OBJECTIVES

On completion of the chapter the student will:

- Have understood how the innate immune system recognizes and attacks pathogens (self/non-self recognition).
- Have understood the interactions of the innate with the adaptive immunity.

4. Antigens - Antibodies

Chapter Outline

- 4.1 Immunogenicity- Antigenicity
- 4.2 Basic antibody structure
- 4.3 Antibody binding sites
- 4.4 Antibody functions
- 4.5 Family of immunoglobulins
- 4.6 Monoclonal Antibodies

LEARNING OBJECTIVES

On completion of the chapter the student will:

- Have learned about the characteristics of antigens, the structure of antibodies, the sites of antigen binding, the classes and biological actions of antibodies, and the production of monoclonal antibodies.
- Be familiar with terms such as immunogenicity, antigenicity, epitope, immunoglobulin domain, isotype, allotype, idiotope.

5. Organization and expression of immunoglobulin genes

Chapter Outline

- 5.1 Polygenic organization of immunoglobulin genes
- 5.2 Gene rearrangements of the variable region
- 5.3 Variety of antibodies
- 5.4 Class switch
- 5.5 Expression of membrane and secretory immunoglobulin

LEARNING OBJECTIVES

On completion of the chapter the student will:

- Have learned how the genes of immunoglobulins are rearranged for the production of the variable region and the process of class switch for the production of different types of antibodies.
- Have understood the importance of antibody diversity and the mechanisms that induce it.

6. Major histocompatibility complex - Antigen processing and presentation

Chapter Outline

- 6.1 Organization of the MHC locus
- 6.2 MHC molecules and genes
- 6.3 Cellular MHC expression
- 6.4 The role of antigen-presenting cells
- 6.5 Endogenous antigen - Cytoplasmic route
- 6.6 Exogenous antigen - Intracellular route

LEARNING OBJECTIVES

On completion of the chapter the student will:

- Have learned how MHC I and MHC II genes are organized and why there is diversity in the population.
- Have understood the antigen-presenting mechanisms of endogenous antigens in MHC I molecules via the cytoplasmic pathway and exogenous antigens in MHC II via the intracellular pathway.

7. T lymphocyte receptor

Chapter Outline

- 7.1 Structure and roles of $\alpha\beta$ and $\gamma\delta$ T cell receptors
- 7.2 Organization and rearrangement of TCR genes
- 7.3 TCR-CD3 complex
- 7.4 CD4 and CD8 co-receptors
- 7.5 TCR-MHC/peptide binding

LEARNING OBJECTIVES

On completion of the chapter the student will:

- Have understood the mechanisms that induce the diversity of the TCR receptor, its structure, and its interaction with MHC / antigen.

8. Maturation, Differentiation, Activation of T lymphocytes

Chapter Outline

- 8.1 Maturation of T cells in the thymus
- 8.2 Positive and negative selection
- 8.3 Activation of T cells, stimulatory signals
- 8.4 T cell differentiation
- 8.5 Cell death

LEARNING OBJECTIVES

On completion of the chapter the student will:

- Have gained knowledge of the mechanisms of T cell maturation and differentiation in the thymus through positive and negative selection.
- Have learned about the importance of B7-CD28 co-stimulating signals between antigen-presenting cells and T lymphocytes and the inhibition of stimulation through the expression of CTLA4 by activated T lymphocytes.
- Have understood the differences between virgin T lymphocytes, active cells and memory and learn about the pathways that lead to apoptosis.

9. Maturation, Differentiation, Activation of B lymphocytes

Chapter Outline

- 9.1 Maturation of B lymphocytes
- 9.2 Activation and proliferation of B lymphocytes
- 9.3 Humoral response
- 9.4 Germinal centers and antigen-induced B cell differentiation

LEARNING OBJECTIVES

On completion of the chapter the student will:

- Have understood how B lymphocytes are developed and selected in the bone marrow and how are activated in secondary lymphoid organs to produce plasma cells or memory cells.
- Have learned about the differences between primary and secondary humoral response and understand the importance of germinal centers in somatic hypermutation and class switch.

10. Cytokines

Chapter Outline

- 10.1 Properties of cytokines

- 10.2 Cytokine receptors
- 10.3 Cytokine production from TH1 and TH2 subpopulations
- 10.4 Cytokine therapeutic applications

LEARNING OBJECTIVES

On completion of the chapter the student will:

- Be familiar with cell communication mechanisms through the production of cytokines by TH1 and TH2 CD4 + T lymphocytes for effective immune response.

11. Cell-mediated cytotoxic responses

Chapter Outline

- 11.1 Effector T cells
- 11.2 Cytotoxic T cells
- 11.3 Destruction of cells by cytotoxic T cells

LEARNING OBJECTIVES

On completion of the chapter the student will:

- Be trained in cell-mediated immune mechanisms through the recognition of target cells by cytotoxic T cells.

12. Tolerance and autoimmunity, Autoimmune diseases

Chapter Outline

- 12.1 Central tolerance
- 12.2 Peripheral tolerance
- 12.3 Organ-specific autoimmune diseases
- 12.4 Systemic autoimmune diseases
- 12.5 Mechanisms of autoimmunity

LEARNING OBJECTIVES

On completion of the chapter the student will:

- Have understood how the immune system eliminates self-reactive B and T clones either before maturation or in the periphery.
- Have gained knowledge about the characteristics of the most important autoimmune diseases.

13. Laboratory practicals

Outline

- Study of Antibody structure and epitope mapping
- ELISA method
- Histological analysis of lymphoid organs
- Western blot
- Flow cytometry

Upon successful completion of laboratory exercises, the student will be able:

Study of Antibody structure and epitope mapping: to search for structures in the PDB database and analyze the structure of antibodies and their complexes with the assistance of

computer programs in order to identify interactions and epitopes. To identify epitopes using data from with antigen-antibody binding competition by antigen fragments or peptides. To adequately present the results and conclusions of a relevant study.

ELISA method: to learn the basic principles of ELISA analysis methodologies and how the above techniques are applied in Biotechnology and biological sciences. To develop experimental and data analysis skills for indirect ELISA tests in order to determine antigen concentration. To adequately present the results and conclusions of a relevant study.

Histological analysis of lymphoid organs: to know the structure of the primary lymphoid organs such as bone marrow and thymus but also of secondary lymphoid organs such as spleen, lymph nodes and Peyer's patches. To be able to recognize lymphoid tissues in paraffin sections through microscopy. To know the stages of tissue processing, their embedding in paraffin blocks, thin sectioning with microtome and staining with hematoxylin /eosin for their histopathological observation. To adequately present the results and conclusions of a relevant study.

WESTERN blot: to understand the principle of the method, its applications and stages of the procedure such as the preparation of protein samples, preparation of polyacrylamide gel, electrophoresis in denatured conditions, transfer of proteins to membrane, appearance of signal in the membrane, and membrane stripping for reuse. To develop experimental skills in the western blot procedure, evaluate experimental results and quantify the bands in western blots. To adequately present the results and conclusions of a relevant study.

Flow cytometry: to understand the principle of the method, the experimental process and the applications of flow cytometry in the analysis of cell subpopulations in the blood and lymphoid organs using fluorescent antibodies. To be trained how to isolate mouse splenocytes and stain them with multiple antibodies for analysis in flow cytometry. To develop skills in analyzing flow cytometry files with the FCSalyzer software in order to create FSC / SSC diagrams, CD4 / CD8, CD11b / Gr1, and histograms upon gating in alive cells. To be able to calculate the % percentages of the subcellular populations and their absolute number in each spleen sample based on these diagrams. To evaluate the experimental results and adequately present the results and conclusions of a relevant study.