

SUBJECT:	STRUCTURE AND FUNCTION OF THE BLOOD AND THE IMMUNE SYSTEM		
CREDITS:	Total: 7.5	Theory: 4	Practical: 3.5

INTRODUCTION

The aim of the subject is for students to learn and understand the functions of the blood, in particular transport functions, hemostasis and coagulation functions and the mechanisms that control the immune system, which are vital to the homeostatic maintenance of the body and its defence against external agents.

SPECIFIC OBJECTIVES

A) Knowledge-based objectives

Students will be expected to acquire sufficient knowledge to allow them to:

- understand, describe and identify the microscopic structure of the various elements that constitute the blood and the immune system when healthy, so that they can establish the relation between structure and function
- understand and describe the functions of the blood and the immune system at the different organizational levels, from the intact organism to the cellular, subcellular and molecular levels
- know and understand the mechanisms involved in the functions and regulation of the blood and the immune system, using the language of Immunology, Physiology, Biochemistry, Molecular Biology and Cell Biology - this will allow students at a later stage to understand the mechanisms of disease
- understand and describe the methods of functional exploration of the blood and the immune system
- The course will focus on current research areas in the fields of Immunology and Hematology in general, since knowledge of these fields requires awareness of concepts that are developing rapidly and could involve conceptual changes.

A) Skill-based objectives

Students will have to acquire different types of skills outlined individually in the relevant guides, for example:

- identification of the different components of the blood and the immune system
- manual skills for carrying out functional explorations and laboratory practice
- know the methodological bases of the different immunological techniques
- ability to make the most of the knowledge acquired by applying it in a rational manner and using it to solve problems

PROGRAMME

Theory

I.- STRUCTURE AND FUNCTION OF THE BLOOD AND HEMATOPOIETIC ORGANS

1. Body fluids and blood

Functions of the blood in homeostasis. Composition and general functions of the blood. Transport, defence, hemostatic and coagulation functions. Other functions.

2. Plasma

Composition and functions. Plasma proteins. Types, structure and functions of the different plasma proteins: transport functions, defence functions: complement proteins; immunoglobulins: structure and types; hemostatic functions.

3. Erythrocytes

Structure and composition of the adult erythrocyte. Metabolism of the erythrocyte. Hemoglobin: structure and types of physiological and pathological hemoglobins. Synthesis and degradation of hemoglobin. Function of gas transport in erythrocytes: oxygen transport; molecular mechanisms; oxyhemoglobin dissociation curve and modifying factors. Transport of carbonic anhydride.

4. Leukocytes and platelets

Structure of the different types of granulocytes: neutrophils, basophils and eosinophils. Functional characteristics of granulocytes. Structure and function of monocytes. Nonspecific defence functions. Types of lymphocytes, plasma cells. Structure of platelets.

5. Origin of figurative elements of the blood

Hematopoiesis. Bone marrow. Precursor cells. Structure of the hematopoietic organs. Concept de *stem cell* or *precursor*. Erythropoiesis, granulopoiesis, monocytopenoiesis, lymphocytopenoiesis and thrombopoiesis. Regulation of hematopoiesis

6. Hemostasis

Concept and phases of *hemostasis*: stages and regulation. Participation of platelets in hemostasis. Primary hemostasis.

7. Coagulation of blood

Coagulation pathways. Fibrinolysis. Physiological regulation of hemostasis. Pharmacological regulation of hemostasis.

8. Blood group systems

ABO and Rh systems. Other erythrocyte blood groups. Leukocyte antigen systems. HLA system. Platelet antigen systems.

9. Functional exploration of the blood.

Functional exploration of plasma and the erythrocyte, leukocyte and platelet series. Functional exploration of hemostasis.

II. INTRODUCTION TO THE IMMUNE SYSTEM

10. Introduction. Basic elements of the immune system.

Natural and acquired immunity. Nonspecific defence mechanisms: physical barriers. Phagocytosis, complement and inflammation. Basic and characteristic elements of the immune system: specificity, diversity, memory, autoregulation and tolerance.

11. The immune response.

Humoral response. Cellular immunity. Clonal selection. Cell cooperation. Effector mechanisms.

III. CELLULAR BASES OF IMMUNITY

12. Primary and secondary lymphoid organs and tissues.

Thymus. Lymphatic ganglia. Spleen. Mucosa-associated lymphoid tissue (MALT)

13. Immune system cells

B and T lymphocytes. Differentiation antigens. Large granular lymphocytes (LGL) and NK cells. Monocytes/macrophages. Granulocytes: neutrophils, eosinophils and basophils. Dendritic cells and other accessory cells.

IV. IMMUNE SYSTEM MOLECULES

14. Antigens

Immunogens and antigens. Haptens. Immunogenicity and antigenicity. Determining factors of immunogenicity. T-dependent antigens and T-independent antigens.

15. Immunoglobulins.

Structure, types and functions. Genetic bases of diversity. Organization of light chains and heavy chains. Somatic recombination. Allelic exclusion. Production of secreted or membrane immunoglobulins. Isotype change.

16. Major Histocompatibility Complex (MHC).

Class I and II MHC molecules. Cellular distribution.. Genomic organization. Polymorphism and haplotype. HLA association and diseases.

17. The T cell receptor.

Structure and diversity. α/β receptor. γ/δ receptor. TCR/CD3 complex: structure and function.

18. Adhesion molecules.

Families of adhesion molecules and their ligands. Selectins and integrins. Adhesion molecules from the immunoglobulin superfamily. Interaction of leukocytes with the endothelium. Role of adhesion molecules in the inflammation and circulation of lymphocytes.

19. Accessory molecules.

Costimulation for lymphocyte activation. Accessory molecules: CD4 and CD8. CD28 and its ligands CD80 (B7.1) and CD86 (B7.2). Tyrosinphosphatase CD45.

20. Complement.

Biological functions of the complement system. Classic pathway and alternate pathway. Physiological activation and regulation.

21. Cytosines.

General characteristics. Cytosines involved preferentially in inflammatory processes: IL-1, TNF, IL-6, IL-8 15.3 Cytosines involved in cell activity: IL-2, IL-4, IL-5, $INF\gamma$. Cytosines that affect lymphocyte / hemapoietic growth: IL-3, CSF, IL-7. Classification of Th1 and Th2 populations according to cytosine production. Other cytosines: TGF- β , IL-10.

V. REGULATION OF THE IMMUNE RESPONSE**22. Development and maturation.**

Maturation of the T lymphocyte. Thymic selection process. Concept of *apoptosis*. Maturation of the B lymphocyte.

23. Mechanisms of antigen presentation.

Antigens and superantigens. Antigen-presenter cells. Antigen processing: endogenous and exogenous antigens. Processed antigen bond with class I and II MHC molecules.

24. Molecular bases of T-lymphocyte activation.

Molecular activation complexes bonded to receptors by antigen in T lymphocytes. Role of phospholipases, G proteins, kinases and phosphatases in signal transduction mechanisms. Calcium mobilization. Signal pathways in T-lymphocyte activation. Transcriptional activation and gene expression.

25. Molecular bases of B-lymphocyte activation.

B-lymphocyte antigen receptor. Primary and secondary humoral response. Production of antibodies. Isotype change. Somatic mutations, memory cells.

26. Effector mechanisms in T lymphocytes and macrophages.

Role of T-helper lymphocytes in the regulation of response. Th1 and Th2 populations. Activation macrophages. Delayed hypersensitivity reactions. Cell cytotoxicity. Antibody-independent cytotoxicity. Antibody-dependent cell cytotoxicity (ADCC).

27. Regulation of the immune response.

Homeostasis of the immune system. Antigen elimination. Tolerance. Suppressor cells. Idiotypic network. Antibody feedback.

VI. THE IMMUNE SYSTEM IN DEFENCE AND PATHOLOGY

28. Immunological response to infections and parasites.

Extracellular signals. Intracellular bacteria. Fungus. Virus. Parasites

29. Immunodeficiencies

Primary immunodeficiencies. Characteristics of the HIV virus. Immunology of HIV infection. AIDS

30. Hypersensibility

Inflammatory processes. Chemical mediators. Gell-Coombs classification. Immediate hypersensibility (type I reactions). Hypersensibility. Inflammation produced by cytotoxic antibodies (type II reactions). Immunocomplex-mediated inflammation (type III reactions). Delayed hypersensibility type IV reactions)

31. Autoimmunity

Concepts of *tolerance* and *autoimmunity*. Predisposition factors. Activation mechanisms of the autoimmune response. Pathogeny of antibodies. Organ-specific and systemic autoimmune diseases.

32. Transplant immunology. Immunointervention

Transplant laws. Allograft transplantation and xenograft transplantation. Immunological response. Rejection response. Types of rejection: hyperacute, acute and chronic. Clinical transplantation.

33. Tumor immunology

Tumor antigens. Immunological response to tumors. Immunodiagnosis. Immunotherapy

Practical training

1. Techniques for the extraction, manipulation and conservation of blood.
2. Preparation of blood extensions. Identification of the figurative elements of the blood. Leukocyte formula.
3. Determination and analysis of the principal general hematological parameters. Counting erythrocytes, leukocytes and platelets. Hematocrit, hemoglobin, VCM, HCM and CHCM.
4. Determination of blood groups.
5. Principal general functional exploration tests of hemostasis.
6. Serotyping of HLA antigens.
7. Enzyme-Linked Immunosorbent Assay (ELISA).
8. Immunohistochemistry.
9. Immunoglobulin electrophoresis.

Seminars

- 1.- Analysis of biochemical parameters
- 2.- Analysis of hematological parameters
- 3.- Functional exploration of the red series
- 4.- Exploration of hemostasis and coagulation
- 5.- Current areas of immunology research
- 6.- The ability to identify and describe the corresponding histological preparations