UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

SYLLABUS DEL CORSO

Immunologia Generale

2627-2-H4103D162

Aims

The Immunology course aims to provide 2nd-year students of the Medicine and Surgery degree programme with the conceptual and methodological foundations needed to understand the functioning of the immune system under physiological and pathological conditions, in preparation for subsequent study of general pathology, clinical microbiology and clinical disciplines. The learning objectives are organized according to the five Dublin Descriptors.

Knowledge and Understanding

Students will be expected to know the cellular and molecular organization of the innate and adaptive immune system, the mechanisms of antigen recognition, the structure and function of the main immune molecules (antibodies, MHC, cell receptors, cytokines), the processes of lymphocyte development and selection, and the pathogenic basis of the major immunopathological phenomena (hypersensitivity, autoimmunity, immunodeficiencies).

Applying Knowledge and Understanding

Students will be expected to apply the acquired immunological concepts to the interpretation of basic clinical scenarios (e.g. allergic reactions, transplant rejection, autoimmune diseases), to correlate immunological laboratory data (e.g. antibody titres, lymphocyte subsets) with the underlying pathophysiology, and to recognize the general diagnostic and therapeutic implications of the mechanisms studied.

Making Judgements

Students will be expected to develop the ability to critically analyse experimental and clinical data related to immunological phenomena, to distinguish between protective and pathological mechanisms of the immune response, and to formulate plausible hypotheses on immunopathogenetic mechanisms starting from simplified clinical cases, including under conditions of informational uncertainty typical of medical practice.

Communication Skills

Students will be expected to present the fundamental concepts of immunology using correct and rigorous scientific terminology, to clearly describe a complex immunological mechanism to a peer audience (fellow students), and to begin building a shared clinical-scientific vocabulary, preparatory to communication with patients and colleagues in later stages of their studies.

Learning Skills

Students will be expected to acquire a study method based on the integration of molecular and cellular mechanisms with their pathophysiological significance, developing the autonomy necessary for the continuous

updating of immunological knowledge — a field undergoing constant and rapid evolution — and for the independent, in-depth study of specialized topics during subsequent clinical training.

Contents

The Immunology course provides an integrated treatment of the fundamental principles of the innate and adaptive immune response, starting from epithelial barriers and the molecular mechanisms of pathogen recognition (PRRs, complement, phagocytes, NK cells), and then examining in depth the role of antigen-presenting cells and the Major Histocompatibility Complex (MHC) as the functional bridge between innate and adaptive immunity. The programme continues with the thymic and bone-marrow development of T and B lymphocytes, the activation and differentiation of effector and memory lymphocyte populations, the structure and function of antibodies, and the dynamics of the humoral response within germinal centers. The course then addresses the mechanisms of central and peripheral immune tolerance and the main conditions of medical immunopathological relevance — autoimmunity, hypersensitivity reactions (types I–IV), primary and secondary immunodeficiencies — with essential references to transplant immunology and tumor immunosurveillance. The course concludes with a summary lecture on how the immune system integrates and adapts its responses depending on the type of pathogen encountered, together with the biological principles of vaccination, thereby providing the conceptual foundations indispensable for the subsequent study of general pathology and the clinical disciplines.

Detailed program

The programme is organized into 24 lectures of 2 hours each (48 total contact hours), structured into six teaching macro-modules that follow a conceptual progression from innate to adaptive immunity, culminating in basic clinical-pathological correlations and a final integrative summary lecture. Both a concise macro-module overview and the detailed lecture-by-lecture calendar are provided below.

Macro-module Lectures Hours Key contents
Module 1 – Innate Immunity Lectures 1–5 10h Barriers, PRRs, phagocytes, complement, inflammation, NK/ILC
Module 2 – Antigen Presentation and MHC Lectures 6–7 4h APCs, immunological synapse, MHC I/II, HLA polymorphism
Module 3 – Cell-Mediated Adaptive Immunity (T) Lectures 8–11 8h Thymic development, TCR, Th subsets, CTLs, memory
Module 4 – Humoral Adaptive Immunity (B) Lectures 12–15 8h Bone-marrow development, antibodies, germinal center, mucosal immunity
Module 5 – Tolerance and Immunopathology Lectures 16–23 12h Tolerance, autoimmunity, hypersensitivity I–IV, immunodeficiencies, transplant/tumor immunity
Module 6 – Integration and Vaccinology Lecture 24 2h Pathogen-specific integrated immune response; principles of vaccinology; course summary

Introduction to the Immune System: General Organization. General concepts of innate and adaptive immunity; primary and secondary lymphoid organs; cells and tissues of the immune system; overview of lymphoid and myeloid hematopoiesis.
Epithelial Barriers and Surface Innate Immunity. Physical, chemical and microbiological barriers; skin and mucosal epithelium; antimicrobial peptides; commensal microbiota and its immunological role. Innate Immune Receptors (PRRs) and Pathogen Recognition. PAMPs and DAMPs; Toll-like Receptors (TLRs); NOD-like, RIG-like and C-type lectin receptors; signaling pathways and induction of inflammatory responses.
Phagocytes: Neutrophils and Macrophages. Origin and differentiation of neutrophils and macrophages; chemotaxis; phagocytosis and intracellular killing; respiratory burst; M1/M2 macrophage polarization. The Complement System. Classical, alternative and lectin pathways of complement activation; opsonization,

anaphylatoxins, membrane attack complex (MAC); regulation and pathologies due to complement deficiencies.

Acute Inflammation and Soluble Mediators. Kinetics of the inflammatory response; innate immunity cytokines and chemokines; eicosanoids; fever and acute-phase proteins; resolution of inflammation.

Natural Killer Cells and Innate Immunity against Viruses and Tumors. Biology of NK cells; activating and inhibitory receptors; recognition of infected or transformed cells ('missing self'); Innate Lymphoid Cells (ILCs) and their classification.

Antigen-Presenting Cells (APCs) and the Innate-Adaptive Bridge. Dendritic cells: subsets, maturation and migration; macrophages and B cells as APCs; cross-presentation; immunological synapse and costimulatory signals.

The Major Histocompatibility Complex (MHC) Class I and II. Genetic organization of the human MHC locus (HLA); structure of MHC class I and II molecules; endogenous (class I) and exogenous (class II) antigen processing and presentation pathways; genetic polymorphism and clinical relevance (transplantation, disease association); lipid presentation via CD1.

T Lymphocyte Development in the Thymus. T-cell lymphopoiesis; TCR gene rearrangement (V(D)J recombination); positive and negative thymic selection; generation of the T-cell repertoire; the thymus as a primary lymphoid organ.

T-Cell Receptor (TCR) and T-Cell Activation. TCR structure and the CD3 complex; CD4 and CD8 co-receptors; activation signals (signal 1, 2, 3); immunological synapse and signal transduction pathway.

Differentiation of T Helper Lymphocytes (Th1, Th2, Th17, Tfh). Polarizing cytokines and lineage-specific transcription factors; effector functions of Th1, Th2, Th17 cells; T follicular helper (Tfh) cells and T-B cooperation.

Cytotoxic T Lymphocytes (CTLs) and T-Cell Memory. CTL killing mechanisms (perforin/granzymes, Fas-FasL); generation and maintenance of T-cell immunological memory; central memory, effector memory and tissue-resident memory T cells.

B Lymphocyte Development in the Bone Marrow. B-cell lymphopoiesis; immunoglobulin gene rearrangement; B-cell selection checkpoints (central tolerance); pre-BCR and BCR; bone marrow as a primary lymphoid organ.

Structure and Function of Antibodies (Immunoglobulins). Molecular structure of immunoglobulins; classes and subclasses (IgM, IgG, IgA, IgE, IgD); effector functions (neutralization, opsonization, ADCC, complement activation).

T-Dependent Humoral Response: Germinal Center, Class Switching and Affinity Maturation. Germinal center organization; class switch recombination (CSR); somatic hypermutation (SHM) and affinity maturation; generation of plasma cells and memory B cells.

Mucosal Immunity and T-Independent Responses. Mucosa-associated lymphoid tissue (MALT, GALT); secretory IgA and transepithelial transport; T-independent antigens and type 1/2 B-cell responses; gut immunity and tolerance to the microbiota.

Central and Peripheral Immune Tolerance. Mechanisms of central tolerance (thymic and bone-marrow clonal deletion); peripheral tolerance: anergy, deletion, suppression; regulatory T cells (Tregs): origin, markers (FoxP3), function.

Autoimmunity: General Pathogenic Mechanisms. Breakdown of immunological tolerance; genetic (HLA association) and environmental factors (infections, molecular mimicry); effector mechanisms of autoimmune damage; paradigmatic examples (SLE, rheumatoid arthritis, type 1 diabetes).

Type I and Type II Hypersensitivity. Coombs and Gell classification; Type I: IgE, mast cells, basophils and allergic/anaphylactic reactions; Type II: antibodies against cellular/tissue antigens, antibody-dependent cytotoxicity, clinical examples (hemolytic anemias, Graves' disease).

Type III and Type IV Hypersensitivity. Type III: immune complexes, serum sickness, vasculitis; Type IV: delayed-type cell-mediated hypersensitivity, contact dermatitis, granulomas, cell-mediated transplant rejection.

Primary and Secondary Immunodeficiencies. Classification of congenital immunodeficiencies (T cells, B cells, phagocytes, complement); secondary immunodeficiencies (HIV/AIDS, iatrogenic immunosuppression, malnutrition); basic diagnostic approach.

Transplant Immunology and Tumor Immunosurveillance: Integrative Summary and Clinical Cases. Immunological basis of rejection and GVHD; principles of clinical immunosuppression; tumor immunosurveillance and immune evasion; integrative clinical case discussion drawing on course themes; general course summary.

Integration of the Immune Response According to Pathogen Type; Principles of Vaccinology. Integrated summary of how the immune system adapts and combines innate and adaptive responses depending on the type of microorganism encountered (intracellular viruses: CTLs/IFN-?; extracellular pyogenic bacteria: antibodies/complement/neutrophils; mycobacteria and intracellular pathogens: macrophages/Th1/granulomas;

fungi: Th17; helminths: Th2/IgE/eosinophils/mast cells); biological principles of vaccination (live-attenuated, inactivated, subunit and mRNA vaccines; adjuvants; vaccine-induced immunological memory); integrative clinical case discussion and general course summary.

Prerequisites

A correct understanding of the course contents requires that students possess preparatory knowledge in the following basic disciplines, normally acquired during the 1st year of the degree programme:
• Cell biology: structure and function of the eukaryotic cell, intercellular communication, membrane receptors and signal transduction pathways, the cell cycle and apoptosis.
• Histology: organization of epithelial and connective tissues, microscopic structure of primary and secondary lymphoid organs.
• Genetics: basic principles of molecular genetics, genome organization, transcription and translation mechanisms, concepts of genetic polymorphism and recombination.
• Biochemistry: structure and function of proteins, basic enzymology, principles of biological membrane biochemistry.
• A basic knowledge of medical terminology and of the general principles of microbiology is also recommended, as it facilitates understanding of the interactions between the immune system and pathogens.

Teaching form

• Lectures (24 lectures × 2 hours, for a total of 48 hours), supported by structured multimedia presentations and summary diagrams of the molecular and cellular mechanisms covered.
• Discussion of paper-based clinical cases to complement the theoretical lectures, aimed at encouraging the application of immunological concepts to simplified clinical-pathological scenarios (in particular within the modules on hypersensitivity, autoimmunity and immunodeficiencies).
• Use of an institutional e-learning platform for sharing teaching materials (lecture slides, in-depth scientific articles, summary diagrams), for posting announcements, and for optional formative self-assessment quizzes.
• Interactive teaching moments (guided questions, quick-response questions during lectures) to promote active participation and ongoing monitoring of learning.
• Possible seminar-style deep dives into frontier topics in immunology (e.g. cancer immunotherapy, vaccinology), depending on schedule availability.

Textbook and teaching resource

Recommended Textbooks
• Abbas A.K., Lichtman A.H., Pillai S. — Cellular and Molecular Immunology (latest edition), Elsevier.
• Murphy K., Weaver C. — Janeway's Immunobiology (latest edition), Garland Science.
• Mak T.W., Saunders M.E., Jett B.D. — Primer to the Immune Response, Academic Cell.
• Roitt I.M., Delves P.J., Martin S.J., Burton D.R. — Roitt's Essential Immunology, Wiley-Blackwell.

Supplementary Materials
• Lecture slides made available on the institutional e-learning platform after each lecture.
• A selection of scientific articles (up-to-date reviews from indexed journals, e.g. Nature Reviews Immunology, Annual Review of Immunology) on specific topics of the programme, progressively distributed throughout the course.

• Summary diagrams and concept maps prepared by the instructor for the most complex molecular mechanisms (e.g. antigen processing, gene rearrangement, signaling pathways).
• Self-assessment materials (sample multiple-choice questions).

Semester

The Immunology course is delivered during the **Second Semester** of the 2nd year of the Master's Degree Programme in Medicine and Surgery, according to the academic calendar approved annually by the Degree Programme Council. The distribution of the 24 lectures throughout the semester is planned to ensure an adequate progression of content and a suitable study interval before the examination session.

Assessment method

Examination Structure
• Preliminary written test, consisting of a multiple-choice examination (typically 60 questions, each with a single correct answer among four options), aimed at verifying the acquisition of basic knowledge across all programme topics. Passing the written test (minimum threshold normally set at 60% correct answers) is a necessary condition for admission to the oral examination.
• Oral examination, to be taken after passing the written test, aimed at verifying the student's ability to present immunological mechanisms in a coherent manner, to establish connections between the different topics of the programme, and to apply the acquired knowledge to the interpretation of simple clinical-pathological scenarios.

Grading Criteria
The final grade is expressed on a 30-point scale (trentesimi), with the possible award of honours (lode) for outstanding performance. The final grade takes into account the following criteria:
• Correctness and completeness of the knowledge demonstrated in the written test and oral examination.
• Ability to integrate reasoning across the different topics of the programme (innate immunity, adaptive immunity, immunopathology).
• Appropriate scientific language and clarity of presentation.
• Ability to apply theoretical knowledge to simple clinical-pathological cases proposed during the oral examination.
• Honours (lode) are awarded when, in addition to fully meeting the above criteria, the student demonstrates particular critical judgement and the ability to make interdisciplinary connections.

Office hours

The instructor is available to meet students according to the following modalities:
• Weekly in-person office hours, by appointment arranged via institutional e-mail, at the instructor's office.
• Availability for remote consultations (videoconference via the institutional platform), upon reasoned request arranged in advance.
• Asynchronous communication via institutional e-mail and via the messaging tools of the course's e-learning platform, with a response guaranteed within ordinary technical timeframes.
• The weekly in-person office hours schedule is communicated at the beginning of each semester via the course's e-learning platform, and is subject to updates in case of overlap with other institutional commitments.

Sustainable Development Goals

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