



UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

SYLLABUS DEL CORSO

Immunology I

2627-2-H4104D011-H4104D01102

Aims

The Immunology-I module aims to provide 2nd-year students of the Medicine and Surgery degree programme with the conceptual foundations of general and molecular immunology — innate and adaptive immunity — necessary to subsequently address, in later modules and courses, the study of clinical immunopathology (autoimmunity, hypersensitivity, immunodeficiencies, transplant rejection), which is not covered in this module. The learning objectives are organized according to the five Dublin Descriptors, calibrated to the pre-clinical level.

Knowledge and Understanding

Students will be expected to know the cellular and molecular organization of lymphoid organs, the mechanisms of antigen recognition by innate and adaptive immunity, the structure and function of the main immune molecules (antibodies, TCR, BCR, MHC), the molecular mechanisms generating receptor diversity, and the processes of lymphocyte development and selection.

Applying Knowledge and Understanding

Students will be expected to apply the acquired molecular and cellular concepts to a coherent description of the stages of the immune response, to correlate the structure of immune molecules with their function, and to recognize the biological foundations that will subsequently be used to understand immunopathological phenomena in advanced courses.

Making Judgements

Students will be expected to develop the ability to critically analyse the molecular and cellular mechanisms of immunity, to distinguish between the different stages and components of the innate and adaptive immune response, and to independently assess the logical consistency between molecular mechanism and resulting biological function.

Communication Skills

Students will be expected to present the fundamental concepts of general and molecular immunology using correct and rigorous scientific terminology, and to clearly and systematically describe a complex immunological mechanism (e.g. V(D)J recombination, thymic selection) to a peer audience.

Learning Skills

Students will be expected to acquire a study method based on the integration of molecular and cellular mechanisms, developing the autonomy necessary to approach subsequent modules in clinical immunopathology and related clinical disciplines with a solid foundation.

Contents

The Immunology-I module provides an integrated treatment of the fundamental principles of general and molecular immunology, from the organization of lymphoid organs to the cellular and molecular mechanisms of innate immunity (epithelial barriers, PRRs, complement, acute inflammation) and adaptive immunity (antigen presentation, MHC, BCR/TCR receptors, generation of receptor diversity, lymphocyte development and selection, differentiation of T helper and cytotoxic populations, humoral response). The module concludes with a summary of how these mechanisms are integrated and adapted depending on the type of pathogen encountered, together with an overview of the biological principles of vaccination. The module focuses exclusively on basic physiological mechanisms, deliberately excluding clinical immunopathological phenomena (autoimmunity, hypersensitivity, immunodeficiencies, transplant rejection), which will be addressed in the subsequent Pathology and Medicine course, thereby ensuring a coherent teaching progression without overlap.

Detailed program

The programme is organized into 12 lectures of 2 hours each (24 total contact hours), structured according to a conceptual progression from the general organization of the immune system to the molecular and cellular mechanisms of innate and adaptive immunity, culminating in the humoral response, the integrative summary by pathogen type, and the principles of vaccinology.

Detailed Calendar of the Lectures

Introduction to the Immune System; Primary and Secondary Lymphoid Organs. General concepts of innate and adaptive immunity; anatomical and functional organization of primary (thymus, bone marrow) and secondary (lymph nodes, spleen, MALT) lymphoid organs; lymphocyte circulation and homing.

Innate Immunity: Epithelial Barriers, Cells and Pattern Recognition Receptors (PRRs). Physical, chemical and microbiological barriers; cells of innate immunity (neutrophils, macrophages, dendritic cells, NK cells); Pattern Recognition Receptors (PRRs): TLRs, NOD-like, RIG-like, C-type lectin receptors; PAMPs and DAMPs.

The Complement System and Acute Inflammation. Classical, alternative and lectin pathways of complement activation; opsonization, anaphylatoxins, membrane attack complex; kinetics and mediators of the acute inflammatory response.

Antigen-Presenting Cells (APCs) and Antigen Processing. Dendritic cells, macrophages and B cells as APCs; endogenous and exogenous antigen processing pathways; cross-presentation; dendritic cell maturation and migration.

The Major Histocompatibility Complex (MHC) Class I and II: Genetics and Structure. Genetic organization of the human MHC locus (HLA); molecular structure of MHC class I and II proteins; genetic polymorphism and its functional implications; lipid antigen presentation via CD1.

Structure of Antigen Receptors: the BCR and Antibodies (Classes and Functions). Molecular structure of the B-Cell Receptor (BCR) and soluble immunoglobulins; antibody classes and subclasses (IgM, IgG, IgA, IgE, IgD); structure-function relationships and effector functions.

Generation of Receptor Diversity (V(D)J Recombination). Genetic organization of immunoglobulin and TCR loci; molecular mechanism of V(D)J recombination; role of RAG1/RAG2; combinatorial and junctional diversity of the receptor repertoire.

The T-Cell Receptor (TCR) and the Immunological Synapse. TCR structure and the CD3 complex; CD4 and CD8 co-receptors; formation and molecular organization of the immunological synapse; activation signals (signal 1,

2, 3) and signal transduction pathways.

T-Lymphocyte Maturation: Positive and Negative Selection in the Thymus. T-cell lymphopoiesis; thymocyte differentiation stages (double-negative, double-positive, single-positive); mechanisms of positive and negative selection; generation of the self-tolerant T-cell repertoire.

B-Lymphocyte Maturation and Selection in the Bone Marrow. B-cell lymphopoiesis; immunoglobulin gene rearrangement; B-cell selection checkpoints and central tolerance; transition from immature to mature naive B cell.

Activation and Differentiation of T Helper (Th1, Th2, Th17, Treg) and Cytotoxic T Cells. Polarizing cytokines and lineage-specific transcription factors; effector functions of Th1, Th2 and Th17 subsets; overview of regulatory T cells (Tregs); killing mechanisms of cytotoxic T lymphocytes.

Humoral Response and Immunological Memory. T-B cooperation and the role of T follicular helper cells; germinal center organization; class switch recombination and somatic hypermutation; generation of plasma cells and memory B cell.

Integration of the Immune Response; Overview of Vaccinology. Summary of how innate and adaptive responses combine depending on the type of pathogen (viruses, extracellular bacteria, intracellular pathogens, fungi, helminths); overview of the biological principles of vaccination and of vaccine-induced immunological memory.

Prerequisites

A correct understanding of the module's 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.
- 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, gene recombination.
- Biochemistry: structure and function of proteins, basic enzymology, principles of biological membrane biochemistry.

Teaching form

- Lectures (12 lectures × 2 hours, for a total of 24 hours), supported by structured multimedia presentations and summary diagrams of the molecular and cellular mechanisms covered.
- Use of an institutional e-learning platform for sharing teaching materials (lecture slides, in-depth scientific articles, summary diagrams) and for formative self-assessment quizzes.
- Interactive teaching moments (guided questions, quick-response questions during lectures) to promote active participation and ongoing monitoring of learning.
- Close pedagogical coordination with the Immunology-II module, in order to ensure conceptual consistency between basic theory and methodological application.

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.

Supplementary Materials

- Lecture slides made available on the institutional e-learning platform after each lecture.
- A selection of in-depth scientific articles (up-to-date reviews, e.g. Nature Reviews Immunology) on specific topics of the programme.
- Summary diagrams and concept maps prepared by the instructor for the most complex molecular mechanisms (e.g. V(D)J recombination, thymic selection).

Semester

The Immunology-I module is delivered during the **Second Semester** of the 2nd year of the Single Cycle Master's Degree Programme in Medicine and Surgery, according to the academic calendar approved annually by the Degree Programme Council. It is recommended that the Immunology-I module be delivered as preparatory to, or concurrently with, the Immunology-II module, in order to ensure integration between basic theory and methodological application.

Assessment method

Examination Structure

- Preliminary written test, consisting of a multiple-choice examination (typically 30–35 questions, each with a single correct answer among four options), aimed at verifying the acquisition of basic knowledge of the molecular and cellular mechanisms covered in the module. Passing the written test (minimum threshold normally set at 60% correct answers) is a necessary condition for admission to the integrated oral examination.
- Integrated oral examination, conducted in a single session together with the Immunology-II module (the final grade for the Immunology course integrates the contents of both 2-CFU modules), aimed at verifying the student's ability to present basic immunological mechanisms coherently and to establish connections between the different topics of the programme.

Grading Criteria

The final grade is expressed on a 30-point scale (trentesimi), with the possible award of honours (lode) for outstanding performance, and integrates performance across both modules (Immunology-I and Immunology-II). 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 general and molecular immunology programme.
- Appropriate scientific language and clarity of presentation.
- 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 between the two modules.

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 Department website and the course's e-learning platform.

Sustainable Development Goals

GOOD HEALTH AND WELL-BEING | QUALITY EDUCATION | PARTNERSHIPS FOR THE GOALS
