

COURSE SYLLABUS

Immunology II

2627-2-H4104D011-H4104D01103

Aims

The Immunology-II module aims to provide second-year students in Medicine and Surgery, in close continuity with the Immunology-I module, with operational and interpretative mastery of the main biotechnological and diagnostic methods used in immunology, with constant reference to practical cases and clinical-analytical examples. The educational objectives are structured according to the five Dublin Descriptors, calibrated at the pre-clinical level and oriented towards the acquisition of methodological skills.

1. Knowledge and Understanding

Students must understand the physicochemical and biological principles of the main immunological methods (immunometric assays, immunofluorescence techniques, flow cytometry, molecular techniques, cellular assays, and in vivo tests), as well as the rationale for their use in clinical diagnostics and biomedical research.

2. Applying Knowledge and Understanding

The student must be able to select the most appropriate method for a given diagnostic question, correctly interpret an immunological laboratory report (e.g., flow cytometric panel, ELISA, HLA typing), and connect the analytical data to the relevant clinical-analytical framework.

3. Making Judgements

The student must develop the ability to critically evaluate the reliability and limitations of a given immunological diagnostic method, recognize potential sources of analytical error, and formulate reasoned interpretative hypotheses based on complex or conflicting clinical-analytical cases.

4. Communication Skills

The student must be able to describe the principle and applications of an immunological method using correct technical terminology, and communicate the interpretation of analytical data in a clear and structured manner within a clinical-analytical case discussion.

5. Learning Skills

Students will acquire a learning approach geared toward laboratory and diagnostic practice, developing the autonomy necessary for ongoing training on emerging immunological methods, which are constantly evolving technologically, and for their future use in clinical practice.

Contents

The Immunology-II module is dedicated to the critical presentation of the main biotechnological and diagnostic methods used in immunology, from the production of monoclonal and polyclonal antibodies to precipitation and agglutination reactions, from labeled immunometric assays (ELISA, ELISPOT, RIA) to flow cytometry, from molecular techniques (quantitative PCR, HLA typing) to in vivo immunological assays (skin tests). Each method is consistently linked to practical cases and clinical-analytical examples, with the goal of developing the student's ability to critically interpret immunological laboratory reports in a clinical context.

Detailed program

The program is divided into 12 two-hour exercises (24 hours in total), organized according to a methodological progression ranging from basic immunochemical techniques to more advanced cellular and molecular methods, up to the integrated analysis of complex diagnostic panels.

1. Monoclonal and polyclonal antibody technology: production and engineering. Principles of polyclonal antibody production. Hybridoma technology for monoclonal antibodies (MoAbs). Techniques for humanizing MoAbs. Diagnostic applications and transition to biologics.
2. Agglutination reactions and immunohematology: blood typing and cross-matching. Theoretical principles of agglutination reactions. Blood grouping (ABO and Rh systems). Pre-transfusion compatibility testing (cross-matching).
3. The Coombs Test and the Diagnosis of Hemolytic Disease of the Newborn (HND). Methodological Differences between the Direct Coombs Test (DAT) and the Indirect Coombs Test (IAT). Diagnosis of Autoimmune Hemolytic Anemia (AHA). Maternal-Fetal Incompatibility and Anti-D Immunoprophylaxis.
4. Macromolecular Precipitation Reactions in Fluid and Gel. Principles of Precipitation (Equivalence Curve). Flocculation Assays (VDRL Test for Syphilis). Ouchterlony Double Immunodiffusion and Radial Immunodiffusion (RID).
5. In Vivo Immunoassays: Skin Tests and Hypersensitivity Reactions. Immunopathological Basis of Immediate (Type I) and Delayed (Type IV) Hypersensitivity Reactions. Skin Prick Test and Mantoux Intradermal Reaction.
6. Physical Fractionation of Leukocyte Populations and Apheresis Techniques. Cell fractionation by density gradient (Ficoll-Paque). Macroscopic separation of peripheral blood lymphocytes (PBMCs) and polymorphonuclear leukocytes (PMNs). Principles and applications of selective apheresis (plasmapheresis, plateletpheresis, preparative/therapeutic leukapheresis).
7. Solid-phase immunoassays: technological evolution from ELISA to CLIA assays. ELISA formats (direct, indirect, sandwich). Principles of chemiluminescence (CLIA) and advantages of automation. Practical cases: serological screening of blood donors (HIV, HBV, HCV, syphilis) and emergency hemostasis (ADAMTS-13 and anti-PF4/HIT).
8. Membrane immunoassays (ELISPOT) and diagnostics of cell-mediated immunity. Principle of the ELISPOT assay for the identification of single cytokine-secreting cells (IFN-gamma). Interpretation of real-world case studies. Comparison of Mantoux and in vitro evolution using IGRA tests.
9. CD classification, immunomagnetic separation, and advanced therapies (CAR-T). The Cluster of Differentiation (CD) system as a marker of cellular identity. Principles of cell isolation using magnetic beads (MACS: CD-based positive and negative selection). Expansion, transduction, and therapeutic production of CAR-T cells (e.g., anti-CD19).
10. Flow cytometry (FACS): physical principles, gating, and clinical applications. Physical principles of flow cytometry (fluidic, optical, electronic). Fluorochromes conjugated to antibodies directed against CD. Gating and dot plot strategies. Characterization of lymphocyte subpopulations (CD3, CD4, CD8, CD19, CD56).
11. Advanced applications of flow cytometry in multispecialty settings. Immunophenotypic analysis of bronchoalveolar lavage (BAL) fluid. Platelet immunophenotyping for rare bleeding disorders. HLA-B27

typing and fetal hemoglobin (HbF) screening.

12. Molecular techniques applied to immunology: quantitative PCR and HLA typing by sequencing. Principles of quantitative PCR (qPCR) and its immunological applications. Low- and high-resolution HLA typing methods. Clinical relevance in transplant compatibility.

Prerequisites

To fully understand the module's contents, students must possess preliminary knowledge of the following core disciplines, typically acquired in the first year of the degree program:

- Knowledge of the contents of the Immunology-I module (organization of the immune system, antibodies, MHC, lymphocyte development), which is essential for a full understanding of the rationale for the methods presented.
- Biochemistry: basic principles of enzymology, kinetics of biochemical reactions, protein structure.
- Cellular and molecular biology: basic molecular biology techniques (nucleic acid extraction, principles of PCR), cell culture.
- Applied physics: basic notions of optics and the operating principles of laboratory instrumentation (useful for understanding flow cytometry and microscopy).

Teaching form

- Laboratory, seminar and/or practical exercises (12 meetings × 2 hours, for a total of 24 hours), with illustration of the tools and protocols through multimedia presentations, demonstrations).
- Analysis and guided discussion of real or simulated clinical-analytical cases (laboratory reports, flow cytometric panels, immunofluorescence images), with an approach based on problem-based learning.
- Use of the University e-learning platform for sharing teaching material, simplified experimental protocols and self-assessment material.
- Work in small groups for collegial discussion of the cases proposed in the module lessons.

Textbook and teaching resource

Reference Textbooks

- Abbas A.K., Lichtman A.H., Pillai S. — Cellular and Molecular Immunology (most recent Italian edition), Edra — chapters on immunological methods.
- Detrick B., Schmitz J.L., Hamilton R.G. (Eds.) — Manual of Molecular and Clinical Laboratory Immunology, American Society for Microbiology (ASM) Press.
- Rich R.R. et al. — Clinical Immunology: Principles and Practice (methodological chapters), Elsevier.

Supplementary Materials

- Technical and illustrative materials (simplified protocols, instrument diagrams) made available on the University e-learning platform for each method covered.
- Collection of clinical and analytical cases (anonymized or simulated laboratory reports) for classroom discussion.
- Selected methodological scientific articles relating to the most advanced techniques (multiparametric flow cytometry, sequencing for HLA typing).

Semester

The Immunology-II module is taught during the second semester of the second year of the Single-Cycle Master's Degree in Medicine and Surgery, according to the academic calendar approved annually by the Degree Programme Council. It is recommended that the Immunology-II module be taught in close chronological order with the Immunology-I module, to allow students to immediately apply the presented methods to the theoretical concepts already acquired.

Assessment method

Exam Structure

- A preparatory written exam consisting of a multiple-choice test (typically 10–12 questions) and/or short-answer questions relating to the interpretation of a simplified clinical-analytical case (e.g., reading a flow cytometric panel or an ELISA report), aimed at assessing the acquisition of basic methodological skills. Passing the written exam is a prerequisite for admission to the integrated oral exam.
- An integrated oral exam, conducted in a single location with the Immunology-I module (the final evaluation of the Immunology course takes into account the contents of both 2-credit modules in an integrated manner), is aimed at assessing the student's ability to describe the principle of a diagnostic method and critically interpret a complex clinical-analytical case presented during the exam.

Assessment Criteria

The final grade is expressed in thirtieths, with possible honors awarded for excellent performance, and takes into account both modules (Immunology-I and Immunology-II) in an integrated manner.

The final grade takes into account the following criteria:

- Accuracy and completeness of the methodological knowledge presented in the written exam and oral examination.
- Ability to select and describe the appropriate diagnostic method for a specific clinical-analytical question.
- Ability to critically interpret a report or a complex clinical-analytical case.
- Honors are awarded for performance that, in addition to fully satisfying the previous criteria, demonstrates particular independence of critical judgment and the ability to establish an interdisciplinary connection between the two modules.

Office hours

The instructor receives students as follows:

- Weekly in-person office hours, by appointment arranged via institutional email (mmarchetti@asst-pg23.it), at the instructor's office.
- Availability for remote office hours (videoconference via the University platform), upon motivated and prior arrangement.
- Asynchronous communication via institutional email and the course's e-learning platform's messaging tools, with a guaranteed response within standard deadlines.
- The weekly in-person office hours are announced 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 | INDUSTRY, INNOVATION AND INFRASTRUCTURE | PARTNERSHIPS FOR THE GOALS
