Universitat Autònoma de Barcelona

2022/2023

Immunology

Code: 101932
ECTS Credits: 6

Degree	Type	Year	Semester
2501230 Biomedical Sciences	OB	2	2

Contact

Name: Mercè Marti Ripoll
Email: merce.marti@uab.cat

Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: Yes
Some groups entirely in Spanish: No

Other comments on languages

Les activitats de pràctiques d'aula són en anglès

Prerequisites

To enroll in this subject, students must have obtained the basic knowledge of Biochemistry, Molecular Biology and Cell Biology of the subjects that have completed the first year of the Degree

Objectives and Contextualisation

Objectives of the subject:

At the end of the course, students will have to:

- Know the components of the immune system: molecules, cells and lymphoid organs.

- Understand the innate and adaptive immune response, humoral and cellular; the phases of the immune response and the regulation and homeostasis of the immune system.

- Know the communication between components of the immune system through blood and lymphatic traffic; and the anatomical location of the immune response.

- Apply the knowledge of the immune response in infections for viruses, bacteria, protozoa, helminths and fungi.

- Identify the cellular and molecular immunological techniques applicable to the different biological systems.

- Analyse how to apply the reactions of the immune system and its specificity to the study of biomolecules, diagnosis, vaccines and immunotherapy.

- Know the basics of immunopathology

Competences

- Act with ethical responsibility and respect for fundamental rights and duties, diversity and democratic values.
- Display knowledge of the bases and elements applicable to the development and validation of diagnostic and therapeutic techniques.
- Display knowledge of the basic life processes on several levels of organisation: molecular, cellular, tissues, organs, individual and populations.
- Display knowledge of the concepts and language of biomedical sciences in order to follow biomedical literature correctly.
- Display theoretical and practical knowledge of the major molecular and cellular bases of human and animal pathologies.
- Make changes to methods and processes in the area of knowledge in order to provide innovative responses to society's needs and demands.
- Read and critically analyse original and review papers on biomedical issues and assess and choose the appropriate methodological descriptions for biomedical laboratory research work.
- Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
- Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
- Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
- Students must develop the necessary learning skills to undertake further training with a high degree of autonomy.
- Students must have and understand knowledge of an area of study built on the basis of general secondary education, and while it relies on some advanced textbooks it also includes some aspects coming from the forefront of its field of study.
- Take account of social, economic and environmental impacts when operating within one's own area of knowledge.
- Take sex- or gender-based inequalities into consideration when operating within one's own area of knowledge.
- Work as part of a group with members of other professions, understanding their viewpoint and establishing a constructive collaboration.

Learning Outcomes

1. Act with ethical responsibility and respect for fundamental rights and duties, diversity and democratic values.
2. Analyse the relationship between the nature of the immune response and the molecular and physical characteristics of the antigens that induce it.
3. Define the properties of the adaptive immune response that distinguish it from the innate response. Understand the clonal distribution of the antigen receptors of lymphocytes and the theory of clonal selection.
4. Describe the most important groups of pathogenic microorganisms .
5. Describe the principal mechanisms by which the immune system participates in pathology: immunodeficiencies, hypersensitivity, autoimmunity.
6. Describe the theoretical principles of immunological techniques.
7. Display practical skills in performing a diagnostic analysis in immunopathology.
8. Display practical skills in using the technologies applicable to experimentation in immunology.
9. Explain the mechanisms of activation and regulation of the cellular and humoral immune response and their link to immunopathology.
10. Explain the relationships between a possible pathogen and its host.
11. Identify the principal elements intervening in the immune response to infections and tumours, and in the situation of allogeneic transplant.
12. Make changes to methods and processes in the area of knowledge in order to provide innovative responses to society's needs and demands.
13. Recognise the role of microorganisms as agents of disease or toxicological problems in human beings, animals and plants.

14. Reproduce a general vision of the modes of intervention in the immune response, that is, the principles of immunotherapy.
15. Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
16. Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
17. Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
18. Students must develop the necessary learning skills to undertake further training with a high degree of autonomy.
19. Students must have and understand knowledge of an area of study built on the basis of general secondary education, and while it relies on some advanced textbooks it also includes some aspects coming from the forefront of its field of study.
20. Take account of social, economic and environmental impacts when operating within one's own area of knowledge.
21. Take sex- or gender-based inequalities into consideration when operating within one's own area of knowledge.
22. Understand scientific texts and write review papers on immunology and biology.
23. Understand the scientific literature and the databases specialising in problems of immunology and immunopathology, and interpret the results of a scientific project.
24. Understand the structure and function of the immune system on the scale of molecules, cells, tissues and organs.
25. Work as part of a group with members of other professions, understanding their viewpoint and establishing a constructive collaboration.

Content

Contents of the subject:

Section I. Basic immunology (2 ECTS)

Section II. Organization of the Immune Response (2 ECTS)

Section III. Applications of Immunology (1,5 ECTS)

Section IV. Introduction to Immunopathology (0.5 ECTS)

Section I. Basic immunology: elements of the Immune System (2 ECTS)

UNIT 1. Introduction: general view of the immune system

1.1 Basic concepts. Components and actions of the immune response

Brief introduction to the course: description of the syllabus, recommended bibliography, study councils, evaluation. What is Immunology? Elements of the immune system: organs, cells and molecules. Definition of innate or natural immunity and acquired or adaptive. Concept of immune response: humoral and cellular response. Concept of antigenic clonality.

UNIT 2. Innate immunity

2.1 Inmediate and induced innate immune response

Definition Mechanisms of natural resistance. External defense system, physical and chemical barriers. Danger signal. Molecular patterns associated with pathogens (PAMP). Pattern Recognition Receptors (PRRs). Antimicrobial chemical components: lysozyme, defensins. Cells of innate immunity: phagocytes. Soluble PRRs: Acute phase proteins, Complement System (Subject 3). Membrane PRRs: Toll-like Receivers (TLRs).

2.2 The Complement System

Introduction. Enzymatic system of activation in cascade. Nomenclature: inactive precursors and molecules with enzymatic activity. Hydrolysis products. Complement activation pathways: classical pathway, alternative pathway and lectin pathway. Characteristics of each pathway. Membrane attack complex (MAC). Regulation of the complement system. Biological activity

2.3. Cells of the innate immune response

Phagocytes: neutrophils and macrophages. Effector mechanisms: respiratory burst and phagocytosis. Other effector cells: basophils and eosinophils, mast cells. Foci of inflammation. Initiation of the adaptive response.

UNIT 3. Acquired Immunity - Specific Antigen Receptors and Antigen Recognition

3.1 B-cell antigen receptor (BCR): structure of immunoglobulins

Structure of the immunoglobulin: Light chains (VL-CL) and heavy chains (VH-CH).Antigen binding site, hinge region, biological activity of the Fc region. Variable (V) and constant (C) domains. Variable domains: hypervariable region (CDRs). Isotypes: classes and subclasses of the Igs. BCR as a membrane antigen receptor.

3.2. Reorganization of immunoglobulin genes

Coding genes of light (L) and heavy (H) chains. Recombination of the gene segments of the variable region: V-D-J in the heavy chain (H); V-J in the light chain (L). Mechanism of somatic recombination. Imprecision in the recombination of DNA. Generation of diversity of the immunoglobulin repertoire.

3.3. Antigen-antibody interaction. Generation of monoclonalantibodies.

Seminar conducted by Dr. Antoni Iborra will explain what an immunogen is, how the monoclonal antibodies are generated and what science has meant to obtain such reagents.

3.4 T cell antigen receptor (TCR): structure and genetics

T lymphocyte receptor (TCR): structure and gene organization. Homology with the B-cell receptor (BCR) and generation by somatic recombination. CD3 complex: TCR signaling complex. Trimolecular interaction TCR / MHC / antigen. Epitopes recognized by the TCR. Restriction of antigen recognition by the MHC.

3.5 Main Histocompatibility Complex (MHC): structure, synthesis and function

Definition of the Major Histocompatibility Complex (MHC): class I and class II. Structural characteristics and function of the MHC. Three-dimensional structure. Peptide binding site. Characteristics of the antigenic peptides that bind MHC class I and class II molecules. Restriction of the T-cell response by the MHC. Polymorphism and peptide binding. MHC-peptide complex: interactions, conformational changes, recognition surface, molecular mimicry. Antigen processing. Synthesis of the MHC class I and class II molecules. Processing pathways: endogenous and exogenous antigens. Peptides resulting from processing. Crosspriming.

3.6 Genetics of the Major Histocompatibility Complex

Genetic organization of MHC (HLA in humans). Location in the genome. Description of the class region I. Classical "class" loci: HLA-A, B, C. Characteristics of the class I genes. Description of the class II region: HLA-DP, HLA-DQ and HLA-DR. HLA-DM and HLA-DO. Description of the class III region. Properties of MHC: polymorphism, polygenic and codominance. Some basic definitions: Alleles, HLA phenotype, haplotype. Alloreactivity. Cellular distribution of HLA antigens. HLA and disease.

UNIT 4. Interaction of the different elements by soluble mediators of the immune system

4.1 Cytokines and chemokines

Cytokines: definition, general molecular features and function. Families of cytokine receptors: structure andfunction. Chemokines: structure and function. Types ofreceptors.

4.2 Lymphocyte recirculation: concept of homing. Co-stimulatory molecules. Adhesion molecules.

Recirculation of lymphocytes through the lymphatic and blood circulation. Leucocyte trafficking: tethering, rolling, activation, adhesion and transmigration. Molecular families involved involved in leucocyte trafficking: selectins, molecules of the immunoglobulin superfamily and integrins. Definition of homing, function of high endothelial venules. Lymphocyte traffic from the lymph node to the peripheral organs.

Section II. Organization of the Immune Response (2 ECTS)

UNIT 5. Organization of the immune response

5.1 Organs of the immune system

Description of the structure of the primary lymphoid organs. Classification of secondary lymphoid organs (SLO): lymph nodes, spleen, MALT. Anatomical and functional characteristicsof the different morphological and histological areas on the SLO.

5.2 Cellular immuneresponse

T-cell activation. Description of the first, second and third activation signals. Definition of the immunological synapse. Description of the signalling pathway and activation of the transcription factors NFkB, NFAT and AP-1. Types of effector T cells and transcription factors related to Th-cell lineage. Effector mechanisms of Thelper cells and cytotoxic T cells.

5.3 Humoral immune response

T-independent and T-depenent antigens. Activationof B lymphocytes: first and second signals. T-B collaboration. Generationof the germinal center. Follicular T helper lymphocytes (Thf). Maturation of response B: somatic hypermutation, maturation by affinity and isotype switching. Efector role of immunoglobulins in the immune response. Definition of memory B-*cells.*

5.4 Regulation of the immune response

Definition of the concept of peripheral tolerance and comparison with the centraltolerance mechanisms. Main regulatory mechanisms of the immune response: according to signals, mechanisms of induction of apoptosis, regulatory cytokines, inhibitory receptors (ITIM motifs). "Linfocitos reguladores Tregs y lidiar" Regulating lymphocytes Tregs and Bregs.

UNIT 6. Immune response to pathogens and evasion mechanisms

6.1 Immune response to bacteria

Infective pathways of the bacteria. Bacteria and secondary lymphoid organs. Role of conventional dendritic cells. Effector response in front of extracellular and intracellular bacteria. Evasion mechanisms.

6.2 Immune response to fungi and parasites

Characteristics of fungal infections. Elements that direct effector immune response against fungi: Type C lectin receptors (CLRS), Th17; against infection by helminths: innate lymphoid cells, mast cells and Th2; infection by protozoa: life cycle, immune response and evasion mechanisms.

6.3 immune response to the virus

Viral infections and cell tropism. Plasmacitoid dendritic cells. Effector mechanisms ofthe innate immune response: type I interferons and NK cells. Th1 response and cytotoxic T cells. Evasion mechanisms.

Section III. Experimental applications of Immunology (1.5 ECTS)

UNIT 7. Basic techniques to study the immune response

Experimental techniques related to Immunology and its application

Antibody reaction. Design of a label with primary and secondary antibodies. Staining of tissue sections by immunohistochemistry (IHC), immunofluorescence (IF). Staining of cell suspensions and analysis by flow cytometry. Description of experimental techniques to define the functionality of T cells. Determination of cytokines: plaque ELISA, ELISpot, intracytoplasmic staining. Proliferation and cytotoxicity assays. Determination of monoclonal expansions: CDR3 sequencing.

Section IV. Introduction to immunopathology and treatment (0.5 ECTS)

UNIT 8. Introduction to Immunopathology associated with the immune response

Definition and basic examples of the three types of pathologies associated with the immune system: hypersensitivity reactions, autoimmunity and immunodeficiencies.

UNIT9. Immunotherapy. Vaccines

Forms of intervention on the immune response. Passive immunization. Nonspecific active immunization. Definition and importance vaccines in public health. Types of vaccines: with attenuated and inactivated germs. Vaccines generated by biotechnologic techniques.

Methodology

The topics of the program will be taught in 29 sessions of theoretical teaching.

Classroom practices (PAUL) will be two activities to reinforce the theoretical content and give tools to understand the scientific articles related to the subject. In this classes, the student will work cross-cutting skills such as looking for bibliography, exposing in public, to select the important information of the topic.

UNIT 7. Basic techniques to study the immune response will be done in sessions of PAUL in which the most used experimental techniques in immunology will be explained and discussed.

Cooperative learning work. Throughout the course, cooperative work topics will be programmed for groups of 3 (or 4) students, which will consist of:
Problem-based learning: a theoretical presentation of a scientific article related to the topics taught that will prepare them cooperatively.
Project-based learning: design of a research project.

Information on each topic and application guidelines will be saved on the UAB Virtual Campus (Moodle). Students will raise questions in tutorial sessions with the teacher

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			

Lectures	29	1.16	2, 24, 23, 3, 4, 5, 6, 9, 10, 11, 13, 14
Seminars and problem based learning	14	0.56	25
Type: Autonomous			
Autonomous study	56	2.24	23
Interpretation of experimental data	15	0.6	25
Preparation of work in cooperative learning format	25	1	25

Assessment

The evaluation of the subject will be individual and continuous through the following tests, understanding by continuous evaluation the possibility that the student has to evaluate how his learning is and to be able to have time to the improvement during the course.

TEACHING ACTIVITIES:

Partial examinations: two partial examinations with half the syllabus for each one. Part 1 and part 2 exams will be worth 30 and 35% of the final grade, respectively. They will be multiple choice exams with 5 options with only possible answer. In the correction, 1/5 of the value of each question will be subtracted by incorrect answer. The student will have to answer 70% of the questions of the exam to be evaluated. The duration of each test will be of a maximum of 2 hours.

Cooperative learning consisting of three activities

Group activities, cooperative learning (AC) help peer collaboration, development of students 'self-learning, synthesis and written and oral communication skills.

1) Problems on experimental techniques (TE): This part of the subject will be evaluated with 10%. Activity carried out in English and will consist of a questionnaire with problems about experimental techniques related to immunology.

2) Problem Based Learning (PBL). The evaluation will represent 10% of the final mark of the subject. Activity carried out in English and based on the presentation of a research article.

3) Project Based Learning (ABPrj). The evaluation will represent 15% of the final mark of the subject. Activity carried out in English and based on the design of a research project based on a given hypothesis.

Attendance at PAULs must be at least 80% and for this a list will be passed to sign during the session.

Final Exam: A final exam will be scheduled for students who have not reached the required minimum or who want to raise the grade. The part that has not been approved or both may be recovered in the event that neither has been approved. To appear means to give up the note of the partial to which it is presented.

Final Exam: A final exam will be scheduled for students who have not achieved the minimum necessary or who want to raise the grade. Each partial exam will be worth 35%.

EVALUATION:

1) The tests are: 65% exams (30% first part and 35% second part) and 30% Cooperative Learning

2) To pass: Students must achieve a minimum of 5/10 in all tests to make the summation of the evaluation of the subject and be able to compensate the mark between tests. To pass, the final result must be ≥ 5 / 10.

3) To retake the exams: Students who have not passed with the sum of the two partial exams, may be examined for the failed partial exam. In the case of not passing any part during the course, a final exam must be taken.

4) The same calculation will be made for students who want to raise the mark. This implies WAIVING the grade obtained in the part you want to improve.

5) In the event that the student has passed the PAUL but not the exams, the mark that will appear in the file will be the one obtained in the exams. The PAUL grade will be saved until the student passes the subject.

6) Failure to take any of the tests must be justified. The reason must be important enough to consider taking the exam another day. The justification must be presented to the teacher as soon as possible, sending the document by e-mail.A student who is not present at any exam will be described as NOT EVALUATIVE. A student who is only presented to a partial and does not recover the subject in the examination of recovery, will not be kept the note of the work of seminars and cooperative learning for next year.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Cooperative learning (group work)	30%	2	0.08	1, 21, 20, 2, 24, 23, 22, 3, 7, 8, 5, 6, 9, 10, 12, 19, 18, 17, 15, 16, 13, 25
Final exam	Test 1 30% / Test 2 35%	4	0.16	2, 24, 23, 22, 3, 7, 8, 4, 5, 6, 9, 10, 11, 13, 14
Test 1	30%	2	0.08	2, 24, 23, 22, 3, 7, 8, 6
Test 2	35%	3	0.12	23, 22, 7, 8, 4, 5, 9, 10, 11, 13, 14

Bibliography

TEXT BOOKS

Janeway's Immunobiology by K. Murphy, C. Weaver. Ltd/Garland Science, NY & London, 9th ed (2016). ISBN: 9780815345053
Kuby Immunology (with web support) by J. Punt, S. Stranford, P. Jones and J. Owen. W. H.Freeman and Co Ltd. 8th Edition, (2018). ISBN13: 9781319114701
Cellular and Molecular Immunology by A. K. Abbas, A. H. Lichtman, S. Pillai. Elsevier, 9th ed (2017). Paperback ISBN: 9780323479783 eBook ISBN: 9780323523226; eBook ISBN: 9780323523233; eBook ISBN: 9780323523219
Roitt's Essential Immunology by P. Delves, S Martin, D Burton, I Roitt. Wiley-Blackwell Ed., 13rd ed (2017). ISBN: 978-1-118-41577-1
Fundamental Immunology by William E. Paul. Wolters Kluwer (LWW); 7th edition (2012). ISBN-13: 978-1451117837
The immune system by P. Parham. Ltd/Garland Science, NY & London, 4th ed (2014). ISBN: 9780815345275

Software

No more software is needed than the Office 365 available from UAB.