

**Immunology**

Code: 101932  
ECTS Credits: 6

Degree	Type	Year	Semester
2501230 Biomedical Sciences	OB	2	2

**Contact**

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**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

**Teachers**

Francesc Enric Borrás Serres

**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

## **Skills**

- Contribute to public discussions on cultural matters.
- Develop critical thinking and reasoning and communicate ideas effectively, both in the mother tongue and in other languages.
- Develop independent learning habits and motivation to continue training at postgraduate level.
- Develop independent learning strategies.
- Develop scientific knowledge, critical reasoning and creativity.
- 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.
- Generate innovative and competitive proposals for research and professional activities.
- Identify and understand the advances and challenges of research.
- Read and critically analyse original and review papers on biomedical issues and assess and choose the appropriate methodological descriptions for biomedical laboratory research work.
- Respect diversity in ideas, people and situations.
- Work as part of a group with members of other professions, understanding their viewpoint and establishing a constructive collaboration.

## **Learning outcomes**

1. Analyse the relationship between the nature of the immune response and the molecular and physical characteristics of the antigens that induce it.
2. Contribute to public discussions on cultural matters.
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. Develop critical thinking and reasoning and communicate ideas effectively, both in the mother tongue and in other languages.
8. Develop independent learning habits and motivation to continue training at postgraduate level.
9. Develop independent learning strategies.
10. Develop scientific knowledge, critical reasoning and creativity.
11. Display practical skills in performing a diagnostic analysis in immunopathology.
12. Display practical skills in using the technologies applicable to experimentation in immunology.
13. Explain the mechanisms of activation and regulation of the cellular and humoral immune response and their link to immunopathology.
14. Explain the relationships between a possible pathogen and its host.
15. Generate innovative and competitive proposals for research and professional activities.
16. Identify and understand the advances and challenges of research.
17. Identify the principal elements intervening in the immune response to infections and tumours, and in the situation of allogeneic transplant.
18. Recognise the role of microorganisms as agents of disease or toxicological problems in human beings, animals and plants.
19. Reproduce a general vision of the modes of intervention in the immune response, that is, the principles of immunotherapy.
20. Respect diversity in ideas, people and situations.
21. Understand scientific texts and write review papers on immunology and biology.
22. Understand the scientific literature and the databases specialising in problems of immunology and immunopathology, and interpret the results of a scientific project.

23. Understand the structure and function of the immune system on the scale of molecules, cells, tissues and organs.
24. Work as part of a group with members of other professions, understanding their viewpoint and establishing a constructive collaboration.

## **Content**

### **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 Immediate 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 Receptors (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 monoclonal antibodies.

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 and function. Chemokines: structure and function. Types of receptors.

### 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 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 characteristics of 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. Activation of B lymphocytes: first and second signals. T-B collaboration. Generation of 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 of the innate immune response: type I interferons and NK cells. Th1 response and cytotoxic T cells. Evasion mechanisms.

## **Section III. Applications of Immunology (1.5 ECTS)**

### **UNIT 7. Basic techniques to study the immune response**

#### 7.1 Cellular techniques

Description of the experimental techniques to define the function of T cells. Detection of cytokines by different techniques: ELISA, ELISPOT, intracytoplasmic staining. Assays of proliferation and cytotoxicity. Determination of monoclonal expansions: CDR3 sequencing.

#### 7.2 Molecular Techniques

Antibody-antigen reaction. Primary and secondary antibodies. Staining of tissue sections by immunohistochemistry (IHC) and immunofluorescence (IF). Staining of cell suspensions and analysis by flow cytometry.

## **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.

The work of cooperative learning: Seminars of current issues and expansion of the knowledge taught in the theoretical classes. Throughout the course, topics of cooperative work will be programmed for groups of 3 (or 4) students, which will consist on a first part introducing the field of the paper and an a second exposing a scientific paper with the data / results realted to the topic. The information on each topic and the application guidelines will be stored in the UAB Virtual Campus (Moodle). The students will ask questions to tutor sessions with the teachers.

## Activities

Title	Hours	ECTS	Learning outcomes
<b>Type: Directed</b>			
Lectures	29	1.16	1, 23, 22, 3, 4, 5, 6, 13, 14, 17, 18, 19
Seminars and problem based learning	14	0.56	2, 10, 8, 24
<b>Type: Autonomous</b>			
Autonomous study	56	2.24	22, 10, 9, 8, 7, 16
Interpretation of experimental data	15	0.6	10, 9, 16, 20, 24
Preparation of work in cooperative learning format	25	1	10, 9, 8, 7, 15, 24

## Evaluation

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. Each test will be worth 35%

of the final grade. 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.

**Problem based learning:** This part of the subject will be evaluated with problems about experimental techniques and experimental data that will be evaluated with 10%.

**Seminars and cooperative work:** Seminars and group work help develop the self-learning, synthesis and written and oral communication skills of the students. The assessment will represent 30% of the final grade of the subject and the written presentation of the seminar, the oral presentation, the answer to questions and the participation in the discussion will be valued. This type of work is very important because cross-curricular skills for the student's professional life are evaluated. Attendance at the seminars must be at least 80%.

**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: 35% first partial, 35% second partial, 20% seminar and 10% cases
- 2) To pass: The students must reach a minimum of 4/10 in all the tests to allow the sum to perform de final mark. To pass, **the final result must be  $\geq 5 / 10$ .**
- 3) Students who have not passed the two partial tests will be able to do the final exam.
- 4) The same calculation will be done by students who want to raise notes.
- 5) Non-submission to any of the tests must be justified. "La justificació s'ha de presentar al professor el més aviat possible, enviant el document per correu als professors màxim el diade l'examen."

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.

#### Evaluation activities

Title	Weighting	Hours	ECTS	Learning outcomes
Cooperative learning (group work)	20%	0.75	0.03	21, 2, 10, 8, 7, 15, 16, 20, 24
Final exam	Test 1 35% / Test 2 35%	4	0.16	1, 23, 22, 21, 3, 11, 12, 4, 5, 6, 9, 7, 13, 14, 17, 18, 19
Seminars and problem based learning	10%	0.25	0.01	22, 21, 6, 9, 16
Test 1	35%	3	0.12	1, 23, 22, 21, 3, 11, 12, 6, 9
Test 2	35%	3	0.12	22, 21, 11, 12, 4, 5, 13, 14, 17, 18, 19

#### Bibliography

**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. Owen, J. Punt and S. Stranford. W. H. Freeman and Co. 7th Edition, (2013). ISBN: 978-14641-3784-6

**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

## **Journals and reviews**

Advances in Immunology

[http://www.elsevier.com/wps/find/bookdescription.cws\\_home/716912/description#description](http://www.elsevier.com/wps/find/bookdescription.cws_home/716912/description#description)

<http://www.sciencedirect.com/science/bookseries/00652776>

Annual Review of Immunology

<http://arjournals.annualreviews.org/loi/immunol>

Current Opinion in Immunology

[http://www.elsevier.com/wps/find/journaldescription.cws\\_home/601305/description#description](http://www.elsevier.com/wps/find/journaldescription.cws_home/601305/description#description)

<http://www.sciencedirect.com/science/journal/09527915>

Immunological Reviews

<http://www3.interscience.wiley.com/journal/118503650/home>

Nature Reviews in Immunology

<http://www.nature.com/nri/index.html>

Seminars in Immunology

[http://www.elsevier.com/wps/find/journaldescription.cws\\_home/622945/description#description](http://www.elsevier.com/wps/find/journaldescription.cws_home/622945/description#description)

Trends in Immunology

<http://www.cell.com/trends/immunology/>

**Immunobiology** by C. A. Janeway, P. Travers, M. Walport and M. Shlomchik, Garland Science 2001

<http://www.ncbi.nlm.nih.gov/bookshelf/br.fcgi?book=imm>

**Roitt's Essential Immunology**, by [Peter Delves](#), [Seamus Martin](#), [Dennis Burton](#), [Ivan Roitt](#), Wiley-Blackwell Ed., 11 th ed., (2006)

<http://www.roitt.com/>

**Kuby Immunology** (with web support) by T.J. Kindt, R.A. Goldsby, B.A. Osborne. W.H. Freeman Co., 6 th ed, (2006)

<http://www.whfreeman.com/kuby/>

<http://bcs.whfreeman.com/immunology6e/>



**Microbiology and Immunology On line. School of Medicine, University of South Carolina**

<http://pathmicro.med.sc.edu/book/welcome.htm>

**Faculty of Medicine, Dalhouse University (Halifax, Nova Scotia, Canada)**

<http://immunology.medicine.dal.ca/bookcase/>

**The Infectious Diseases WebLink**

<http://webpages.charter.net/deziel/>

**Departament of Molecular and Cellular Biology, Harvard University**

<http://mcb.harvard.edu/BioLinks/Immunology.html>

**Biology Animations**

<http://biology-animations.blogspot.com/>

**Molecular Expressions: Images from the microscope, Florida State University**

<http://micro.magnet.fsu.edu/primer/virtual/virtual.html>

**Introduction Immune System**

<http://www.biology.arizona.edu/immunology/tutorials/immunology/main.html>

**Immunobiology**

<http://www.skidmore.edu/academics/biology/courses/erubnst/BI348/pages/resources.html>

**Janeway's animations**

<http://www.blink.biz/immunoanimations/>

**Davison College (Immunology course, Molecular Movies)**

<http://www.bio.davidson.edu/courses/Immunology/Bio307.html>

**Pathology of Infectious Diseases (images of infected tissues by bacterial, fungi and viruses)**

<http://info.fujita-hu.ac.jp/~tsutsumi/index.html>

**Movies from Ronald Germain**

<http://www.niaid.nih.gov/LabsAndResources/labs/aboutlabs/li/lymphocyteBiologySection/Pages/videos.asp>

**The von Andrian Laboratory**

<http://labs.idi.harvard.edu/vonandrian/>