BIOCHEMISTRY/BIOTECHNOLOGY

FACULTY OF SCIENCE

UNIVERSITY OF ZARAGOZA

INDEX

INTRODUCTION

FACULTY OF SCIENCE

The Faculty of Science is located at the heart of Zaragoza city, in San Francisco Campus. It has a long history of excellence in teaching and research. The Faculty has a strong international profile and attracts students from Europe and around the world. With more than 1,000 ISI journal articles published per year, the Faculty is a leading research hub at the University of Zaragoza, ranked among the top 200 world-class universities for Natural Sciences & Mathematics (ARWU 2016).

Figures for the Faculty of Science:

- 1850 students
- 450 professors + 100 researchers + 100 support staff
- 40 classrooms + 20 teaching labs + 150 research labs + 9 computer classrooms

Undergraduate Degree Programs

- BSc in Biotechnology
- BSc in Chemistry
- BSc in Geology
- BSc in Mathematics
- BSc in Optics and Optometrics
- BSc in Physics

MSc Degree Programs

- MSc in Geology: Techniques and applications
- MSc in Industrial Chemistry
- MSc in Mathematical modelling and research, Statistics and Computation
- MSc in Molecular and Cellular Biology
- MSc in Quantitative Biotechnology (***in English***)
- Msc in Molecular Chemistry and Homogeneous Catalysis
- MSc in Physics and Physical technologies
- MSc in Nanostructured Materials and Nanotechnological Applications (***in English***)
- MSc Erasmus Mundus in Membranes Engineering (***in English***)

English-language friendly (ELF) modules

Three of our MScs are taught in English, while the rest of MScs and all the BScs are taught in Spanish. In the programs taught in Spanish, most of the modules are English-language friendly (ELF). This means that, in those modules, foreign students will have, upon request:

- Learning material in English.
- Office hours in English.
- Assessment (exams, homework...) in English.

In the list of modules for each program, see below, English-language friendly modules for 2018/2019 are marked with an ELF label. The list of ELF modules may change slightly by 2019/2020; a list of ELF modules taught that year will be available some weeks before the start of the classes.

High level research: More than 1.000 research papers in JCR per year

The Faculty has been the seed of Research Institutes of the University of Zaragoza:

- BIFI: Institute of Biocomputation and Physics of Complex Systems
- ICMA: Aragon Materials Science Institute
- INA: Institute of Nanoscience of Aragon
- ISQCH: Institute of Chemical Synthesis and Homogeneous Catalysis
- IUCA: Environmental Science Institute of Aragon
- IUMA: Institute of Mathematics and Applications

Most professors/researchers in the Faculty of Science are members of these institutes.

BSc IN BIOTECHNOLOGY

Duration: 4 years full time. 60 ECTS per year.

Language: Spanish.

Program aims:

The Biotechnology Degree at UNIZAR aims to provide with interdisciplinary training integrating conceptual, manual skills and technical knowledge of the functions and potential of living beings to understand and manage biomolecules at the molecular and cellular levels. Training in this degree is complemented with knowledge of the areas of bioinformatics, bioethics, legislation, and management. On these conceptual and technical basis, future professionals will be able to apply science and technology to biomolecules, living beings and their cellular or molecular behavior to improve and develop goods or services in diverse areas of human activities: Chemistry, Agriculture, Health, Bioremediation, etc,… Training will also allow them to check biosecurity, the registry and the administrative authorization of biotechnological products. The degree will particularly provide a good knowledge of the structure and characteristics of biomolecules and the principles and procedures used in their production and characterization. It will also provide an integrated view of the cell and its performance in its biological context, as well as knowledge of the molecular foundations of gene information and management skills for their manipulation on microorganisms, plants and animals. Biotechnology is a field in major expansion that has diversified towards a wide variety of areas, such as medicine and health, agro-food production, industrial production, energy and the environment. All of these areas will be covered during training.

The integrated set of this knowledge will allow those who pursue the degree to:

- Recognize and evaluate ecologic, environmental and health problems in the development and application of molecular life sciences.
- Use Biotechnology to characterize and conserve genetic biodiversity, improve production processes, protect the environment and improve the quality of life.
- Apply the legal and ethical bases involved in the development and application of molecular life sciences.
- Develop biological tools with technological impact in diverse human activities: industrial production, agriculture, health, bioremediation, energy, etc…

Structure:

Year 1. In the first year students must register in the following modules:

Module	ECTS	Semester
27100 - General Chemistry[ELF]	12	YL
27101 - Mathematics[ELF]	9	YL
27102 - Physics[ELF]	9	YL
27103 - General Biology[ELF]	12	YL
27106 - Statistics[ELF]	6	S1
27105 - Genetics[ELF]	6	S2
27111 - Organic Chemistry[ELF]	6	S2

S1: Semester 1. Mid-September to mid-January

S2: Semester 2. Beginning-February to end-May

YL: Year-long. Mid-September to end-May

[ELF]: English-language friendly module (see first page)

Year 2. In the second year students must register in the following modules:

Module	ECTS	Semester
27107 - Instrumental Techniques in Biotechnology[ELF]	9	YL
27108 - Biochemistry	12	YL
27109 - Microbiology[ELF]	9	YL
27110 - Physical Chemistry[ELF]	6	S1
27113 - Macromolecules Structure[ELF]	6	S1
27104 - Physiology[ELF]	6	S2
27112 - Immunology[ELF]	6	S2
27114 - Plant Physiology[ELF]	6	S2

Year 3. In the third year students must enroll in the following modules:

Module	ECTS	Semester
27115 - Chemical Engineering[ELF]	9	YL
27116 - Clinical Biotechnology[ELF]	9	YL
27117 - Molecular Biology[ELF]	6	S1
27118 - Cell Culture[ELF]	6	YL
27119 - Introduction to Management Systems	6	S1
27126 - Environmental Biotechnology[ELF]	6	S1
27120 - Social and Legal Elements[ELF]	6	S2
27121 - Genetic Engineering[ELF]	6	S2
27123 - Bioinformatics[ELF]	6	S2

Year 4. In the fourth year students must enroll in the following modules:

Module	ECTS	Semester
27124 - Bioreactors[ELF]	6	S1
27125 - Plant Biotechnology[ELF]	6	S1
27128 - Microbial Biotechnology[ELF]	6	S1
27127 - Animal Biotechnology[ELF]	6	S2
27122 - Introduction to Systems Biology[ELF]	6	S2
27129 – Undergraduate Dissertation [ELF*]	10	YL

In this fourth year they must also select three modules from the list of optional modules:

Module	ECTS	Semester
27132 - Biochemistry of Nutrition[ELF]	6	S2
27137 - Pharmacology[ELF]	6	S1
27131 - Biophysics[ELF]	6	**
27133 - Wine Biochemistry and Microbiology	6	S1
27134 - Food Biotechnology[ELF]	6	S2
27135 - Biotechnology applied to Immunology and Microbiology[ELF]	6	S2
27136 - Veterinary Biotechnology	6	S2
27140 - Bioinorganic Chemistry	6	**
27141 - Bioorganic Chemistry[ELF]	6	**
27148 - Molecular Basis of Cell Communication and Cancer[ELF]	6	S2
27147 – Internship	6	YL

Not all the optional modules are available every year. A list of the available modules for the following year (starting in September) is published in June. The modules with ** in the Semester column are not being offered in 2018/2019.

***Undergraduate Dissertation**

Undergraduate Dissertation (UD) is a 250 hours project on any of the subjects of the Degree. It is undertaken during the 4th year. Students are supervised by a professor who defines the objectives of the project and guides them along the work. Students must write a report and give a public presentation of it. The following list includes some examples of UDs performed in the last years:

- Analyzing sequence polymorphisms and HvFT1 expression in a biparental barley population.
- Use of the vaccine candidate for tuberculosis MTBVAC as an expression vector of Granzyme B
- Improvement of an identification technique of animal species in meat samples
- Study of physiopathological mediators implied in the digestive transit
- Phenotype effect of polymorphic variants of mtDNA

- Development of antimicrobial coverings on medical devices
- Cell culture in microfluidic devices for mimicking in vitro biological environments in 2 and 3 dimensions
- Characterization of the inflammatory activity of mutation L144R in the apolipoprotein A1
- Development of a protocol for in vitro and in vivo angiogenesis assays
- Characterization of context-specific networks of protein-protein interactions in *Mycobacterium tuberculosis*
- Mutations of gene AP0A5 in patients with severe hypertriglyceridemia. Study of prevalence in a sanitary district in Aragon
- Molecular-genetic characterization of cellular models for the study of Alzheimer's disease
- Sensitivity of colon carcinoma cells to treatment with activated NK allogeneic cells
- Expression and secretion of lethal ligand Apo2L/TRAIL in immune system effector cells
- Toxicogenomics of mitochondrial diseases
- Isolation of LP (a) particle by FPLC
- Genomic polymorphisms in Mycobacterium tuberculosis
- 3D cell cultures under conditions of mechanic stimulation in tissue engineering
- Experimental characterization and computer simulation of a model for *in vitro* oxidation
- Energetic metabolism and sensitivity to cell damage in primary cultures of renal epithelium
- *In vitro* antitumoral effect of BH3 mimetic compounds combined with a proteasome inhibitor and a PARP-1 (Olaparib) inhibitor
- Polyoxometalates based polymeric capsules as antimicrobial capsules
- Splicing mutations and associated phenotype in two patients with Cornelia de Lange syndrome
- Expression of Carbonic Anhydrase IX as a new tool for diagnosing renal tumors
- Evolutionary ecology of bacteria populations
- Characteristics and separation of lysozyme from hen egg white
- Role of mitochondrial DNA genetic variation in Parkinson's disease

MSc IN MOLECULAR AND CELLULAR BIOLOGY

Presentation

This master's Degree is aimed to provide students with a solid theoretical-practical experience in Molecular and Cellular Biology which will allow them to begin a research career by entering the Doctorate program and to be trained as molecular scientists in the skills required for research work or related professional activities.

The Master program and its development is organized by the Biochemistry and Molecular and Cellular Biology Department (**BMCBD**, established in the University of Zaragoza in 1977 and composed by 6 different research groups (see below)), with the collaboration of researchers from other Departments and Institutes of our University, and with invited scientists from other Universities and research centres from Spain and abroad.

In order to be admitted in this Master program, students must hold a degree in Biochemistry, Biotechnology, Biology, Pharmacy, Microbiology, Chemistry, Veterinary Science, Medicine or Food Science and Technology. Applicants (excluding Biochemistry and Biotechnology graduates) must have background knowledge in molecular biology and/or biotechnology.

The Master is developed throughout one academic year comprising 60 ECTS divided in two modules. A theoretical-practical module covers 30 ECTS (5 subjects of 6 ECTS each, 3 of which are mandatory and 2 selected out of 4 options) and the other 30 ECTS will consist of an experimental research project (Master's Dissertation, MD) to be carried out in one of the research groups affiliated to the postgraduate program (see below).

Duration: 1 year full time. 60 ECTS.

Language: Spanish.

Program aims:

The main objectives for the Master's degree in Molecular and Cellular Biology are:

1) To provide students a systematic, rigorous and up-to-date knowledge and a critical vision of the main topics in the discipline of Molecular and Cellular Biology (including protein structure, molecular basis of genetic diseases, functional genomics, apoptosis, etc.).

2) To offer students a deeper understanding of the molecular and cellular mechanisms underlying cell function as well as the physiopathology of human diseases.

3) To enable students to acquire and practice the basic skills required to conduct experimental work in the laboratory in the fields of Molecular and Cellular Biology. It is also aimed to teach the students how to analyse and interpret the experimental data obtained and take decisions for the development of a given project.

4) To familiarize students with some of the most important technologies currently used in research in Molecular and Cellular Biology and with the search tools to obtain relevant biological information.

5) To ensure that students acquire the knowledge and ability they will need to identify problems, and find practical and creative solutions, as well as to apply them in a research or professional context in the fields of Molecular and Cellular Biology.

6) To develop their ability to present scientific work in a clear and concise manner, orally and in writing, both to the specialist as well as to a general audience, understanding the ethical and social implications involved.

Structure

Students must enroll in the following modules:

Module	**ECTS**	**Semester**
66030 - Advanced methods in Molecular and Cellular Biology[ELF]	6	S1
66029 - Advanced methods in Biophysics[ELF]	6	S1
66028 - Quality control and legislation in biotechnological processes[ELF]	6	S1
66017 – Master's Dissertation [ELF*]	30	YL

They must also enroll in two modules from the list of optional modules:

Module	**ECTS**	**Semester**
66022 - Functional Genomics[ELF]	6	S2

66023 - Advanced Immunology[ELF]	6	S2
66026 - Cell separation and viability analysis[ELF]	6	S2
66018 - Advances in molecular Pathology[ELF]	6	S2

***Master's Dissertation**

The Master's Dissertation is a 750 hour experimental project on any of the subjects of the Master's program to be carried out at the end of the course. The student will have to prepare a written report of its MD that will be presented and defended orally in before a committee made up of three members. The committee will evaluate both the structure and contents of the written report as well as the student communication skills and mastering of the project's research field. The following list includes some examples of MDs performed in the last years:

- Prokaryotic FAD synthetases (FADS): a potential pharmacologic target in therapy. Analysis of structure-function relationships and inhibitor design. (Directors: Dr. Milagros Medina and Dr. Ana Serrano, BMCBD and BIFI)
- Tumor stem cell activation effects of Granzyme A induced inflammation in colorectal carcinoma. (Director: Julian Pardo, IACS)
- Development and validation of an immunochemical test for the diagnosis of invasive aspergillosis. (Director: Julian Pardo, IACS)
- Multifunctional nanoparticles for transport and selective delivery of anti-hepatitis C (VHC) drugs (Director: Olga Abian, BIFI)
- Identification and characterization of new ionic cannel modulators for the treatment of neurological and cardiovascular diseases. (Director: Ralf Kohler, UIT-IACS)
- Functional analysis of polymorphisms in promoters involved in lipid metabolism. (Directors: Miguel Pocoví e Isabel de Castro BMCBD and IACS)
- Functional effects of directed mutations in human Apoptosis Inducing Factor (hAIF). (Directors: Dr. Patricia Ferreira and Dr. Raquel Moreno-Loshuertos, BMCBD and BIFI)
- Search for pharmacological chaperones to rescue MeCP2 mutations involved in Rett syndrome. (Directors: Dr. Adrián Velázquez Campoy and Dr. Olga Albian, BIFI-IACS)
- In vitro antitumoral effects of BH3-mimetic compounds combined with the proteosomal inhibitor Carfilzomib and with PARP-1 inhibitor Olaparib. (Director: Isabel Marzo, BMCBD)

- Role of new mtDNA mutations in mitochondrial diseases. (Directors: Julio Montoya and Eduardo Ruiz-Pesini, BMCBD)

MSc IN QUANTITATIVE BIOTECHNOLOGY

Presentation

This master's Degree is aimed to provide students with a solid theoretical-practical experience in the quantitative aspects of Biotechnology which will allow them to begin a research career by entering the Doctorate program and to be trained in the skills required for research work or related professional activities in Biotech companies.

The Master program and its development is organized by the Institute of Biocomputation and Physics of Complex Systems (BIFI, created in 2002 and composed by different research groups (see below)), with the collaboration of researchers from other Departments and Institutes of our University, and with invited scientists from other Universities and research centers from Spain and abroad.

In order to be admitted in this Master program, students must hold a degree in Biochemistry, Biotechnology, Biology, Physics, Chemistry, Veterinary Science, Medicine or Food Science and Technology.

The Master is developed throughout one academic year comprising 60 ECTS divided in two modules. A theoretical-practical module covers 30 ECTS (3 mandatory subjects of 6 ECTS each, and 3 subjects of 4 ECTS selected out of 6 options) and the other 30 ECTS will consist of a research project (Master's Dissertation, MD) to be carried out in one of the research groups affiliated to the postgraduate program (see below) or in one of the local Biotech companies that have agreed to collaborate with us in the master, co-supervised by one or our researchers.

Duration: 1 year full time. 60 ECTS.

Language: English.

Program aims:

The main objectives for the Master's degree in Quantitative Biotechnology are:

- To provide students with a sufficient knowledge on the structural, functional and dynamical properties of biological networks to be able to

formulate and simulate the behavior of a network to match experimental data.

- To provide students with the abilities to obtain, visualize and interpret information on the tridimensional structure of biological macromolecules, organic molecules or organometallic compounds
- To provide students with the sufficient knowledge on computer simulation of biomolecules, at the classical and quantum levels. They will learn to choose the algorithm for each problem and to analyze the results using standard techniques (principal components, normal modes, free energy differences...)
- To provide students with the ability to use molecular docking at the protein-protein and protein-ligand levels, considering also the coupling of a given target and a library and the efficiency of the process. Use them to identify ligands for different purposes (pharmacological chaperones, inhibitors, etc.).
- To provide students with the ability to use statistical tools to relate molecular structure and biological activity and produce predictive models.
- To provide the students with the ability of design and perform experiments to solve a given research or industrial problem taking into account the time and the potential benefits.

Structure

Students must enroll in the following modules:

Module	**ECTS**	**Semester**
63100.- Systems and Synthetic Biology	6	S1
63101.- Simulation of Biomolecules	6	S1
63102.- Bioactive Molecules - Identification, design and development	6	S1

They must also enroll in two modules from the list of optional modules:

Module	**ECTS**	**Semester**
63103.- Molecular Biotechnology - Instrumental techniques	4	S2
63104.- Cell and Organism Biotechnology - Experimental methodology	4	S2
63105.- Biostatistics and Bioinformatics	4	S2
63106.- Biological Modelling	4	S2
63107.-The SME-Biotech: characteristics, creation and management	4	S2
63108.- Regulation and Quality Control Issues	4	S2

Master's Dissertation

The Master's Dissertation is a 750 hour experimental project on any of the subjects of the Master's program to be carried out at the end of the course.

We have agreements with the most prominent Biotech companies of our region to offer our students the possibility of start doing applied research for their Master Thesis. They would start working in some research line at the company while being co-supervised by one of the researchers at BIFI and one researcher at the company. In some special cases the company will offer an internship for the student to continue the work after the thesis.

The student will have to prepare a written report of its MD that will be presented and defended orally in front of a committee made up of three members. The committee will evaluate both the structure and contents of the written report as well as the student communication skills and mastering of the project's research field.

RESEARCH GROUPS AT THE DEPARTMENT IN BIOCHEMISTRY AND MOLECULAR AND CELLULAR BIOLOGY (BMCBD)

- Apoptosis, Immunity and Cancer
- Biology and Biotechnology of Reproduction
- Mitochondrial Biogenesis and Pathology
- Mediterranean Diet and Atherosclerosis
- Protein Targets
- Structural Biology

Members of the Department are also involved in the Institutes of Biocomputation and Physics of Complex Systems (BIFI), of Nanoscience of Aragon (INA), the Aragon Institute of Health Sciences (IACS) and the Environmental Sciences Institute. Moreover, some research groups are also involved in the Centros de Investigación Biomédica en Red (CIBER) of Rare Diseases (CIBERER) and Obesity and Nutrition Physiopathology (CIBERobn).

Groups from other Departments/Institutes participating in the BSc and Master Programs:

- Mycobacterial genetics group (Dpt. of Microbiology)
- LAGENBIO research group (Dpt. of Anatomy, Embryology and Animal Genetics)
- Computational and Structural Biology group (CSIC-Aula Dei)
- Ionic channels research group (UIT-Miguel Servet Universitary Hospital)

A list of some recent publications can be found here.

RESEARCH GROUPS AT BIFI INVOLVED IN THE MASTER IN QUANTITATIVE BIOTECHNOLOGY

In biochemistry and molecular biology area:

Apoptosis and metabolism

Development of antimicrobials and mechanisms of resistance

Genetic regulation and physiology of cyanobacteria

Genetics and pig metabolism

Functional genomics of the OXPHOS system (GENOXPHOS)

In Biophysics area:

ProtMol: Protein folding and molecular design

Biomolecular Interactions

Protein glycosylation and its role in disease

Complex systems and networks

Physical modeling of biomolecules

Molecular dynamics and electronic structure

Flavoenzymes: action mechanisms and biotechnology

Protein Misfolding and Amyloid Aggregation

Clinical Diagnosis and Drug Delivery