# MASTER IN FUNCTIONAL GENOMICS AND PROTEOMICS

**Main Language of Instruction:**
French ☑ English ○ Arabic ○

**Campus Where The Program Is Offered:** CST

## OBJECTIVES

The Master in Functional Genomics and Proteomics provides multidisciplinary training for biologists and biochemists. It is founded on comprehensive, research-based teaching employing complementary approaches in structural and functional genomics and proteomics. The program aims to equip graduates with the skills to design and implement methodological and experimental approaches, developing innovative solutions to elucidate and address complex biological questions.

## PROGRAM LEARNING OUTCOMES (COMPETENCIES)

The program aims to acquire in-depth theoretical knowledge in various fields of biology, including: molecular and cellular biology, biochemistry, structural biology, genetics, immunology, and physiology. The program also aims to develop methodological and practical skills as well as transversal competencies required for the professional integration of graduates.
Graduates of this Master's program are capable of:

- Using scientific knowledge to solve complex situations in biology and biochemistry
- Designing and applying experimental protocols
- Managing a research project related to the fields of biology and biochemistry
- Communicating scientific information related to the fields of biology and biochemistry

## ADMISSION REQUIREMENTS

Admission is based on the examination of the candidate's application and following an interview with the selection committee.

- Admission to the first semester of the Master's program (M1) is open to holders of a Bachelor in Life and Earth Sciences - Biochemistry from the USJ Faculty of Science, or any other degree deemed equivalent by the USJ Equivalence Commission.
- Admission to the third semester of the Master's program (M3) is open to students who have completed the first year of a Master's program in Biology or Biochemistry considered equivalent by the USJ Equivalence Commission.

## COURSES/CREDITS GRANTED BY EQUIVALENCE

Equivalences are established based on the examination of application files and in correlation with the descriptions of the modules previously validated.

## PROGRAM REQUIREMENTS

**Required courses (120 credits)**
Analysis of the Structure of Macromolecules (3 Cr.), Applied Genetics (3 Cr.), Applied Immunology (4 Cr.), Bioinformatics for Transcriptome Analysis (3 Cr.), Cellular Biochemistry (2 Cr.), Communication (4 Cr.), Computational Biology (2 Cr.), Culture of Animal Cells, Stem Cells and Tissue Engineering (2 Cr.), Data Processing and Analysis (4 Cr.), DNA Metabarcoding (2 Cr.), End-of-Study Project (30 Cr.), Genetic Engineering (4 Cr.), Genome Assembly and Annotation (1 Cr.), Genome Editing (2 Cr.), Human Genetics (2 Cr.), Instrumental Analysis Methods (3 Cr.), Law and Legislation (2 Cr.), Molecular Applications for Forensic Sciences (1 Cr.), Molecular Markers (2 Cr.), Molecular Modeling (2 Cr.), Microbial Engineering (4 Cr.), Neurosciences (3 Cr.), Pharmacology (2 Cr.), Physiopathological Basis of Human Diseases (3 Cr.), Population Genetics and Phylogenetics (4 Cr.), Project Management (4 Cr.), Professional Development (4 Cr.), Protein Engineering and Proteome Analysis (2 Cr.), Python Programming for

Biologists (2 Cr.), Receptors of Innate Immunity and Transduction of Immunological Signals (1 Cr.), Regulation of Gene Expression (2 Cr.), Biology Seminars (1 Cr.), Statistics for Genomics (1 Cr.), Structural Bioinformatics (3 Cr.), Structure of Macromolecules (2 Cr.), Study of the Genome, Epigenome, and Transcriptome Using High-Throughput Approaches (3 Cr.), Technology Transfer (1 Cr.).

## SUGGESTED STUDY PLAN

### Semester 1

| Code | Course Name | Credits |
|---|---|---|
| 048ICTBM1 | Applied Immunology | 4 |
| 048TAMTM1 | Data Processing and Analysis | 4 |
| 048COMTM1 | Communication | 4 |
| 048GGCBM1 | Genetic Engineering | 4 |
| 048DRLTM1 | Law and Legislation | 2 |
| 048GMCBM1 | Microbial Engineering | 4 |
| 048MMCBM1 | Molecular Markers | 2 |
| 048POCBM1 | Pharmacology | 2 |
| 048PYCBM1 | Python Programming for Biologists | 2 |
| 048SMCBM1 | Structure of Macromolecules | 2 |
| | **Total** | **30** |
| 048CARCM1* | Communication in the Arabic Language | 2 |

* Refresher course for students joining the Master's program halfway through.

### Semester 2

| Code | Course Name | Credits |
|---|---|---|
| 048ASCBM2 | Analysis of Macromolecular Structure | 3 |
| 048GACBM2 | Applied Genetics | 3 |
| 048BCCBM2 | Cellular Biochemistry | 2 |
| 048BTCBM2 | Genome Assembly and Annotation | 1 |
| 048AINCM2 | Instrumental Analysis Methods | 3 |
| 048NECBM2 | Neurosciences | 3 |
| 048BMCBM2 | Physiopathological Basis of Human Diseases | 3 |
| 048PVPTM2 | Professional Development | 4 |
| 048PRMTM2 | Project Management | 4 |
| 048GPCBM2 | Population Genetics and Phylogenetics | 4 |
| | **Total** | **30** |

### Semester 3

| Code | Course Name | Credits |
|---|---|---|
| 048BATCM3 | Bioinformatics for Transcriptome Analysis | 3 |
| 048COCBM3 | Computational Biology | 2 |
| 048CCCBM3 | Culture of Animal Cells, Stem Cells and Tissue Engineering | 2 |
| 048DNAMM3 | DNA Metabarcoding | 2 |

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|---|---|---|
| 048MGCBM3 | Genome Editing | 2 |
| 048GHCBM3 | Human Genetics | 2 |
| 048MFCBM3 | Molecular Applications for Forensic Sciences | 1 |
| 048MMOBM3 | Molecular Modeling | 2 |
| 048IPCBM3 | Protein Engineering and Proteome Analysis | 2 |
| 048RICBM3 | Receptors of Innate Immunity and Transduction of Immunological Signals | 1 |
| 048RGCBM3 | Regulation of Gene Expression | 2 |
| 048SASBM3 | Biology Seminars | 1 |
| 048SGCBM3 | Statistics for Genomics | 1 |
| 048BSCBM3 | Structural Bioinformatics | 3 |
| 048NGCBM3 | Study of the Genome, Epigenome, and Transcriptome Using High-Throughput Approaches | 3 |
| 048TETBM3 | Technology Transfer | 1 |
| | **Total** | **30** |

**Semester 4**

| Code | Course Name | Credits |
|---|---|---|
| 048PFETM4 | End-of-Study Project | 30 |
| | **Total** | **30** |

## COURSE DESCRIPTION

**048ICTBM1 Applied Immunology 4 Cr.**

This course aims to present and discuss pathologies related to dysfunction or overactivation of the immune system. Specifically, the course covers hypersensitivity reactions, chronic inflammation, autoimmune diseases, graft rejection, immunodeficiencies, and tumor development. It also includes techniques used in immunology research and practical sessions where students learn to manipulate mice – the most commonly used animal model in preclinical research. Practical sessions cover vaccination methods, identification of primary and secondary lymphoid organs, and isolation of their cells. These sessions are used to implement experimental protocols such as ELISA and ELISPOT assays. By the end of this course, students will be capable of analyzing and interpreting experimental results in immunology.

**048TAMTM1 Data Processing and Analysis 4 Cr.**

This course is structured around two main components:

- The first component, "Statistics", provides an introduction to statistical methods applied to biology, with practical exercises using software (SPSS). It covers the essential steps of data analysis, from dataset preparation to the main modeling techniques. The course is presented in a biologist-friendly language, minimizing the use of complex mathematical formulas. Emphasis is placed on the practical application of methods, illustrated with numerous examples from biological research, particularly addressing OMICs-related issues.
- The second component, "Multivariate Analysis", aims to equip students with the skills required to use statistical tools to extract information and generate new knowledge from complex datasets obtained via analytical methods or other sources. Students will learn to analyze multiple explanatory variables simultaneously and to build multivariate models that can describe, compare, classify, and predict the characteristics of sample populations. Multivariate analysis is widely applied across science, engineering, pharmacology, medicine, economics, and sociology.

**048COMTM1 Communication 4 Cr.**

This course covers oral and written communication. It presents oral communication as the most frequent form of interpersonal exchange and the foundation for effective teamwork and collaboration. It addresses expressing ideas, listening and asking questions, maintaining relational exchanges, and providing feedback.
The course also explains the importance of effective written communication in enhancing an organization's image. It introduces key organizational communication situations, including memos, reports, summaries, letters, and other internal messages. Students will learn essential techniques for drafting professional documents, from resumes and cover letters to job application emails and unsolicited applications, and will gain a clear understanding of the appropriate vocabulary for each situation.

**048CARCM1 Communication in the Arabic Language 2 Cr.**

This course covers oral communication as the most frequent form of interpersonal exchange and the foundation for effective teamwork and collaboration. It addresses expressing ideas, listening and asking questions, maintaining relational exchanges, and providing feedback.

**048GGCBM1 Genetic Engineering 4 Cr.**

This course aims to present various techniques developed for the manipulation of nucleic acids. Specifically, it details tools and methods for nucleic acid isolation, cloning, sequencing, directed gene mutation, as well as gene expression in heterologous hosts, and production and purification of recombinant proteins. By the end of this course, students will master molecular biology techniques essential for understanding and utilizing gene function, along with their practical applications.

**048DRLTM1 Law and Legislation 2 Cr.**

This course is divided into two parts: The first part aims to define intellectual property, which encompasses all exclusive rights granted for intellectual creations: legal rights to an idea, invention, or creation in industrial, scientific, literary, and artistic domains. The objective is to present the interests and advantages of such a concept before detailing the procedures for registering inventions or products.
The second part aims to provide students with the set of rules governing interactions with citizens. It covers consumer law, business law, social law, labor law, as well as environmental law. These rules are codified, and students must be able to identify texts related to each domain to navigate them. It includes:

1. International environmental law and its application in Lebanon
2. Labor law
3. Social security law
4. Commercial law
5. Company law and industrial law.

**048GMCBM1 Microbial Engineering 4 Cr.**

The course introduces the rapid evolution and plasticity of bacterial genomes and their implications in bacterial virulence. Topics covered include bacterial conjugation and transformation, bacteriophage genetics, mechanisms of homologous and non-homologous recombination, transposable genetic elements, quorum sensing and its role in bacterial pathogenicity, two-component systems, methods for studying bacterial metabolism (isolation of auxotrophic mutants and syntrophy tests), mutagenesis in bacteria, methods for culture and preservation of microbial strains, and various applications of microbial genetics such as industrial production of enzymes, vitamins, amino acids, and biopesticides. This course includes both lectures and practical sessions in the laboratory.

**048MMCBM1 Molecular Markers 2 Cr.**

This course is dedicated to the exploration and utilization of DNA sequences as fundamental tools to uncover genetic diversity. Specifically, students will compare various techniques used for the detection and characterization of these markers, evaluating their advantages and limitations. The advancements in these techniques and their applications are discussed in various contexts, including the characterization of genetic resources, forensic sciences, phylogenetics, and evolutionary biology.

**048POCBM1 Pharmacology 2 Cr.**

This course aims to provide students with a rational understanding of the fundamentals of drug therapy. Specifically, it aims to:

- Present the various stages of drug development in the pharmaceutical industry.
- Provide essential knowledge regarding the main classes, formulations, and routes of administration of drugs.
- Develop a reasoned approach to drug pharmacology, encompassing pharmacodynamics, pharmacokinetics, and pharmacovigilance.

**048PYCBM1 Python Programming for Biologists 2 Cr.**

This course is designed to equip students with the essential tools for program development, recognizing the relevance of programming across various scientific fields. It is particularly crucial for students aspiring to pursue careers or engage in research in bioinformatics. The primary focus is on Python, a high-level general-purpose programming language. By the end of this course, students will be proficient in utilizing Python for programming tasks, demonstrating real-world application skills, and preparing for advanced topics.

**048SMCBM1 Structure of Macromolecules 2 Cr.**

This course aims to train students in the fundamental principles of structural biology and bioenergetics. It is designed to enable them to identify and characterize the four major classes of biological macromolecules, with a particular emphasis on proteins, their three-dimensional structures, biological functions, and molecular engineering. The course also provides an in-depth introduction to proteomics and the analysis of macromolecular interactions, including protein–DNA and protein–ligand interactions, addressing the conformational, energetic, and affinity aspects of these interactions.

The knowledge acquired serves as a fundamental pillar for understanding the molecular architecture of living systems and for studying pathologies associated with protein dysfunctions, thereby paving the way for the development of novel therapeutic strategies.

**048ASCBM2 Analysis of Macromolecular Structure 3 Cr.**

This course aims to train students in the main techniques of structural biology, with a particular focus on spectroscopic approaches used to explore the structure of biological macromolecules, especially proteins. Understanding and mastering the theoretical principles of these methods, as well as interpreting the resulting experimental data, enable students to analyze macromolecular conformations, relate structure to function, study protein–ligand interactions, and determine interaction affinities and energies, in order to assess their biological significance and apply them in various molecular biology and biochemistry contexts.

**048GACBM2 Applied Genetics 3 Cr.**

This course aims to develop the competencies required for implementing genetic-based research strategies. Using *Drosophila melanogaster* as a model, the course covers various strategies used for characterizing gene function. Specifically, this course addresses methodologies for generating mutant and transgenic lines, mapping mutations and silencing genes through RNA interference (RNAi).

**048BCCBM2 Cellular Biochemistry 2 Cr.**

This course provides students with important information on the general structure of proteins and cell membranes, with specific aspects concerning glycoproteins, membrane-associated proteins, and protein structure predictions. The translocation of proteins within various cellular compartments, the biochemistry of cellular communications, and their regulation are also discussed. Protein denaturation, renaturation, and their impacts on cellular functionality are examined. The affinity and specificity of molecular interactions are analyzed within the context of studying the structure-function relationship of biological macromolecules. Biochemical and spectroscopic approaches to studying molecular interactions are highlighted. Finally, protein splicing is addressed as a novel tool in applied biotechnology.

**048BTCBM2 Genome Assembly and Annotation 1 Cr.**

This course aims to introduce students to various genome analysis tools and applications, with a focus on genome assembly and annotation. Students will be invited to a hands-on application of, first, *de novo* genome assembly using Galaxy Tools, and second, genome annotation. Students will apply bioinformatic tools to annotate DNA sequences, interpret the resulting GenBank format, and analyze the detected proteins through database similarity searches, alignments and phylogenetic tree inference.

**048AINCM2 Instrumental Analysis Methods 3 Cr.**

This course provides theoretical and practical knowledge that, when supplemented with appropriate internships, enables students to use Nuclear Magnetic Resonance spectroscopy (NMR), Mass Spectrometry (MS), Infrared Spectroscopy (IR), UV/VIS spectroscopy, Atomic Absorption Spectroscopy, and separation techniques to address problems at the interface of chemistry and biology. These are powerful analytical techniques for elucidating molecular structures and conformations. Various applications, particularly focusing on protein characterization, are discussed to familiarize students with these techniques and underscore their importance. Practical sessions focus on refining experimental skills for sample analysis.

**048NECBM2 Neurosciences 3 Cr.**

This course builds upon molecular and cellular biology to explore how genes, signaling molecules, and different cell types influence the function of the nervous system. This integrative approach enhances understanding of the processes underlying behaviors, emotions, and cognition in both animals and humans.
The introduction presents various animal models and experimental techniques used in neuroscience, reviewing basic anatomical and physiological concepts at the level of neurons, synapses, and glial cells. A second part focuses on electrophysiology, detailing ion channels involved in membrane potentials and the electrophysiological characteristics of synaptic transmission.
Regarding complex brain functions, the course primarily addresses nociceptive sensation, sexual development, as well as learning and memory. Throughout, the course maintains an integrative perspective, linking genes to behavior. Finally, the last part of the course delves into common neurodegenerative diseases, touching upon neuro-inflammatory responses, neuronal repair, neurogenesis, and current therapeutic advances in neuronal stem cells.

**048BMCBM2 Physiopathological Basis of Human Diseases 3 Cr.**

This course describes and analyzes, at the cellular and molecular levels, both the mechanisms involved in the dysregulation of homeostasis and those involved in the various responses of the body to stress of organic origin, with a particular emphasis on the cardiovascular, nervous, renal, and muscular systems.

**048PVPTM2 Professional Development 4 Cr.**

This course offers students a first experience in a research laboratory. During a short-term internship, students will actively participate in a research project under the supervision of an experienced researcher. They will conduct comprehensive literature reviews related to their project, plan and execute at least one experiment, and analyze and interpret the obtained results. At the end of the internship, students will prepare a comprehensive report detailing their work, and deliver an oral presentation to a panel of faculty researchers, discussing their findings and future perspectives. This course enhances skills in problem-solving, critical analysis, and scientific communication, which are essential for a successful career in scientific research.

**048PRMTM2 Project Management 4 Cr.**

This course is designed to equip students with the skills and knowledge necessary to effectively plan, execute, and manage projects across various disciplines. Through a combination of theoretical concepts and practical applications, students will learn how to navigate the complexities of project management, from start to finish.

**048GPCBM2 Population Genetics and Phylogenetics 4 Cr.**

This course covers population genetics and phylogenetics. It presents population genetics as the study of processes that influence genetic variability and differentiation within populations, forming the foundation of evolution. It addresses calculating allele, genotype, and phenotype frequencies, and the effects of mutations, migrations, deviations from panmixia, genetic drift, and selection on these frequencies.
Students will understand the processes affecting population variability and will apply key models and estimators. The course also presents phylogenetics as the study of relationships among related species. Students will grasp the concept of species, principles of phylogenetic reconstruction, and the interpretation of phylogenies, and will understand the links between evolutionary history, ecology, biogeography, biodiversity, and speciation.

**048BATCM3 Bioinformatics for Transcriptome Analysis 3 Cr.**

This course covers the following topics: Spatial and bulk transcriptomics approaches - Genome structure and analysis - Gene expression and transcriptional regulation - Programming with R - Development of workflows with Galaxy.

**048COCBM3 Computational Biology 2 Cr.**

This course covers the following topics: Computational analysis of cis-regulatory regions using the RSAT software suite - Impact of DNA methylation on transcriptional regulation networks with software demonstrations - Logical modeling of cellular regulatory networks using the GINsim software suite - Transitioning from molecular data to models for personalized cancer treatments.

**048CCCBM3 Culture of Animal Cells, Stem Cells and Tissue Engineering 2 Cr.**

This course explores the theory and various techniques of cell culture, covering the culture of normal cells, cell lines, spontaneously immortalized cells, and genetically engineered immortalized cells, as well as addressing different types of stem cells. It also discusses best practices for isolation and culture of animal cells, along with specific culture requirements for each cell type. Additionally, it examines the co-culture of different cell types, 3D cultures, and their applications in various medical settings.

**048DNAMM3 DNA Metabarcoding 2 Cr.**

This course presents metabarcoding as a rapid method for assessing biodiversity by combining DNA-based identification with high-throughput DNA sequencing. It covers the use of environmental DNA (eDNA) from sediments, soils, water, and other sources, with applications in biodiversity monitoring, animal diet analysis, reconstruction of paleocommunities, and more.
The course explains the bioinformatics and biostatistics skills required to analyze sequencing results. It covers field sampling techniques and laboratory experiments, focusing on sedimentary DNA, diet analysis, paleo-DNA studies, and microbial community metagenomics. Students will gain fundamental knowledge and skills to apply metabarcoding to eDNA and will deepen their understanding of eDNA applications in molecular ecology through lectures and data analyses.

**048MGCBM3 Genome Editing 2 Cr.**

This course provides an overview of the genome editing techniques with a special focus on the CRISPR Cas9 method that is revolutionizing our way of modifying the genome. Hands-on sessions enable students to design their own experiments using different web tools.

**048GHCBM3 Human Genetics 2 Cr.**

This course covers the fundamental basics of human genetics, drawing on various examples of human pathologies.

**048MFCBM3 Molecular Applications for Forensic Sciences 1 Cr.**

This course highlights the importance of genetic testing using DNA and its wide applicability to the forensic field. It tackles using DNA for: identifying suspects and confirmation of guilt, exculpation of innocent parties; linking crimes and helping in uncovering serial killers; researching biological filiation, establishing consanguinity in more complex cases, identification of victims of terrorist attacks or natural catastrophes, etc.

**048MMOBM3 Molecular Modeling 2 Cr.**

This course aims to provide M2 students with a solid theoretical and methodological foundation for the selection, application, and rigorous interpretation of advanced computational tools — including quantum mechanics/molecular mechanics (QM/MM), molecular dynamics (MD), and molecular docking — as applied to complex biological systems such as proteins, DNA, RNA, and in silico drug design.
It is designed to align with the specialized training profile in analytical, modeling, and statistical approaches within the fields of genomics and proteomics.

**048IPCBM3 Protein Engineering and Proteome Analysis 2 Cr.**

The course aims to address modern concepts of the "druggable genome/proteome" and emphasizes enzymatic examples of drug targets. It specifically tackles two examples involving the discovery and development of drugs targeting enzymes (ACE and PDE5).
On the scale of the human genome, a limited number of genes encode enzymatic systems for metabolizing xenobiotics. Describing phases 1, 2, and 3 of xenobiotic metabolism and their function helps understand how these systems cope with the vast chemical diversity of molecules comprising the exposome.
These elements provide insights into factors impacting the toxicity of xenobiotics and/or the efficacy of drug treatments on individual bases. Concepts of pharmacogenomics of xenobiotic metabolism enzymes (XMEs) linked to genetic polymorphisms or mechanisms regulating the expression or activity of these systems is explored. These mechanisms include describing various transcription factors involved in regulating these genes in response to environmental factors, enabling an adaptive response to such exposures.
Inverted teaching methods allow students to present recent examples of enzymatic therapeutic targets in seminar-discussion format. These seminars enable students, among others, to become familiar with scientific communication and exchange.

**048RICBM3 Receptors of Innate Immunity and Transduction of Immunological Signals 1 Cr.**

The course focuses on the mechanisms of activation of the innate immune system, which in turn enables the activation and orientation of the ensuing adaptive immune response in vertebrates. It covers the various families of receptors and their respective ligands, the signaling pathways they activate, and the effector mechanisms they induce. The involvement of these sensing and signaling mechanisms in human pathologies, as well as in the development of new therapeutic strategies, is also discussed.

**048RGCBM3 Regulation of Gene Expression 2 Cr.**

This course delves into the field of regulation of gene expression. It essentially discusses the mechanisms underlying epigenetics, transcriptional and post-transcriptional modes of regulation. This course also allows students to become familiar with the key elements of protein-protein interactions. These play a key role in regulating the activity of several cellular proteins. This course illustrates the different motifs of protein-protein interactions with a special focus on the methods used for their identification. HIV integrase that catalyzes the integration of viral DNA into the genome of the infected cell is used as a model to explain these molecular interactions.

**048SASBM3 Biology Seminars 1 Cr.**

The Functional Genomics and Proteomics Master's program aims to provide comprehensive training focused on scientific research. Seminars on current research in biology are pivotal for developing the skills emphasized in the curriculum. These seminars facilitate direct interaction between students and researchers from diverse areas of biology and biochemistry, where researchers present their projects and discuss their findings. Following these presentations, interactive discussion sessions encourage students to question and gain insights into the challenges encountered during research. Exposure to a variety of research strategies and discussions on different technologies equips students with the critical skills needed to effectively conceive and execute research projects. These sessions not only deepen their understanding of contemporary research methods but also prepare them to adeptly maneuver through the complexities of scientific inquiry with confidence and proficiency.

**048SGCBM3 Statistics for Genomics 1 Cr.**

This course offers an introduction to continuous probability distributions and their use in the context of genomics. After reviewing the fundamental concepts of probability and statistics, students will learn to use statistical tests such as the Student's T-test and one-way ANOVA, as well as two-way ANOVA if time permits. The course concludes with a practical session, where students will analyze proteomic data from cancers (breast and glioblastoma) available in the TCGA database.

**048BSCBM3 Structural Bioinformatics 3 Cr.**

This course presents the impact of high-throughput sequencing on protein databases, where the number of available protein sequences now exceeds $10^9$. It explains that these sequences, involved in diverse biological functions, are typically annotated by analogy and are often poorly characterized.
This course explores the importance of understanding primary sequences and accessing major databases. It emphasizes the distinction between bioinformatics and computational biology, and provides examples of sequence alignments and analysis tools.
Protein function is directly influenced by their three-dimensional structures, which elucidate the mechanisms underlying these functions. Unfortunately, due to high costs and technical challenges, the number of available 3D structures (http://www.rcsb.org/pdb/home/home.do) is limited, standing at only 175,602 as of October 2, 2020. Therefore, bioinformatics enables the transition from amino acid sequences to 3D structural models, advancing both fundamental and applied research.
Secondly, the course addresses available structural data and discusses approaches such as (i) comparative modeling (homology), (ii) machine learning techniques, (iii) ab initio methods, and (iv) de novo or meta-server approaches, depending on the complexity of the research.
Throughout the course, these topics are illustrated with examples from literature and the instructor's research. Students will engage in two practical sessions, where they will learn (i) how to search for sequences with sequence similarities, and (ii) how to use online tools for proposing high-quality structural models and evaluating them.

**048NGCBM3 Study of the Genome, Epigenome, and Transcriptome Using High-Throughput Approaches 3 Cr.**

This course covers the following topics: High-throughput sequencing approaches - Single-cell approaches - Genome and epigenome structure and analysis - Gene expression and transcriptional regulation.

**048TETBM3 Technology Transfer 1 Cr.**

This course aims to familiarize students with the principles, stakeholders, and mechanisms of technology transfer from academic research to the socio-economic sector.
It covers key concepts such as intellectual property, research valorization, patents, startup creation, and industry partnerships, with a focus on the strategic role of Technology Transfer Offices (TTOs) in translating scientific results into practical innovations.

**048PFETM4 End-of-Study Project 30 Cr.**

The end-of-study year project is based on a 4 to 7-month internship in industry or a research laboratory. At the end of this internship, students will prepare a comprehensive report detailing their work, and deliver an oral presentation to a panel of faculty researchers and representatives from the professional sectors, discussing their findings and future perspectives.