



Study Plan

School: School of Sciences and Technology

Degree: Master

Course: Biochemistry (cód. 724)

1st Year - 1st Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
QUI10252M	Stress and Cellular Death	Biochemistry	6	Semester	156
QUI13551M	Bioinformatics Laboratories	Biochemistry	3	Semester	78
QUI13574M	Advanced Methods in Biochemistry	Biochemistry	6	Semester	156
FIL10250M	Ethics of Scientific and Technological Research in Life Sciences	Philosophy	3	Semester	78

Group of Options

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
QUI13661M	Molecular Mechanisms of Disease	Biochemistry	6	Semester	156
MVT13558M	Clinical Microbiology	Veterinary Medicine	6	Semester	156
QUI13655M	Microbiology of Fermentations	Biochemistry	6	Semester	156
QUI13571M	Industrial Biochemistry	Biochemistry	6	Semester	156
QUI13553M	Biochemical Simulations	Biochemistry	3	Semester	78
QUI13550M	Pharmaceutical Chemistry	Chemistry	6	Semester	156
QUI13654M	Quality Control	Chemistry	6	Semester	156
QUI13569M	Biotechnology Applied to Heritage	Biochemistry	3	Semester	78
GES13662M	Laboratory of Transdisciplinary Innovation and Entrepreneurship	Design Management	3	Semester	78
QUI02599M	Biomaterials	Chemistry	3	Semester	78
QUI13659M	Clinical Biochemistry	Biochemistry	6	Semester	156
CMS13554M	Biochemical Pharmacology	Biochemistry	6	Semester	156
QUI13552M	Toxicology of most relevant pollutants	Biochemistry	3	Semester	78
CMS11889M	Immunity and Environment	Biochemistry	3	Semester	78
QUI13660M	Food Biochemistry and Processing	Biochemistry	3	Semester	78
MVT12323I	Animal Models in Research	Veterinary Medicine	3	Semester	78
QUI13572M	Bioreactors	Biochemistry	6	Semester	156
QUI13570M	Bioremediation	Biochemistry	3	Semester	78



1st Year - 2nd Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
QUI13647M	Biochemistry and Molecular Biotechnology	Biochemistry	6	Semester	156
QUI13586M	Research Methodologies in Biochemistry	Biochemistry	3	Semester	78
QUI13646M	Research Topics in Biochemistry	Biochemistry	3	Semester	78

Group of Options

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QUI13661M	Molecular Mechanisms of Disease	Biochemistry	6	Semester	156
MVT13558M	Clinical Microbiology	Veterinary Medicine	6	Semester	156
QUI13655M	Microbiology of Fermentations	Biochemistry	6	Semester	156
QUI13571M	Industrial Biochemistry	Biochemistry	6	Semester	156
QUI13553M	Biochemical Simulations	Biochemistry	3	Semester	78
QUI13550M	Pharmaceutical Chemistry	Chemistry	6	Semester	156
QUI13654M	Quality Control	Chemistry	6	Semester	156
QUI13569M	Biotechnology Applied to Heritage	Biochemistry	3	Semester	78
GES13662M	Laboratory of Transdisciplinary Innovation and Entrepreneurship	Design Management	3	Semester	78
QUI02599M	Biomaterials	Chemistry	3	Semester	78
QUI13659M	Clinical Biochemistry	Biochemistry	6	Semester	156
CMS13554M	Biochemical Pharmacology	Biochemistry	6	Semester	156
QUI13552M	Toxicology of most relevant pollutants	Biochemistry	3	Semester	78
CMS11889M	Immunity and Environment	Biochemistry	3	Semester	78
QUI13660M	Food Biochemistry and Processing	Biochemistry	3	Semester	78
MVT12323I	Animal Models in Research	Veterinary Medicine	3	Semester	78
QUI13572M	Bioreactors	Biochemistry	6	Semester	156
QUI13570M	Bioremediation	Biochemistry	3	Semester	78

2nd Year - 3rd Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
QUI13656M	Seminars in Biochemistry	Biochemistry	3	Year	78
Dissertation					
Project Work					
Internship					



2nd Year - 4th Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
	Dissertation				
	Project Work				
	Internship				

Conditions for obtaining the Degree:

*** TRANSLATE ME: Para aprovação na componente curricular deste Mestrado, é necessário a aprovação (através de avaliação ou creditação) das seguintes unidades curriculares:

1.º Ano

1.º Semestre { \ } newLine

- 4 UC Obrigatórias num total de 18 ECTS

- 2 UC Optativa num total de 12 ECTS

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2.º Semestre { \ } newLine

- 3 UC Obrigatórias num total de 12 ECTS

- 3 UC Optativa num total de 18 ECTS

2.º Ano

{ \ } newLine

3.º Semestre { \ } newLine

- 1 UC Obrigatórias num total de 3 ECTS { \ } newLine

- { \ } newLine

Para obtenção do grau, é necessário também a aprovação em Dissertação/Estágio/Trabalho de Projeto, com o total de 57 ECTS, no 3.º e 4.º Semestre. ***

Program Contents

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Stress and Cellular Death (QUI10252M)

1. Oxygen is a toxic gas. 2. Cell processes implicated in ROS formation and RNS. 3. Model organisms used in stress studies. 4. Reactive species with biochemical importance, transition metals, sulphur, hydroxyl, superoxide, peroxy, alkoxyl and nitric oxide. 5. Non-radicals reactive species, hydrogen peroxide, hypochlorous acid, singlet oxygen and peroxynitrite. 6. Enzymatic and non-enzymatic antioxidants mechanisms. 7. Oxidative stress, adaptation, damages, repair and death. Detection of free radicals and other reactive species. 9. Biotransformation and stress. 10. Reactive species, inflammatory states, aging, nutrition, pathologies and therapy.

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Bioinformatics Laboratories (QUI13551M)

1. Historical perspective of Bioinformatics.
2. Data bases and SRS.
3. Algorithms for sequences alignment
4. Sequences search. Motifs, profile and domains.
5. Servers and tools for genome analysis.
6. Genes and regulator sequences identification.
7. Analysis of biochips.
8. Phylogenetic analysis.
9. Genome and cancer, from genotype to phenotype.
10. Three-dimensional structure of proteins. Mono and three-dimensional alignments.
11. Structural data Bases. The Protein Data Bank. The format of type files .pdb.
12. Protein modelling by homology. Modelling by homology based on Web.



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Advanced Methods in Biochemistry (QUI13574M)

Immunochemical methods - concepts and applications: Antibodies and antigens; Antibody production; Detection and quantification of biomolecules by antibody-based techniques; Diagnostic applications; therapeutic applications of monoclonal antibodies.

Chromatographic Methods - Basic concepts and applications of chromatographic methods in the area of Biochemistry (Review); Hyphenated chromatographic analytical techniques; Use of chromatographic methods for the detection of compounds with biochemical interest.

Electrochemical methods - relevance in the context of contemporary biochemistry; Fundamental concepts, material, instrumentation and essential equipment; Techniques of species analysis with biochemical interest and development / electrochemical characterization of biochemical systems; Applications: electrochemical biosensors, biofuel cells, electrosynthesis and electroremediation, and electrical monitoring techniques of cell culture media.

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Ethics of Scientific and Technological Research in Life Sciences (FIL10250M)

1. The axiological dimensions of the Life Sciences' scientific and technological research;
2. the main lines of scientific and technological progress in life sciences; the importance of technology and techno science;
3. Techno science and the manipulation of human nature: the emerging bioethical issues;
4. In search of a reliable criterion of decision: the human nature;
5. Major theoretical models in bioethics:
6. The concepts of Freedom, Autonomy, Dignity of the Human Person and their use in bioethics.
7. Social, economic and political ethics of Scientific and Technological Research in Life Sciences.
8. The legal framework, at international, European and national level, for the ethics of scientific research, particularly in the Life Sciences. Rules, regulations and protocols. The functioning of ethics committees and research authorization requests. The deontology of scientific research.
9. Practical cases.

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Molecular Mechanisms of Disease (QUI13661M)

The program addresses the biological, biochemical and molecular genetics processes in chronic noncommunicable diseases and current models for their research, focusing on changes in signaling and regulation mechanisms at the cellular and molecular level, aiming at an integrated perspective of biochemistry in pathophysiology and its repercussions on the organism.

Contents to develop:

Aging and its relationship to non-communicable chronic diseases;
Biochemistry of metabolic diseases, particularly, the various forms of diabetes, dyslipidemias and their relationship to obesity;
Relevant biological and biochemical processes in inflammatory hypersensitivity diseases (Allergies);
Biology of cancer, cellular and molecular changes in oncological disease;
Risk factors and influence of the internal and external environment on the development of the referred non-communicable diseases;
Therapeutic approaches: challenges and opportunities.



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Clinical Microbiology (MVT13558M)

Theoretical program:

- 1 - The Clinical Analysis Laboratory
- 2 - Selection, collection, transport and processing of clinical samples for microbiological analysis.
- 3 - Sterilization, pasteurization, disinfection and asepsis.
- 4 - Antimicrobial agents.
- 5 - Laboratory diagnosis of infectious diseases.
- 6 - Clinical bacteriology: classification, morphology and physiology.
- 7 - Clinical Mycology: morphology and general biology. Immunity and chemotherapy of fungal infections.
- 8 - Clinical Virology: viral structure and classification of viruses. Diagnosis, pathogenesis, prevention and control.
- 9 - Protozoa and helminths of clinical importance.

Practical program:

Bacteriological examination: Isolation and identification of aerobic and anaerobic bacteria.

Antimicrobial susceptibility test.

Molecular diagnostic techniques.

Mycological analyzes.

Serological diagnosis.

Virological diagnosis.

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Microbiology of Fermentations (QUI13655M)

Microbiology Overview of fermentation processes. Microorganisms of interest in fermentation processes. Importance of Microorganisms on the quality of wines. The wine microorganisms and their natural habitat. Microbial growth. Controlling factors. Measures of microbial growth. Microorganisms of winemaking interest: biochemical, morphological and genetic differences. Nutrition and culture media. Cellular transport of nutrients. Principles of microbial metabolism. The transformation of must into wine. Alcoholic fermentation. Biochemistry of fermentation. Malolactic fermentation. Bioconversion of malic acid. Biochemistry and physiology of the malolactic fermentation. Winemaking, mixed populations: growth and kinetics. Application of starters. Microorganisms of wine spoilage.

Practical: Isolation of microorganisms from a spontaneous fermentation of grape juice. Characterization of the performance of a yeast strain during grape fermentation.



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Industrial Biochemistry (QUI13571M)

- 1 Introduction to Industrial Biochemistry
 - 1.1 Definition, concepts and historical outlook
 - 1.2 Elements of bioprocesses: raw materials, biological agents and products
 - 1.3 Applications of the principles of microbiology, genetics, biochemistry and molecular biology, and engineering
 - 1.4 Present and future of Industrial Biochemistry
- 2 Introduction to Industrial Microbiology
 - 2.1 Microorganisms of industrial interest
 - 2.2 Isolation, identification and selection of microorganisms of industrial interest
 - 2.3 Production of primary and secondary metabolites with industrial interest
- 3 Enzymes and enzymatic reactions of industrial interest
 - 3.1 Industrial production of enzymes
 - 3.2 Concepts of biotransformation, biocatalysts and immobilized biocatalysts
- 4 Introduction to Bioprocesses
 - 4.1 Growth media for industrial use
 - 4.2 Sterilization
 - 4.3 Industrial fermentations
 - 4.4 Bioseparations
 - 4.5 Control and operation parameters
- 5 Areas of application of bioprocesses
- 6 Safety and regulations in Biotechnology

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Biochemical Simulations (QUI13553M)

1. Introduction to molecular dynamics simulations
2. Applications to protein models and cell membrane models.
3. Analysis of simulation results.
4. Analysis of simulation equilibrium.
5. Radial distribution functions.
6. Mechanical properties.
7. Fluctuations.
8. Correlation functions.
9. Dynamical properties.

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Pharmaceutical Chemistry (QUI13550M)

- Introduction to Pharmaceutical Chemistry: object of study and historical perspective. Nomenclature and classification of drugs.
- General cycle of drugs in the body. Chemical and structural properties of compounds and their pharmacokinetics: Absorption, Distribution, Metabolism and Excretion of drugs; prodrugs.
- Drugs and their action: molecular mechanisms of drug action in the main groups of biomolecules. Receptors.
- Qualitative and quantitative structure-activity relationships: SAR, QSAR, 3DQSAR.
- Main sources of drugs. Methods of searching, finding and isolating new drugs. The contribution of Natural Product Chemistry, Combinatorial Chemistry, Computational Chemistry and Chemical Synthesis and Asymmetric Synthesis.
- Development and production of new drugs.
- Study of some drugs: chemical structures, mechanisms of action, structure-activity relationship, pharmacodynamics, pharmacokinetics and applications.
- Preparation, isolation and analysis of drugs.



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Quality Control (QUI13654M)

1. Evolution and quality policies

Quality control in XX century.

Quality policies and objectives.

Total Quality Management.

Six Sigma system.

SPQ subsystems.

Standardization, metrology and qualification. Certification and accreditation of organizations.

2. Quality Tools

The basic quality tools.

Planning and quality management tools.

3. Quality control in a laboratory.

Terminology. Definition of objectives.

Evaluation of deviations.

4. Sampling

Sampling types and quality. COC.

5. Statistics applied to quality

The CEP using control charts.

6. Metrology.

Qualification and calibration.

Patterns and references.

7. The standards, ISO, EN, NP. ISO 9000; ISO 14000. ISO 17025.

8. Principles of hygiene, safety and health at work

OSHAS 18001: implementation of HSST system and HACCP-ISO 22000.

Fundamentals of hygiene and safety. Risk assessment in operation: hazard identification, risk estimation and tolerance. Responsible Care® actuation. Norms on safety, hygiene and health at work. REACH regulation

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Biotechnology Applied to Heritage (QUI13569M)

The biodeterioration of heritage: different ecological niches, material characteristics, monuments and cultural artefacts. Aesthetic damage and / or structural damage of the artworks.

Colonizing microorganisms: the main colonizing agents involved and the various pathologies. Processes for detecting their metabolic activity.

Methodological schemes applied to the study of heritage artefacts: sensitive microanalysis methodologies combined with molecular tools.

Fluorescent in situ hybridization (FISH). Fluorescent probes and most commonly used fluorochromes. Simultaneous detection of two or more targets, detection by microscopic epifluorescence and flow cytometric analysis.

Microbial community dynamics: non-culture dependent methods; metagenomic DNA extraction and next generation sequencing (NGS).

New biotechnological approaches applied to heritage: the role of biochemistry / biotechnology for innovative solutions.



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Laboratory of Transdisciplinary Innovation and Entrepreneurship (GES13662M)

1. Innovation and entrepreneurship
 - 1.1. Innovation and entrepreneurship concepts
 - 1.2. Who are the entrepreneurs?
 - 1.3. The entrepreneurial process
2. Strategic Innovation and Design Thinking
 - 2.1. Strategic Design Principles for Innovation
 - 2.2. Design Thinking Processes
 - 2.3. Business model canvas
 - 2.4. Pitch Presentation Techniques
3. Transdisciplinary Innovation
 - 3.1. Methods and tools of transdisciplinary research
 - 3.2. The concept of co-creation and focus groups;
 - 3.3. Transdisciplinary Innovation as a Process;
 - 3.4. Case Study Analysis.

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Biomaterials (QUI02599M)

Historical introduction to biomaterials.

Introduction to materials science ? types of material (metals, ceramics, polymers, composites), and their properties; methods of mechanical, structural and superficial characterisation.

Fundamentals of biomaterials ? types of material (Ti, alloys, amalgams, calcium phosphates, carbon, polyHEMA, UHMWPE, PMMA, PEG/PEO, PLA/PGA, PTFE, bisGMA, ionomers, silicones, chitosan, collagen, others); hydrogels; tissue engineering scaffolds; surface films.

Tissue-biomaterial interaction ? biofilm; protein adsorption; biocompatibility; toxicology; osseointegration; degradation.

Applications ? joint and bone replacement, cardiovascular implants, tendon and ligament replacement, contact lens, orthodontology, controlled drug release. Biosensors. Ethics and future perspectives.

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Clinical Biochemistry (QUI13659M)

Basic concepts in Clinical Biochemistry. The problematic of a Clinical Biochemistry Lab. Biological specimens. Collection and handling of biological samples. Quality control. Techniques and methods of analysis used individually or in automatic analysers. Reference values and their clinical significance.

Physiology and pathophysiology of several organs and systems. Biochemical markers. Plasmatic proteins. Nutritional markers. Liver, function and main disorders. Serum enzymes markers on hepatic disease, acute myocardial infarction, pancreatic and muscular disease. Plasmatic lipoproteins, metabolic disorders and risk of cardiovascular disease. Carbohydrate metabolism and glucose homeostasis. Diabetes mellitus. Hypoglycemia and inborn errors of carbohydrate metabolism. Renal function and electrolytes balance. Endocrine function and hormonal disorders. Tumoral markers. Data analysis in Clinical Biochemistry. Interpretation of case studies.



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Biochemical Pharmacology (CMS13554M)

Introduction

Historical Review

Nature as a source of medicines

Part I

Pharmacokinetics

Pharmacodynamics

Pharmacological action and effect

Drug-receptor, ligand-receptor and pharmacodynamic interactions

Increased or decreased effects due to drug action mechanisms

Transduction signals

Effect of drugs

Quantification of the effect of drugs

Quantification of reversible and irreversible effects

Quantitative pharmacodynamic models

Maximum effect and potency of a drug

Effect of agonist and antagonist drugs

Individual variations of drug response

Part II

Drug classes

Drugs that act on synapses and neuroeffective junctions and acting on the central nervous system

Autacoids

Drugs that affect renal and cardiovascular functions and gastrointestinal function

Anti-microbial and anti-parasitic chemotherapy

Chemotherapy of neoplastic diseases

Immunomodulators

Drugs acting on blood and hematopoietic organs

Hormones and their antagonists.

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Toxicology of most relevant pollutants (QUI13552M)

1. Origin, distribution and persistence of pollutants with toxicological relevance.

2. Toxicity of pollutants on individuals, populations and communities.

3. Methods for assessing the toxicity of pollutants.

4. Routes, methods of exposure and toxicity factors supporting cast.

5. Principles for assessment of toxic hazards. Markers of exposure and toxicity.

6. Biological mechanisms of response and adaptation.

7. Integration of knowledge from the molecular to the global level, the individual to the ecosystem.



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Immunity and Environment (CMS11889M)

I – Fundamental Mechanisms in Immunity:

- Cells from the immune system;
- Mediators and antibodies;

II – Environment and immune system Interactions:

- Mechanisms of Hypersensitivity – allergic disease;
- Allergens – Structure and function;
- Allergens and cross reactions;
- Allergenicity mechanisms of allergens;
- Air pollutants (indoor and outdoor) and hypersensitivity reactions;

III – Environmental allergens:

- Acari, animal epithelia, fungal spores and pollen
- Sampling methodologies and techniques for detection, quantification and monitoring;
- Exposures and health impacts – risk assessment;
- Environmental risk factors – climate change and geographical factors;
- Risk prevention and forecast;

IV - Common Allergic Diseases

V - Occupational and Environmental Allergy

VI – Other hypersensitivity conditions

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Food Biochemistry and Processing (QUI13660M)

1. Biochemical characterization of foods by analytical and biocatalysis techniques;
2. Red meat, poultry, fish and seafood enzymes, properties and quality impact;
3. Biochemical processing of animal/plant foods;
5. Chemical and enzymatic darkening of fruits, vegetables, cereals and derivatives;
6. Biochemistry of fermented foods;
7. Health/functional foods: probiotics, active peptides, natural pigments; antioxidants
8. Thermal and minimal food processing.
9. Food safety: protein cross-link, allergens, presence of biogenic amines and plant pesticides;
10. Agricultural and livestock strategies for sustainable food production;
11. Proteomics applied to food processing and quality;
12. Profile of structural and stock components, antioxidant and proteolytic enzymes in response to i) production strategies; ii) postmortem/postharvest conservation and iii) food processing.

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Animal Models in Research (MVT12323I)

1-Overall perspective of animals and their utility models; The concept of experimental animal.

2-Bioethics applied to the use of animals for experimental purposes:

Biological foundations of bioethics, ethical aspects relating to animal handling used in educational activities and scientific experimentation, case studies

3-Applicable laws, rules and historical background, ethical and socio-cultural

Selection of standards, maintenance, handling and animal sacrifice model

4. Examples of relevant models:

Use of mice.

Use of small ruminants in the development of biomaterials for orthopaedic and cardiovascular application.

5. Preparation of suitable anaesthetic and analgesic protocols.



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Bioreactors (QUI13572M)

Introduction to bioreactors. Fermenter types: continuous stirred tank reactor; bubble column; expanded bed; fluidized bed; packed bed; Air lift. Operation and performance of bioreactors.

Sterilization. Discontinuous liquid sterilization system. Continuous steam injection system.

Agitation of the culture medium. Factors affecting oxygen transfer. Solubility of oxygen. Factors that affect the transfer of oxygen from the medium to the cell.

Design of different types of homogeneous and heterogeneous bioreactors.

Not ideal reactors.

Case Study.

Anaerobic cultures for biogas production.

Photobioreactors in algal biomass production. Types of systems and technology. Principles of operation. Limiting factors, potentialities and advantages. Productivity and applications.

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Bioremediation (QUI13570M)

1. Introduction to bioremediation processes. Key concepts.

2. Bioremediation of contaminated water and soils. Advantages and disadvantages.

3. Organic and inorganic pollutants. Identification, transport and fate of pollutants in the environment.

4. Accumulation mechanisms of heavy metals and organic compounds.

5. Biological mechanisms of detoxification in microorganisms and plants.

6. Bioremediation technologies (In-situ and Ex-situ).

7. Phytoremediation processes.

7.1. Phytoremediation of contaminated water and soils. Advantages and disadvantages.

7.2. Main processes of pollutant removal/biotransformation.

7.3. Constructed wetlands systems.

8. Case study evaluation.



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Biochemistry and Molecular Biotechnology (QUI13647M)

1. Cloning Strategies
2. Production of recombinant proteins in prokaryotic and eukaryotic systems
3. Protein Engineering
4. Genomics, proteomics, lipidomics and metabolomics
5. Molecular Diagnosis
6. Gene Therapy
7. Drug Design and Drug Targeting
8. Biology and physiology of aging
9. Metabolic Engineering
10. Stem Cells
11. DNA vaccines and RNA therapies;
12. Bio-nanotechnology;
13. Plant molecular improvement
14. Climate change mitigation
15. Biotechnology and terraforming - Mars as a case study.

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Research Methodologies in Biochemistry (QUI13586M)

1. Introduction to Chemometrics. Data treatment and information treatment. Chemometrics and related disciplines in other sciences (Econometrics, Biometrics, etc.).
2. Validation of methodologies for Analytical Biochemistry. Validation of experimental results.
3. Experimental planning and optimization.
4. Cluster analysis, principal components and factors.
5. Quantitative structure-activity relationships (QSARs).
6. Planning of a scientific career: local and international scientific systems. Evaluation by peers.



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Research Topics in Biochemistry (QUI13646M)

1. Biochemistry – History of this science and its importance in today's society;
2. Current perspectives and challenges of biochemistry;
3. Strategies and methodology in the dissemination of scientific work
 - Thesis writing
 - Writing of scientific articles
 - Patent applications.

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Seminars in Biochemistry (QUI13656M)

The work program, as well as its accomplishment, will be defined by the student, under the supervision of their supervisor, including choice of a theme, experimental work planning and presentation of results.

Conferences (conference cycles) organized in diverse topics in the area of Biochemistry annually.