MASTER

CHEM BIO&MAT

CHEMISTRY

at the Interface with

BIOLOGY *and*

MATERIALS Science

BROCHURE 2023/2024

Contact:

master.chembio-mat@usc.es

☎ +34 881 815 746 ☎ +34 881 815 797

More information:

http://masterchembiomat.usc.es

@ChemBio&Mat ChemBioMatMSc

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Welcome letter

Dear Master Students,

With this letter we want to wish you our warmest welcome. We are delighted that you have chosen our master school to continuing with your education and formation. My name is Juan R. Granja and I have the pleasure of serving as the coordinator of this master for the 2023-2024 academic year that is now starting.

The ChemBio&Mat aims to provide the right environment and conditions to allow the best training and skills in several topics of Chemistry, and especially on those at the interface with molecular and cell biology and material science. We trust that with your dedication and effort, this master will open many opportunities for your scientific and/or professional future. One key prerequisite for your academic success is, of course, your own personal engagement. Work hand-in-hand with our teaching staff by preparing lectures and discussions ahead of time, and by carefully reviewing your notes afterwards. Please, also take advantage of our academic support services.

All of us will support you in your venture. We expect that after taking our program you will be part of a body of exceptionally talented students that can be recognized for its academic abilities, ambition and creativity.

Probably, you have often heard that the CiQUS (*Centre for Research in Biological Chemistry and Molecular Materials*) is a special place at the USC. It is a research centre fully committed to scientific excellence and equipped with state-of-the-art research facilities. This unique scientific environment will contribute to make of this Master one of the bests.

Our academic program aims at providing future graduates with a multidisciplinary training in several topics of **chemistry, biomedicine and materials science**. Importantly, the program should also allow to acquire leading and problem-solving abilities and set you in an idoneal position to perform research tasks, start an academic career or enter the job market in areas like biotechnology, nanotechnology or energy.

No doubt, the challenges facing the 21st century society in areas as diverse as health, energy or sustainable development must be tackled from a multidisciplinary perspective; and those with knowledge on molecular chemistry, biomedicine and physics will be in a better position to provide solutions. In this context, the proposed master's program will provide you with a rigorous and practical training in these disciplines, and a multi- and interdisciplinary vision of science and technology.

We look forward to working with you to provide transformative and innovative learning experiences. We are confident that you will find this a truly exciting time of intellectual stimulation and growth. I hope your one year and a half ahead is both challenging and successful.

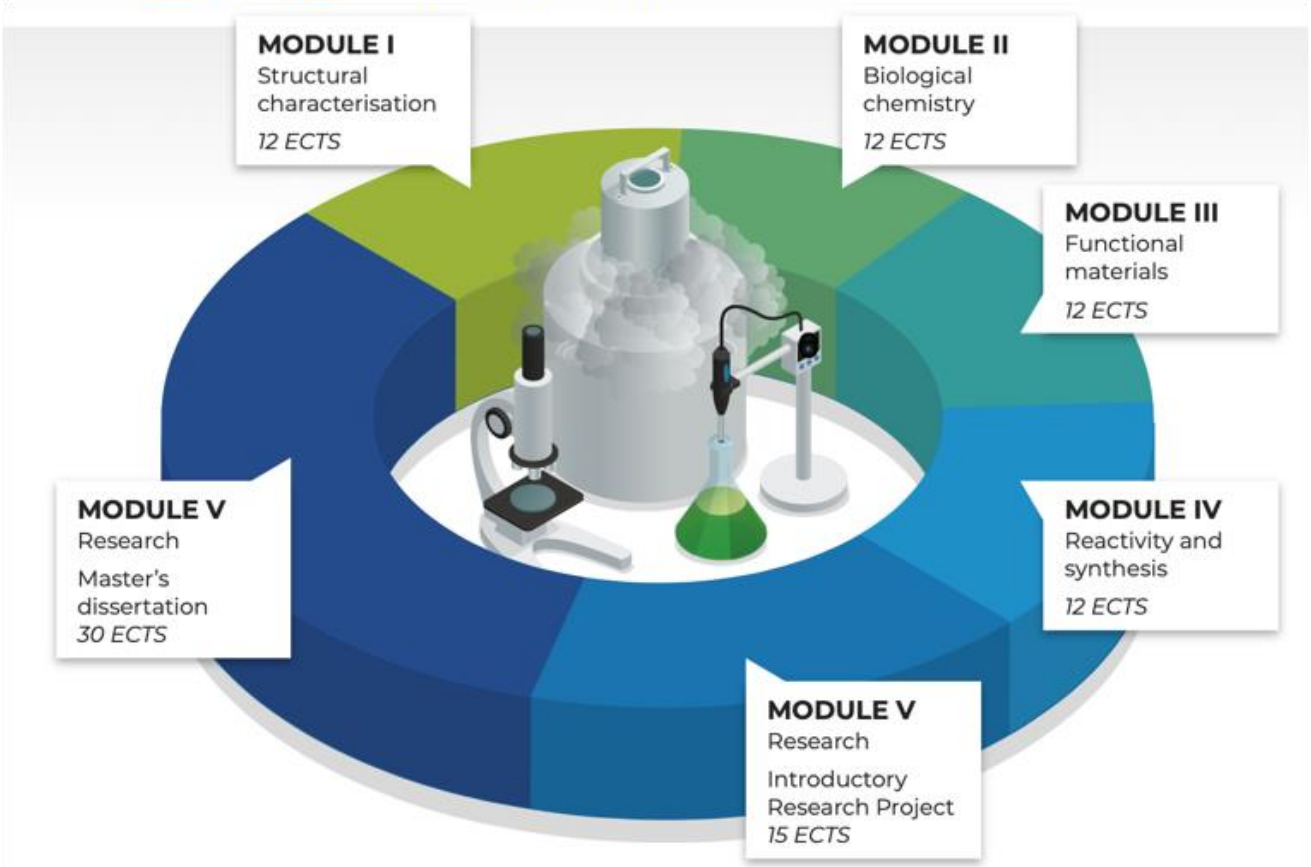
Again, welcome!

PROGRAMME

MASTER

CHEM BIO&MAT

CHEMISTRY *at the Interface with* BIOLOGY *and* MATERIALS Science



90 ECTS
It is a study programme organized in 5 areas (modules)

1.5 YEARS
Programme lenght: 3 semesters (18 months)

ENGLISH
All courses are taught in English

MULTIDISCIPLINARY
19 Research Groups at CiQUS working in 3 thematic areas: Biological & Medicinal Chemistry; Functional Materials and Synthetic Methodologies

INTERNATIONAL
The teaching staff includes up to 5 ERC grantees (8 ERC Projects) and other internationally renowned scientists

EXPERIMENTAL
Hands-on training in state-of-the-art experimental techniques. Research projects mean 50% (45 ECTS) of the study plan

MOBILITY
Opportunity to do an internship to conduct research in a different Partner institution or company

MENTORING
Academic and industrial supervisors for career advising and professional development

1ST SEMESTER (1ST YEAR - 30 ECTS)	2ST SEMESTER (1ST YEAR - 30 ECTS)	3RD SEMESTER (2ND YEAR - 30 ECTS)
MODULE I		
STRUCTURAL CHARACTERISATION (12 ECTS)		
▪ Magnetic Resonance ▪ Microscopy ▪ Colloidal and Interface Characterisation ▪ Spectroscopic and Spectrometric Techniques		
MODULE II		
BIOLOGICAL CHEMISTRY (12 ECTS)		
▪ Biological and Cellular Chemistry ▪ Supramolecular Chemistry	▪ Experimental Techniques in Molecular Biology and Medicine *(Op.)* ▪ Biophysics *(Op.)*	
MODULE III		
FUNCTIONAL MATERIALS (12 ECTS)		
▪ Nanostructured Materials ▪ Molecular Materials	▪ Molecular Magnetism *(Op.)* ▪ Nanobiotechnology *(Op.)*	
MODULE IV		
REACTIVITY AND SYNTHESIS (12 ECTS)		
▪ Catalysis ▪ Chemical Synthesis	▪ Determination of Reaction Mechanisms *(Op.)* ▪ Computational Chemistry *(Op.)*	
MODULE V		
RESEARCH (48 ECTS)		
▪ Tutored Training Activities	▪ Introductory Research Project	▪ Master Dissertation

COURSES OVERVIEW

IDENTIFICATION FORM

Course Data

Course number	**P1251101**
Subject	*Magnetic Resonance*
Title	Chemistry at the interface with Biology and Materials Science (ChemBio&Mat) **P1251V01**
Course Level	Master
Credits	3.0
Module	**I (Structural Characterization)**
Academic Year	2023-2024

Titulation

Title	Center	Course	Semester
ChemBio&Mat	FACULTAD de QUÍMICA/CiQUS	1	First

Subject

Title	Course Title	Course type
ChemBio&Mat	Magnetic Resonance	Compulsory

Coordination

Name	Department	Contact
Víctor Sánchez Pedregal	Organic Chemistry	victor.pedregal@usc.es / 15710

SUMMARY

NMR spectroscopy is one of the most powerful analytical tools in organic and inorganic chemistry. It finds application in other fields of science, such as biology, medicine, or materials science, among others. Applications of NMR are not limited to structure determination. NMR spectroscopy is also used to study other molecular properties, like diffusion, reaction mechanism, dynamic processes or intermolecular interactions, for example. ESR spectroscopy is a technique used to study chemical species with unpaired electrons. This plays an important role in the understanding of organic and inorganic radicals, transition metal complexes, and some biomolecules. This course will give and overview of the theoretical principles and the most valuable methods for the research chemist.

PREREQUISITES

Relation with other topics of the Master

No enrollment restrictions have been specified with other subjects of the curriculum.

Other requirements

No enrollment restrictions have been specified with other subjects of the curriculum. Students are expected to have a basic knowledge of spectroscopy, in general, and magnetic resonance, in particular, at the undergraduate level.

COMPETENCES

Basic

- **CB6**: Possess and understand the knowledge that provides a basis or an opportunity for being creative and unique in the development and/or implementation of ideas, often in a research context.
- **CB7**: Students should know how to use the knowledge acquired and their problem-solving capacity in new or little-known environments within wider (or multidisciplinary) contexts related to their field of study.
- **CB8**: Students should be able to integrate knowledge and deal with the complexity of making judgements from information which – being incomplete or limited – includes reflections on the social and ethical responsibilities linked to the use of their knowledge or judgements.
- **CB9**: Students should know how to communicate their findings and the knowledge and underlying reasons underpinning them to specialised and non-specialised audiences in a clear and unambiguous way.
- **CB10**: Students should have the learning skills that allow them to carry on studying in such a way that should be mainly self-directed or autonomous.

General

- **CG2**: Know how to apply the scientific method and acquire skills for developing the necessary protocols for the design and critical assessment of chemical experiments.
- **CG3**: Be able to discuss and communicate ideas, in both oral and written form, to specialised and non-specialised audiences (congresses, conferences, etc.) in a clear and reasoned way.
- **CG5**: Have the skills that allow students to develop an autonomous method for studying and learning.
- **CG7**: Be able to work as part of multidisciplinary teams and collaborate with other professionals, both nationally and internationally.
- **CG8**: Be able to use scientific literature and develop the judgement needed for its interpretation and use.
- **CG11**: Be able to adapt efficiently to future doctoral studies in multidisciplinary areas.

Transversal

- **CT1**: Develop teamwork skills: cooperation, leadership and good listening skills. Adapt to multidisciplinary teams.
- **CT2**: Draft scientific and technical reports and defend them publicly.

- **CT4**: Apply the concepts, principles, theories and models related to Biological Chemistry and Molecular Materials to new or little-known environments within multidisciplinary contexts.
- **CT7**: Show critical and self-critical reasoning when seeking scientific rigour and quality. Handle IT tools and information and communication technology (ICT), as well as on-line access to databases.

Specific

- **CE4**: Know and understand the chemical tools and analytical techniques used for biological chemistry and molecular materials.
- **CE7**: Students should acquire knowledge on advanced techniques for the structural characterization of macromolecules, supramolecules and colloids which are relevant in the field of biological chemistry and molecular materials.
- **CE8**: Gain technical skill for carrying out the structural characterization of molecules, biomolecules, supramolecules and nanoparticles and interpreting the experimental data obtained.
- **CE10**: Know the potential of NMR and ESR techniques for the analysis of biomolecule dynamic processes (diffusion) in biological media, being able to process and interpret real spectra of these techniques.

OBJECTIVES OF TRAINING

The students, once passed the subject, should be able to:

- Know the basics of NMR and ESR spectroscopy, as well as the type of information they provide in the study of chemistry.
- Be able to process data and interpret NMR and ESR spectra, in order to deduce the structure and other properties of molecules and / or supramolecular complexes.
- Design their own solutions, selecting the most suitable spectroscopic methods for the study of each chemical problem.

COURSE CONTENTS

1. ESR spectroscopy. Acquisition of spectra and interpretation

Electron Spin Resonance spectroscopy. Introduction and theory. Range of application. Laboratory practicals: data acquisition and analysis.

2. One-dimensional NMR spectroscopy.

Multipulse 1D experiments: homonuclear decoupling, NOE, 13C, DEPT. Interpretation of 1D spectra.

3. Two-dimensional NMR spectroscopy.

Introduction to 2D NMR. Homonuclear (COSY, TOCSY, NOESY) and heteronuclear (HMQC, HSQC, HMBC) correlations. Interpretation of 2D spectra.

4. Processing of NMR spectra

Introduction to NMR data acquisition and processing. Laboratory practicals: the NMR spectrometer and processing software.

COURSE BIBLIOGRAPHY

1. Basic

- Field, L.D.; Sternhell, S.; Kalman, J.R. *Organic Structures from Spectra*, 5th ed., Wiley, **2013**. ISBN: 978-0-470-31926-0.
- Hesse, M.; Meier, H.; Zeeh, B. *Spectroscopic Methods in Organic Chemistry*, 2nd ed., Thieme, **2007**.
- Poole, C.P. *Electron Spin Resonance: A Comprehensive Treatise on Experimental Techniques*, 2nd ed., Wiley, **1996**.

2. Complementary

- Günther, H. *NMR Spectroscopy*, 3rd. ed., **2013**. ISBN: 978-3-527-33000-3.
- Claridge, T.D.W. *High-Resolution NMR Techniques in Organic Chemistry*, 2nd ed., Tetrahedron Organic Chemistry, vol. 27, **2009**. ISBN-13: 978-0080548180.
- Silverstein, R.M.; Webster, F.X.; Kiemle, D.J. *Spectrometric Identification of Organic Compounds*, Wiley, **2005**. ISBN: 0-471-39362-2.
- Friebolin, H. *Basic One- and Two-Dimensional NMR Spectroscopy*, 5th ed., Wiley, **2011**. ISBN: 978-3-527-32782-9.
- Crews, P.; Rodriguez, J.; Jaspers, M. *Organic Structure Analysis,* 2nd ed., Oxford University Press, New York, **2009**. ISBN: 9780195336047.

STUDENT WORKLOAD

The training activities will be distributed according to the following table.

	Activity	hours	% presential
Presential classes	Lectures and conferences	4	100%
	Seminars and classroom exercises	6	100%
	Tutorials	1	100%
	Practical laboratory or computer classes	12	100%
	Oral presentations os students or lectures by guest speakers	2	100%
	Final exam	2	100%
Non Presential	Preparation and study of problems	10	0%
	Elaboration of individual work	35	0%
	Literature searching	3	0%
	TOTAL	75	

TEACHING METHODOLOGY

The Virtual Campus will be used for delivering the necessary material to the students, according to the professor criterion. This material will include: the course program, exercises and problems to be solved, copies of the classroom presentations, etc.
Along the course, the student should participate in various formative activities, with the aim of acquiring the established knowledge and skills.

- **Lectures.** Explanation of theoretical contents. The active participation of the students will be intended through the formulation of appropriate questions that they should try to answer.
- **Interactive classes encouraging student participation (seminars).** Discussion of exercises and problems, individually or in groups.
- Combined use of blackboard and fast and anonymous response methods in class (*clickers*) to know the degree of follow-up of the subject.
- Promoting **autonomous student learning**, through the work on topics proposed in class.
- Resolution of practical **exercises** (problems, multiple choice test, interpretation and processing of information, evaluation of scientific publications, etc.).
- **Oral** presentations of previously prepared topics, including discussion with classmates and teachers.

Recommendations for the study of the subject

- In the seminar classes we will mainly work on solving problems. The problems and the class schedule will be available to the students in the virtual classroom. Students should try to solve them autonomously in advance of the classes. The solutions will be analyzed in the classes.
- It is advised that students use the recommended bibliography. The faculty will advise the sections of each book that are most appropriate for each topic.
- In case of finding difficulties, students can raise their doubts both in the classes and in the tutorials.

ASSESSMENT SYSTEM

Guiding principles.
With the aim of encouraging the constant student work to favor the learning, a continuous evaluation will be applied. This methodology will inform the professor about the content's assimilation by the student as well as their ability to apply them to problem solving. The evaluation will be individual.
Along the course, on professor criterion, the students will have to solve some exercises and hand them in at the scheduled date. Performing short tests in classroom is also foreseen.
In order to evaluate the knowledge related to the master classes and the problem-solving ability of the students, one exam and/or individual oral presentation will be performed.

Final grade.
The grade of this subject will be determined by *CONTINUOUS ASSESSMENT* (30%) and a *FINAL EXAM* (70%).

The access to the final exam is conditioned to the participation in at least 80% of the compulsory attendance activities (practicals, seminars and tutorials).

FINAL EXAM (70%). There will be a single theoretical-practical final exam that will cover all the contents of the subject. To pass the subject, it is mandatory to achieve a grade of at least 4 out of 10 in the final exam (4/10). Otherwise the score of the elements of the continuous assessment will not be added, the final grade being that obtained in the exam.

CONTINUOUS ASSESSMENT (30%). Along the course, the students will do a series of activities (problems, presentation of works, participation in seminars, etc.) that will be evaluated.

CALCULATION OF THE FINAL GRADE.
In case of passing the final mark of the final exam (4/10), the final grade of the subject will be obtained as the following weighted average:

CF = (0.7 * Ex) + (0.3 * EC)

CF: Final mark of the subject (0 - 10)
Ex: Exam rating (0 - 10)
EC: Continuous Evaluation (0 - 10)

The subject will be passed if the final grade is **at least 5/10**.

In the case of not passing the subject at the 'first opportunity', the student will be evaluated again of the final exam at the 'second opportunity', keeping the grade of the continuous evaluation.
Repeating students will have the same attendance regime for classes as those who take the subject for the first time.

FACULTY DATA

Faculty	Contact	Semester	Class
Francisco Rivadulla Fdz.	15724	1st	Maths (3rd floor)
Víctor M. Sánchez Pedregal	15710		
Jaime Mateos			

IDENTIFICATION FORM

Course Data

Course number	**P1251106**
Subject	Microscopy
Title	Chemistry at the interface with Biology and Materials Science (ChemBio&Mat) **P1251V01**
Course Level	Master
Credits	3.0
Module	**I (Structural Characterization)**
Academic Year	2023-2024

Titulation

Title	Center	Course	Semester
ChemBio&Mat	FACULTAD de QUÍMICA/CiQUS	1	First

Subject

Title	Course Title	Course type
ChemBio&Mat	Microscopy	Compulsory

Coordination

Name	Department	Contact
Ester Polo	Biochemistry	ester.polo@usc.es

SUMMARY

Microscopy, either optical, electronic or x-ray is an essential technique for the characterization of biological processes and structures, as well as for the detailed determination of the structural characteristics of new materials.

PREREQUISITES

Relation with other topics of the Master

No enrollment restrictions have been specified with other subjects of the curriculum.

Other requirements

No enrollment restrictions have been specified with other subjects of the curriculum. Broad knowledge of general biology aspects is preferred.

COMPETENCES

Basic

- **CB6**: Possess and understand the knowledge that provides a basis or an opportunity for being creative and unique in the development and/or implementation of ideas, often in a research context.
- **CB7**: Students should know how to use the knowledge acquired and their problem-solving capacity in new or little known environments within wider (or multidisciplinary) contexts related to their field of study.
- **CB9**: Students should know how to communicate their findings and the knowledge and underlying reasons underpinning them to specialised and non-specialised audiences in a clear and unambiguous way.
- **CB10**: Students should have the learning skills that allow them to carry on studying in such a way that should be mainly self-directed or autonomous.

General

- **CG1**: Know how to use the knowledge acquired for practical problem solving in the field of research and innovation, in the multidisciplinary context of biological chemistry and molecular materials.
- **CG3**: Be able to discuss and communicate ideas, in both oral and written form, to specialised and non-specialised audiences (congresses, conferences, etc.) in a clear and reasoned way.
- **CG4:** Be able to understand the social and ethical responsibilities linked to the use of knowledge or judgements in research, development and innovation in the field of biological chemistry and molecular materials.
- **CG5**: Have the skills that allow students to develop an autonomous method for studying and learning.
- **CG6:** Have leadership, creativity, initiative and entrepreneurship abilities.
- **CG7:** Be capable of working in multidisciplinary teams and collaborating with other specialists, both nationally and internationally.
- **CG8**: Be able to use scientific literature and develop the judgement needed for its interpretation and use.
- **CG10:** Be able to develop the different research stages (from the conception of an idea and the literature search through to target setting, experiment design, analysis of the results and drawing conclusions).

Transversal

- **CT1**: Develop teamwork skills: cooperation, leadership and good listening skills. Adapt to multidisciplinary teams.
- **CT2**: Draft scientific and technical reports and defend them publicly.
- **CT3:** Perform day-to-day research or professional activity in an independent and efficient manner.

- **CT4**: Apply the concepts, principles, theories and models related to Biological Chemistry and Molecular Materials to new or little-known environments within multidisciplinary contexts.
- **CT5**: Appreciate the value of good quality and continuous improvement by acting rigorously, responsibly and ethically.
- **CT6:** Be capable of adapting to changes by being self-motivated when applying new and advanced technologies and other relevant developments.
- **CT7**: Show critical and self-critical reasoning when seeking scientific rigour and quality. Handle IT tools and information and communication technology (ICT), as well as on-line access to databases.

Specific

- **CE4:** Know and understand the chemical tools and analytical techniques used for biological chemistry and molecular materials.
- **CE5:** Know how to analyze and use the data obtained autonomously in complex laboratory experiments by relating them to the suitable chemical, physical or biological techniques
- **CE7:** Students should acquire knowledge on advanced techniques for the structural characterization of macromolecules, supramolecules and colloids which are relevant in the field of biological chemistry and molecular materials.
- **CE8:** Gain technical skill for carrying out the structural characterization of molecules, biomolecules, supramolecules and nanoparticles and interpreting the experimental data obtained.
- **CE9:** Use advanced instrumentation related to research on biological chemistry and molecular materials.

OBJECTIVES OF TRAINING

- Know the different types of microscopy techniques and their theoretical basis.
- Know the different methods and requirements for the preparation of samples for different types of microscopy.
- Get clear notions about the differences between different microscopy techniques and its uses.

COURSE CONTENTS

1. The optical microscope

Structure and basic operation. Preparation of samples. Phase contrast. Visualization of living cells.

2. Fluorescence microscopy.

FRAP and FRET. 3D optical sectioning: deconvolution and confocal microscopy. Visualization of unique molecules by TIRF. Super-resolution microscopy: types. Treatment and preparation of samples for fluorescence microscopy.

3. Transmission (TEM) and scanning electron microscope (SEM)

Operation basics. Preparation of samples for TEM. Contrast and negative staining. 3D reconstruction by tomography. Cryo-microscopy and determination of structures by single particle reconstruction.

4. Scanning probe microscopy.

Bases and types. Preparation of samples. Application to materials.

COURSE BIBLIOGRAPHY

1. Basic

– Molecular Biology of the Cell, B. Alberts et all, Garland Science, 2014

2. Complementary

–

STUDENT WORKLOAD

The training activities will be distributed according to the following calendar.

	Activity	hours	% presential
Presential classes	Lectures and conferences	3	100%
	Seminars and classroom exercises	4	100%
	Tutorials	1	100%
	Practical classes	14	100%
	Oral presentations	2	100%
	Final exam	3	100%
Non Presential	Preparation and study of problems	10	0%
	Elaboration of individual work	35	0%
	Literature searching and so on	3	0%
	TOTAL	75	

TEACHING METHODOLOGY

- Interactive classes encouraging student participation.
- Combined use of computer and blackboard methods.
- Work in the laboratory: preparation of samples and management / demonstration of different types of microscopes with prepared samples.
- Promotion of self-learning of the student proposing challenges and posing questions.
- Resolution of practical exercises (problems, questions type test, interpretation and processing of information, evaluation of scientific publications, etc.).
- Oral presentations of previously prepared topics, including discussion with classmates and teachers.

ASSESSMENT SYSTEM

General considerations

- The evaluation process will be used to know if the student has acquired the scheduled skills and to review the teaching methodology.
- Written exam on theoretical and practical basic contents of the subject.
- Continuous evaluation associated with active participation and autonomous learning.

Evaluation weights: Minimum weighting (MiW)- Maximum weight (MaW)
Writen Exam: 50%-70%
Oral presentations: 10%-30%
Other Activities: 20%-40%
Tutoring: 0%-10%
In scenario 1, all exams and tests will be in classroom, while in scenarios 2 and 3 they will be conducted online through the Moodle Quizzes and Microsoft's "Teams" software.
For cases of fraudulent performance of exercises or tests, the provisions of the *"Regulations for the evaluation of students academic performance and qualifications review"* will apply.

FACULTY DATA

Faculty	Contact	Semester	Class
Ester Polo	15733	1st	Fac. Chemistry Maths (3rd floor)
José Manuel Vila Fungueiriño			CIQUS

IDENTIFICATION FORM

Course Data

Course number	**P1251103**
Subject	Colloidal Characterization and Interfaces
Title	Chemistry at the interface with Biology and Materials Science (ChemBio&Mat) **P1251V01**
Course Level	Master
Credits	3.0
Module	**I (Structural Characterization)**
Academic Year	2023-2024

Titulation

Title	Center	Course	Semester
ChemBio&Mat	FACULTAD de QUÍMICA/CiQUS	1	First

Subject

Title	Course Title	Course type
ChemBio&Mat	Supramolecular Chemistry	Compulsory

Coordination

Name	Department	Contact
Pablo del Pino	Particle Physics	pablo.delpino@usc.es/15711

SUMMARY

The physicochemical characterization of nanostructured materials is a very important task for knowing the properties of these materials. During this course we will study some basic experimental techniques related to the colloidal and interfacial properties of the nanomaterials, as well as their chemical composition and thermal stability.

PREREQUISITES

Relation with other topics of the Master

No enrollment restrictions have been specified with other subjects of the curriculum.

Other requirements

No enrollment restrictions have been specified with other subjects of the curriculum. Broad knowledge of general physical chemistry is required, especially in aspects related to colloidal chemistry, interfaces and transport properties.

COMPETENCES

Basic

- **CB6**: Possess and understand the knowledge that provides a basis or an opportunity for being creative and unique in the development and/or implementation of ideas, often in a research context.

General

- **CG1**: Know how to use the knowledge acquired for practical problem solving in the field of research and innovation, in the multidisciplinary context of biological chemistry and molecular materials.
- **CG3**: Be able to discuss and communicate ideas, in both oral and written form, to specialised and non-specialised audiences (congresses, conferences, etc.) in a clear and reasoned way.
- **CG5**: Have the skills that allow students to develop an autonomous method for studying and learning.
- **CG9**: Be capable of handling chemical substances safely and work in a chemical laboratory without risks.

Transversal

- **CT3**: Perform day-to-day research or professional activity in an independent and efficient manner.
- **CT4**: Apply the concepts, principles, theories and models related to Biological Chemistry and Molecular Materials to new or little-known environments within multidisciplinary contexts.

Specific

- **CE4:** Know and understand the chemical tools and analytical techniques used for biological chemistry and molecular materials.
- **CE5:** Know how to analyze and use the data obtained autonomously in complex laboratory experiments by relating them to the suitable chemical, physical or biological techniques.
- **CE6:** Know the physicochemical bases of biological processes.
- **CE7:** Students should acquire knowledge on advanced techniques for the structural characterization of macromolecules, supramolecules and colloids which are relevant in the field of biological chemistry and molecular materials.

– **CE8:** Gain technical skill for carrying out the structural characterization of molecules, biomolecules, supramolecules and nanoparticles and interpreting the experimental data obtained.

OBJECTIVES OF TRAINING

The main learning objectives of this course are:

– To know the basic experimental techniques for the physicochemical characterization of nanostructured systems.
– To obtain an integrated and multidisciplinary view of the area, in the context of other scientific areas.
– To obtain a general view of the experimental methods and techniques more widely used for studying nanostructured materials
– To know the possible applications of this scientific area.

COURSE CONTENTS

– Determine the composition of nanomaterials.
– Determine the hydrodynamic size of colloids by dynamic light scattering.
– Determine the zeta potential by "Laser Doppler Anemometry".
– Determine the electrophoretic mobility by gel electrophoresis.
– Determine the thermal stability of colloids by thermogravimetric analysis.
– Determine the quantum efficiency of luminescent nanoparticles.

COURSE BIBLIOGRAPHY

1. Basic

– P. Atkins, J. de Paula & J. Keeler: "Physical Chemistry", 11th Edition; Oxford University Press, 2017
– I. N. Levine: "Physical Chemistry", 6th Edition; McGraw-Hill, 2013

Previous editions are also valid.

2. Complementary

– F. MacRitchie: "Chemistry at Interfaces"; Academic Press, 1990.
– D. Myers: Surfaces: "Interfaces and Colloids: Principles and Applications"; VCH, 1999.
– D. Berti & G. Palazzo: "Colloidal Foundations of Nanoscience"; Elsevier, 2014.
– R.J. Hunter: "Foundations of Colloid Science", 2nd Edition; Oxford University Press, 2001.
– G.T. Barnes & I.R. Gentle: "Interfacial Science: an Introduction", 2nd Edition; Oxford University Press, 2011.

– John P. Sibilia: "A Guide to Materials Characterization and Chemical Analysis". VCH Publishers, 1998.
– M.E. Brown: "Introduction to Thermal Analysis. Techniques and applications"; Chapman and Hall, 1998.

In addition, complementary information (research articles, webpages, texts) will be recommended in each part of the matter.

STUDENT WORKLOAD

The training activities will be distributed according to the following table.

	Activity	hours	% presential
Presential classes	Lectures and conferences	3	100%
	Seminars and classroom exercises	4	100%
	Tutorials	1	100%
	Practical classes	14	100%
	Oral presentations	2	100%
	Final exam	3	100%
Non Presential	Preparation and study of problems	10	0%
	Elaboration of individual work	35	0%
	Literature searching and so on	3	0%
	TOTAL	75	

TEACHING METHODOLOGY

The Virtual Campus will be used for delivering the necessary material to the students, according to the professor criterion. This material will include: the course program, exercises and problems to be solved, copies of the classroom presentations, etc.
Along the course, the student should participate in various formative activities, with the aim of acquiring the established knowledge and skills.
Master classes: Explanation of theoretical contents supplemented by audiovisual aids. The active participation of the students will be intended, through the formulation of appropriate questions that they should try to answer.
Seminars: There will be two classroom hours before the partial exams dedicated to review concepts and/or clarify doubts.
Use of fast and anonymous response methods in class (clickers) to know the degree of follow-up of the subject.
Presentation of individual works on some topics related to the subject, including the debate with his classmates and teachers.
Group and individual tutoring.

ASSESSMENT SYSTEM

General considerations:
- The evaluation process will not only serve to determine whether the learner has acquired the programmed competencies but also to review the teaching methodology.
- Written test on basic theoretical and practical contents of the subject.
- Continuous evaluation associated with active participation and autonomous learning.

SYSTEM OF EVALUATION; WEIGHTING
Final examination: 70 %
Oral exhibition: 10 %
Homework / activities / oral exhibition: 20 %

The continuous assessment will have a weight of 30 % in the qualification of the subject and will consist of two components: resolution of problems and practical cases (20 %), oral exhibition (works, reports, problems and practical cases) (10 %). The seminars and the tutorships will include exercises and face-to-face realized works and delivered to the teacher.
The final examination will have a weight of 70 % and will cover all the contents of the subject.

COMMENTS

The teaching will be mainly given in English.

FACULTY DATA

Faculty	Contact	Semester	Class
Carlos Vázquez Vázquez	13011	1st	Maths (3rd floor)
Pablo del Pino González	15711		CiQUS

IDENTIFICATION FORM

Course Data

Course number	**P1251106**
Subject	*Spectroscopic and Spectrometric Techniques*
Title	Chemistry at the interface with Biology and Materials Science (ChemBio&Mat) **P1251V01**
Course Level	Master
Credits	3.0
Module	**I (*Structural Characterization*)**
Academic Year	2023-2024

Titulation

Title	Center	Course	Semester
ChemBio&Mat	FACULTAD de QUÍMICA/CiQUS	1	First

Subject

Title	Course Title	Course type
ChemBio&Mat	*Spectroscopic and Spectrometric Techniques*	Compulsory

Coordination

Name	Department	Contact
Julián Bergueiro	Organic Chemistry	julian.bergueiro.alvarez@usc.es

SUMMARY

The extraordinary sensitivity, simplicity and speed of optical spectroscopic techniques makes them ideally suited for addressing a broad range of questions in molecular and cellular biophysics. Spectroscopic properties such as absorbance, fluorescence and chiroptical properties provide information about the identity, concentration, energy, conformation, or dynamics of molecules and can be sensitive to tiny changes in molecular structure or in the properties of their surroundings. Because they usually are not destructive, spectrophotometric techniques can be used with samples that must be recovered after an experiment. They also can provide analytical methods that avoid the need for radioisotopes or hazardous reagents. When combined with genetic engineering and microscopy, they provide windows to the locations, dynamics, and turnover of particular molecules in living cells. Altogether, spectroscopic techniques include some of the most powerful weapons in the analytical arsenal, and a basic working knowledge of their scope and applications is fundamental for the development of modern chemistry.

PREREQUISITES

Relation with other topics of the Master

No enrollment restrictions have been specified with other subjects of the curriculum.

Other requirements

No enrollment restrictions have been specified with other subjects of the curriculum. Broad knowledge of general organic and inorganic chemistry is required, especially in its synthetic and structural aspects.

COMPETENCES

Basic

- **CB6**: Possess and understand the knowledge that provides a basis or an opportunity for being creative and unique in the development and/or implementation of ideas, often in a research context.
- **CB7**: Students should know how to use the knowledge acquired and their problem-solving capacity in new or little known environments within wider (or multidisciplinary) contexts related to their field of study.
- **CB9**: Students should know how to communicate their findings and the knowledge and underlying reasons underpinning them to specialised and non-specialised audiences in a clear and unambiguous way.
- **CB10**: Students should have the learning skills that allow them to carry on studying in such a way that should be mainly self-directed or autonomous.

General

- **CG1**: Know how to use the knowledge acquired for practical problem solving in the field of research and innovation, in the multidisciplinary context of biological chemistry and molecular materials.
- **CG2**: Know how to apply the scientific method and acquire skills for developing the necessary protocols for the design and critical assessment of chemical experiments.
- **CG3**: Be able to discuss and communicate ideas, in both oral and written form, to specialised and non-specialised audiences (congresses, conferences, etc.) in a clear and reasoned way.
- **CG5**: Have the skills that allow students to develop an autonomous method for studying and learning.
- **CG8**: Be able to use scientific literature and develop the judgement needed for its interpretation and use.

Transversal

- **CT3**: Work autonomously and efficiently in the daily practice of research or professional activity.
- **CT4**: Apply the concepts, principles, theories and models related to Biological Chemistry and Molecular Materials to new or little-known environments within multidisciplinary contexts.
- **CT5**: Appreciate the value of good quality and continuous improvement by acting rigorously, responsibly and ethically.
- **CT6**: Be able to adapt to changes, having the initiative to apply new technologies and advanced technologies, as well as other relevant developments
- **CT7**: Show critical and self-critical reasoning when seeking scientific rigour and quality. Handle IT tools and information and communication technology (ICT), as well as on-line access to databases.

Specific

- **CE1**: Know the impact of chemistry, biological chemistry and molecular materials on the industry, environment, health, agrofood and renewable energies.
- **CE2**: Be able to critically confront experimental data and theoretical hypotheses.
- **CE3**: Know the rules on risk prevention in the laboratory and in the industry related to chemistry.
- **CE4**: Know and understand the chemical tools and analytical techniques used in biological chemistry and molecular materials.
- **CE5**: Know how to analyze and use the data obtained autonomously in complex laboratory experiments and relate them to the appropriate chemical, physical or biological techniques.
- **CE8**: Acquire technical skills to carry out the structural characterization of molecules, biomolecules, supramolecules and nanoparticles and in the interpretation of the experimental data obtained.

OBJECTIVES OF TRAINING

- Learn the basis of spectroscopic and spectrometric techniques and the structural information that can be obtained from them.
- Obtain an overview of the methods and experimental spectroscopic and spectrometric techniques used in biological chemistry and molecular materials.
- Work safely and with competence with a variety of spectroscopic and spectrometric techniques.
- Ability to interpret spectroscopic and spectrometric results to gain structural information.
- Be able to propose the molecular structure of organic and inorganic compounds through the use of spectroscopic techniques and mass spectrometry.
- Know the possible applications of this field of science.

COURSE CONTENTS

1. Absorption spectroscopy: UV-Vis and Circular Dichroism (CD)

Introduction to electronic spectroscopy and basics of UV and CD spectroscopy. The Lambert-Beer Law; absorbance and Scattering; empirical rules in CD; chirality in metal complexes and CD; conformation of biomolecules and CD.

2. Fluorescence spectroscopy

Basics of fluorescence spectroscopy: Energy levels and Jablonsky diagrams; quantum yield; fluorescence lifetime; excitation and emission spectra; Stoke's shift; Kasha's rule; fluorescence quenching; fluorescence anisotropy; resonance energy transfer; excimers and exciplexes; environmental effects in fluorescence; intrinsic fluorophores in biology; fluorescence sensing.

3. Mass spectrometry

Overview of mass spectrometry techniques; instrumentation: methodology

4. Applications of Spectroscopy

Determination of binding constants in supramolecular processes.

COURSE BIBLIOGRAPHY

1. Basic

- John Greaves, John Roboz. *Mass Spectrometry for the Novice*, CRC Press – Taylor & Francis Group, Boca Raton, USA (2014). **ISBN:** 978-1-420-09418-3.
- Bernard Valeur. *Molecular Fluorescence*, 2nd Edition. Wiley-VCH, Weinheim, Germany (2012). **ISBN:** 978-3-527-32837-6.
- Joseph R. Lakowicz. *Principles of Fluorescence Spectroscopy*, 3rd Edition. Springer, NY, USA (2006). **ISBN-10**: 0-387-31278-1.
- Nagao Kobayashi, Atsuya Muranaka, John Mack. Circular Dichroism and Magnetic Circular Dichroism Spectroscopy for Organic Chemists. Royal Society of Chemistry, Cambridge, UK (2012). **ISBN**: 978-1-84755-869-5.

2. Complementary

Papers on the application of Circular Dichroism for the study of peptides and proteins:

- N. J. Greenfield, Analysis of the kinetics of folding of proteins and peptides using circular dichroism. *Nat. Protoc.* **1**, 2891–2899 (2006).
- N. J. Greenfield, Using circular dichroism spectra to estimate protein secondary structure. *Nat. Protoc.* **1**, 2876–2890 (2006).
- N. J. Greenfield, Determination of the folding of proteins as a function of denaturants, osmolytes or ligands using circular dichroism. *Nat. Protoc.* **1**, 2733–2741 (2006).
- N. J. Greenfield, Using circular dichroism collected as a function of temperature to determine the thermodynamics of protein unfolding and binding interactions. *Nat. Protoc.* **1**, 2527–2535 (2006).
- N. C. Garbett, P. A. Ragazzon, J. B. Chaires, Circular dichroism to determine binding mode and affinity of ligand-DNA interactions. *Nat. Protoc.* **2**, 3166–3172 (2007).

Fluorescence Spectroscopy:

- I. L. Medintz, H. T. Uyeda, E. R. Goldman, H. Mattoussi, Quantum dot bioconjugates for imaging, labelling and sensing. *Nat. Mater.* **4**, 435–446 (2005).
- J. W. Lichtman, J.-A. Conchello, Fluorescence microscopy. *Nat. Methods*. **2**, 910–919 (2005).
- U. Resch-Genger, M. Grabolle, S. Cavaliere-Jaricot, R. Nitschke, T. Nann, Quantum dots versus organic dyes as fluorescent labels. *Nat. Methods*. **5**, 763–775 (2008).
- L. D. Lavis, Chemistry Is Dead. Long Live Chemistry! *Biochemistry*. **56**, 5165–5170 (2017).
- G. Hong, A. L. Antaris, H. Dai, Near-infrared fluorophores for biomedical imaging. *Nature Biomedical Engineering*. **1**, 0010 (2017).
- P. Wu, L. Brand, Resonance energy transfer: methods and applications. *Anal. Biochem.* **218**, 1–13 (1994).

STUDENT WORKLOAD

The training activities will be distributed according to the following table.

	Activity	hours	% presential
Presential classes	Lectures and conferences	3	100%
	Seminars and classroom exercises	4	100%
	Tutorials	1	100%
	Practical classes	16	100%
	Oral presentations	0	100%
	Final exam	3	100%
Non Presential	Preparation and study of problems	10	0%
	Elaboration of individual work	35	0%
	Literature searching and so on	3	0%
	TOTAL	75	

TEACHING METHODOLOGY

The Virtual Campus will be used for delivering the necessary material to the students, according to the professor criterion. This material will include: the course program, exercises and problems to be solved, etc.

Along the course, the student should participate in various formative activities, with the aim of acquiring the established knowledge and skills.
Master classes: Explanation of theoretical contents supplemented by audiovisual aids. The active participation of the students will be intended, through the formulation of appropriate questions that they should try to answer.
Practical classes: The core of this course are these practical laboratory experiments in which the students will use the instruments in designed experiments to illustrate the fundamentals of each technique.
Seminars: There will be four classroom hours before the partial exams dedicated to review concepts and/or clarify doubts.
Group and individual tutoring.

ASSESSMENT SYSTEM

A continuous evaluation will be applied. The evaluation will be individual. The students will have to solve some exercises and hand them in at the scheduled date. Performing short tests in classroom is also foreseen and the participation in the class will also be considered for final grading (25%).
In order to evaluate the knowledge related to the master classes and the practical problem-solving ability of the students, they will handle written reports after each laboratory experiment. (75%).
The students who did not pass the continuous evaluation will have the opportunity to perform a second-chance exam. To pass the course, it will be mandatory obtaining 5 points out of 10.

FACULTY DATA

Faculty	Contact	Semester	Class
Maria Tomás Gamasa		1st	Maths (3rd floor)
Julián Bergueiro			
Rafael Rodríguez			CiQUS

IDENTIFICATION FORM

Course Data

Course number	**P1251105**
Subject	Biological and Cellular Chemistry
Title	Chemistry at the interface with Biology and Materials Science (ChemBio&Mat)
Course Level	Master
Credits	3.0
Module	**II (Biological Chemistry)**
Academic Year	2023-2024

Titulation

Title	Center	Course	Semester
ChemBio&Mat	FACULTAD de QUÍMICA/CiQUS	1	First

Subject

Title	Course Title	Course type
ChemBio&Mat	Biological and Cellular Chemistry	Compulsory

Coordination

Name	Department	Contact
José Luis Mascareñas	Organic Chemistry	joseluis.mascarenas@usc.es

SUMMARY

This subject deals with the understanding of how the main biological macromolecules organize within the cell, and with the discussion of relevant biological and chemical tools for specific manipulations. There will be a specific emphasis in nucleic acids and proteins.

PREREQUISITES

Relation with other topics of the Master

No enrollment restrictions have been specified with other subjects of the curriculum.

Other requirements

No enrollment restrictions have been specified with other subjects of the curriculum. Broad knowledge of general organic and inorganic chemistry is required, especially in its synthetic and structural aspects.

COMPETENCES

Basic

- **CB6**: Possess and understand the knowledge that provides a basis or an opportunity for being creative and unique in the development and/or implementation of ideas, often in a research context.
- **CB7**: Students should know how to use the knowledge acquired and their problem-solving capacity in new or little known environments within wider (or multidisciplinary) contexts related to their field of study.
- **CB9**: Students should know how to communicate their findings and the knowledge and underlying reasons underpinning them to specialised and non-specialised audiences in a clear and unambiguous way.
- **CB10**: Students should have the learning skills that allow them to carry on studying in such a way that should be mainly self-directed or autonomous.

General

- **CG1**: Know how to use the knowledge acquired for practical problem solving in the field of research and innovation, in the multidisciplinary context of biological chemistry and molecular materials.
- **CG3**: Be able to discuss and communicate ideas, in both oral and written form, to specialised and non-specialised audiences (congresses, conferences, etc.) in a clear and reasoned way.
- **CG4:** Be able to understand the social and ethical responsibilities linked to the use of knowledge or judgements in research, development and innovation in the field of biological chemistry and molecular materials.
- **CG5**: Have the skills that allow students to develop an autonomous method for studying and learning.
- **CG6:** Have leadership, creativity, initiative and entrepreneurship abilities.
- **CG7:** Be capable of working in multidisciplinary teams and collaborating with other specialists, both nationally and internationally.
- **CG8**: Be able to use scientific literature and develop the judgement needed for its interpretation and use.
- **CG10:** Be able to develop the different research stages (from the conception of an idea and the literature search through to target setting, experiment design, analysis of the results and drawing conclusions).

Transversal

- **CT1**: Develop teamwork skills: cooperation, leadership and good listening skills. Adapt to multidisciplinary teams.
- **CT2**: Draft scientific and technical reports and defend them publicly.
- **CT3:** Perform day-to-day research or professional activity in an independent and efficient manner.

- **CT4**: Apply the concepts, principles, theories and models related to Biological Chemistry and Molecular Materials to new or little-known environments within multidisciplinary contexts.
- **CT5**: Appreciate the value of good quality and continuous improvement by acting rigorously, responsibly and ethically.
- **CT6:** Be capable of adapting to changes by being self-motivated when applying new and advanced technologies and other relevant developments.
- **CT7**: Show critical and self-critical reasoning when seeking scientific rigour and quality. Handle IT tools and information and communication technology (ICT), as well as on-line access to databases.

Specific

- **CE1**: Know the impact of chemistry, biological chemistry and molecular materials on the industry, environment, health, agrofood and renewable energies.
- **CE4:** Know and understand the chemical tools and analytical techniques used for biological chemistry and molecular materials.
- **CE7**: Students should acquire knowledge on advanced techniques for the structural characterization of macromolecules, supramolecules and colloids which are relevant in the field of biological chemistry and molecular materials.
- **CE8:** Gain technical skill for carrying out the structural characterization of molecules, biomolecules, supramolecules and nanoparticles and interpreting the experimental data obtained.
- **CE9:** Use advanced instrumentation related to research on biological chemistry and molecular materials.
- **CE11:** Be familiar with the basics of biological and cellular chemistry.
- **CE12:** Understand the weak interaction forces that control supramolecular processes and know how to apply them for obtaining new materials and biological functions.

OBJECTIVES OF TRAINING

- Understand the concept of biological chemistry and its relationship with chemical synthesis and cell biology
- Understand the chemical and molecular bases of cells.
- Know and understand the different tools used in biological chemistry
- Obtain a comprehensive and multidisciplinary vision of the area, in the context of other branches of the science.
- Get an overview of the most commonly used experimental methods and techniques in biological and cellular chemistry.
- Know the possible applications of this scientific field.

COURSE CONTENTS

5. Basic architecture of the cell

Compartments and intracellular traffic

6. Biomolecules

Basic aspects of cell chemistry

7. Synthesis of biomolecules

Bioconjugation and bioorthogonal chemistry.

8. Tools in biological chemistry

Sensors, transport peptides, photoactivatable compounds, molecular switches, enzymatic inhibitors, etc.

COURSE BIBLIOGRAPHY

3. Basic

1.- Molecular Biology of the Cell, B. Alberts et all, Garland Science, 2014
2.- Introduction to Bioorganic Chemistry and Chemical Biology. Vranken, D-V; Weiss, G.A. Garland Science 2012
3.- Nucleic Acids in Chemistry and Biology. Blackburn, M.: Gait, M.J.; Loakes, D.; Williams, D.M. (Editors). Rayal Society of Chemistry, 2006
4.- Peptides: Synthesis, Structures and Application. Gutte, B. Academic Press,.1995

4. Complementary

5.- Introduction to Protein Structure. Brändén, C-I; Tooze, J. Garland Science 1999.
6.- Glycochemistry, Principles, Synthesis and Applications. Ed. Peng G. Wang, C. R. Betozzi. Marcel Dekker, New York, 2001.
7.- Concepts and Models in Bioinorganic Chemistry. Karls, R
8.- Metal Complex-DNA Interactions. Hadjiliadis, N.; Sletten, E. (Editors), Wiley, 2009.
9.- The Molecular and Supramolecular Chemistry of Carbohydrates. A chemical introduction to glicoscience. D. Serge. Oxford Science publications, 1997
10.- Introduction to Glycobiology. Taylor, M.E.; Drickamer, K. Oxford University press. 2011

STUDENT WORKLOAD

The training activities will be distributed according to the following table.

	Activity	hours	% presential
Presential classes	Lectures and conferences	14	100%
	Seminars and classroom exercises	4	100%
	Tutorials	1	100%
	Practical classes	0	100%
	Oral presentations	2	100%
	Final exam	3	100%
Non Presential	Preparation and study of problems	10	0%
	Elaboration of individual work	36	0%
	Literature searching and so on	5	0%
	TOTAL	75	

TEACHING METHODOLOGY

- Interactive classes encouraging student participation.
- Combined use of computer methods, and the blackboard.
- Use of fast and anonymous response methods in class (clickers) to evaluate the subject following-up.
- Promotion of student self-learning by proposing challenges and posing questions.
- Resolution of practical exercises (problems, tests, interpretation and information processing, evaluation of scientific publications, etc.).
- Oral presentations of previously prepared topics, including debates with their classmates and teachers.

ASSESSMENT SYSTEM

General considerations

- The evaluation process will be used to know if the student has acquired the scheduled skills and to review the teaching methodology.
- Written exam on theoretical and practical basic contents of the subject.
- Continuous evaluation associated with active participation and autonomous learning.

Evaluation weights: Minimum weighting (MiW)- Maximum weight (MaW)
Writen Exam: 50%-70%
Oral presentations: 15%-40%
Other Activities: 15%-25%
Tutoring: 0%-10%

FACULTY DATA

Faculty	Contact	Semester	Class
José Luis Mascareñas	15737	1st	Maths room (3rd floor)
José M. Martínez Costas	15733		
Javier Montenegro	15791		

IDENTIFICATION FORM

Course Data

Course number	**P1251106**
Subject	*Supramolecular chemistry*
Title	Chemistry at the interface with Biology and Materials Science (ChemBio&Mat) **P1251V01**
Course Level	Master
Credits	3.0
Module	**II (Biological Chemistry)**
Academic Year	2023-2024

Titulation

Title	Center	Course	Semester
ChemBio&Mat	FACULTAD de QUÍMICA/CiQUS	1	First

Subject

Title	Course Title	Course type
ChemBio&Mat	Supramolecular Chemistry	Compulsory

Coordination

Name	Department	Contact
Eugenio Vázquez	Organic Chemistry	email/Extension

SUMMARY

In the last years supramolecular chemistry has developed as one of the interdisciplinary areas that playa a relevant role in different areas, such as biology, chemical biology or material sciences. From the fundamental point of view, the variety of non-covalent interactions that are able induce interactions between different molecules will be evaluated. The formation of discrete aggregates (supermolecules) or large organizations (supramolecules) to create new properties that go beyond the molecule. In general, supramolecular processes are reversible and therefore they are dynamic and can be modulated by external inputs (media conditions, redox process, molecule signal and so on). This dynamic character allows the development of a variety of applications, including novel catalytic methods or molecular motors.

PREREQUISITES

Relation with other topics of the Master

No enrollment restrictions have been specified with other subjects of the curriculum.

Other requirements

No enrollment restrictions have been specified with other subjects of the curriculum. Broad knowledge of general organic and inorganic chemistry is required, especially in its synthetic and structural aspects.

COMPETENCES

Basic

- **CB6**: Possess and understand the knowledge that provides a basis or an opportunity for being creative and unique in the development and/or implementation of ideas, often in a research context.
- **CB7**: Students should know how to use the knowledge acquired and their problem-solving capacity in new or little-known environments within wider (or multidisciplinary) contexts related to their field of study.
- **CB9**: Students should know how to communicate their findings and the knowledge and underlying reasons underpinning them to specialised and non-specialised audiences in a clear and unambiguous way.
- **CB10**: Students should have the learning skills that allow them to carry on studying in such a way that should be mainly self-directed or autonomous.

General

- **CG1**: Know how to use the knowledge acquired for practical problem solving in the field of research and innovation, in the multidisciplinary context of biological chemistry and molecular materials.
- **CG2**: Know how to apply the scientific method and acquire skills for developing the necessary protocols for the design and critical assessment of chemical experiments.
- **CG3**: Be able to discuss and communicate ideas, in both oral and written form, to specialised and non-specialised audiences (congresses, conferences, etc.) in a clear and reasoned way.
- **CG5**: Have the skills that allow students to develop an autonomous method for studying and learning.
- **CG8**: Be able to use scientific literature and develop the judgement needed for its interpretation and use.

Transversal

- **CT1**: Develop teamwork skills: cooperation, leadership and good listening skills. Adapt to multidisciplinary teams.
- **CT2**: Draft scientific and technical reports and defend them publicly.
- **CT4**: Apply the concepts, principles, theories and models related to Biological Chemistry and Molecular Materials to new or little-known environments within multidisciplinary contexts.

- **CT5**: Appreciate the value of good quality and continuous improvement by acting rigorously, responsibly and ethically.
- **CT7**: Show critical and self-critical reasoning when seeking scientific rigour and quality. Handle IT tools and information and communication technology (ICT), as well as on-line access to databases.

Specific

- **CE1**: Know the impact of chemistry, biological chemistry and molecular materials on the industry, environment, health, agrofood and renewable energies.
- **CE11**: Be familiar with the basics of Supramolecular Chemistry, the most significant types of supramolecular entities, characterization methods, their modifications and their application to Science and Technology.
- **CE12**: Understand the weak interaction forces that control supramolecular processes and know how to apply them for obtaining new materials and biological functions.

OBJECTIVES OF TRAINING

- Understand the basic concepts on which supramolecular chemistry is based.
- Know and understand the different strategies of design and synthesis in supramolecular chemistry.
- Obtain an integral and multidisciplinary vision of the area, in the context of other branches of science.
- Obtain an overview of the experimental methods and techniques most commonly used to study supramolecular processes.
- Learn the possible applications of this field of science.

COURSE CONTENTS

1. Supramolecular Chemistry: Non covalent interactions

Introduction to the supramolecular chemistry, history and basic fundaments. Weak interactions, strength and properties.

2. Methods for the characterization of supramolecular processes. Determination of binding constants

Evaluation of methods of characterization: AFM, STM, NMR, EM and so on. Properties and limitations. Methods for determination of association constant.

3. Molecular recognition of neutral and charged species: Design of receptors

Properties of molecular recognition. Design and properties of receptor design. Recognition of neutral molecules. Recognition of cationic and anionic components.

4. Self-assembly and supramolecular topology. Supramolecular dynamic chemistry

Self-assembling, properties and design. Kinetic and thermodynamic parameters in the formation of supramolecules. Methods for the preparation of linear, 2D and 3D structures. Design of dynamic process base on supramolecular chemistry. Covalent bonds in dynamic process and as kinetic traps. Self-organization: Gels and liquid crystal.

5. Coordination and organometallic chemistry in supramolecular chemistry

Supramolecular process based on metal coordination, new topologies. Organometallic complexes in supramolecular processes. Metal-metal interaction in supramolecular processes.

6. Applications of supramolecular processes

Transport processes. Catalysis and self-replication. Fluorescence sensors. Switchers and molecular wires. Molecular machines.

COURSE BIBLIOGRAPHY

1. Basic

- Steed, J. W.; Turner, D. R.; Wallace, K. J. *Core Concepts in Supramolecular Chemistry and Nanochemistry*. John Wiley & Sons, Ltd, **2007**. ISBN: 978-0-470-85866-0.
- Steed, J. W.; Atwood, J. A. *Supramolecular Chemistry*. 2nd Ed., John Wiley & Sons, Ltd, Chichester, **2009.** ISBN: 978-0-470-51234-0.
- Cragg, P. J. *Supramolecular Chemistry. From Biological Inspiration to Biomedical Applications*. Springer, **2010**. ISBN: 978-90-481-2581-4.
- Gale, P. A.; Steed, J. W. (Eds). *Supramolecular chemistry: from molecules to nanomaterials.* John Wiley & Sons Ltd, New York, **2012**. ISBN: 978-0-470-74640-0.

2. Complementary

- Nobuhiko Yui (Ed.). *Supramolecular Design for Biological Applications*. CRC Press, **2002**. ISBN: 0-8493-0965-4.
- Hans-Jörg Schneider (Ed.). *Supramolecular Systems in Biomedical Fields (Monographs in Supramolecular Chemistry).* RSC Publishing. **2013**. ISBN: 978-1-84973-658-9.
- Tatsuya Nabeshima (Ed.). *Synergy in Supramolecular Chemistry*. CRC Press, **2015**. ISBN: 978-1-4665-9504-0.

STUDENT WORKLOAD

The training activities will be distributed according to the following table.

	Activity	hours	% presential
Presential classes	Lectures and conferences	14	100%
	Seminars and classroom exercises	4	100%
	Tutorials	1	100%
	Practical classes	0	100%
	Oral presentations	2	100%
	Final exam	3	100%
Non Presential	Preparation and study of problems	10	0%
	Elaboration of individual work	36	0%
	Literature searching and so on	5	0%
	TOTAL	75	

TEACHING METHODOLOGY

The Virtual Campus will be used for delivering the necessary material to the students, according to the professor criterion. This material will include: the course program, exercises and problems to be solved, copies of the classroom presentations, etc.
Along the course, the student should participate in various formative activities, with the aim of acquiring the established knowledge and skills.
Master classes: Explanation of theoretical contents supplemented by audiovisual aids. The active participation of the students will be intended, through the formulation of appropriate questions that they should try to answer.
Seminars: There will be two classroom hours before the partial exams dedicated to review concepts and/or clarify doubts.
Use of fast and anonymous response methods in class (clickers) to know the degree of follow-up of the subject.
Presentation of individual works on some topics related to the subject, including the debate with his classmates and teachers.
Group and individual tutoring.

ASSESSMENT SYSTEM

With the aim of encouraging the constant student work to favor the learning, a continuous evaluation will be applied. This methodology will inform the professor about the content's assimilation by the student as well as their ability to apply them to problem solving. The evaluation will be individual.
Along the course, on professor criterion, the students will have to solve some exercises and hand them in at the scheduled date. Performing short tests in classroom is also foreseen. (30%)
In order to evaluate the knowledge related to the master classes and the problem-solving ability of the

students, one exam and/or individual oral presentation will be performed. (70%)
The students who did not pass the continuous evaluation will have the opportunity to perform a second-chance exam. To pass the course, it will be mandatory obtaining 5 points out of 10.

FACULTY DATA

Faculty	Contact	Semester	Class
Juan R. Granja	15746	1st	Maths (3rd floor)
Miguel Vázquez			

IDENTIFICATION FORM

Course Data

Course number	**P1251201**
Subject	*Experimental Techniques in Molecular Biology and Biomedicine*
Title	Chemistry at the interface with Biology and Materials Science (ChemBio&Mat) **P1251V01**
Course Level	Master
Credits	3.0
Module	**II (Biological Chemistry)**
Academic Year	2023-2024

Titulation

Title	Center	Course	Semester
ChemBio&Mat	FACULTAD de QUÍMICA/CiQUS	1	Second

Subject

Title	Course Title	Course type
ChemBio&Mat	Experimental Techniques in Molecular Biology and Biomedicine	Optional

Coordination

Name	Department	Contact
José M. Martínez Costas	Biochemistry and Molecular Biology	jose.martinez.costas@usc.es

SUMMARY

Living organisms represent not only the most complex chemical systems, but also a source of inspiration and problems to solve for chemists. In this subject, we will explore some of the most basic and useful techniques in the fields of Molecular Biology and Biomedicine, with a focus in their potential use for chemists. With a essentially applied and hands-on approach, we will learn how to manipulate and edit nucleic acids carrying your favorite gene, how to produce a protein of interest or how to grow cell lines and work with a living model organism.

PREREQUISITES

Relation with other topics of the Master

No enrollment restrictions have been specified with other subjects of the curriculum.

Other requirements

No enrollment restrictions have been specified with other subjects of the curriculum. Broad knowledge of general biology aspects is preferred.

COMPETENCES

Basic

- **CB6**: Possess and understand the knowledge that provides a basis or an opportunity for being creative and unique in the development and/or implementation of ideas, often in a research context.
- **CB7**: Students should know how to use the knowledge acquired and their problem-solving capacity in new or little-known environments within wider (or multidisciplinary) contexts related to their field of study.
- **CB8:** Students should be able to integrate knowledge and deal with the complexity of making judgements from information which – being incomplete or limited – includes reflections on the social and ethical responsibilities linked to the use of their knowledge or judgements.
- **CB9**: Students should know how to communicate their findings and the knowledge and underlying reasons underpinning them to specialized and non-specialized audiences in a clear and unambiguous way.
- **CB10**: Students should have the learning skills that allow them to carry on studying in such a way that should be mainly self-directed or autonomous.

General

- **CG1**: Know how to use the knowledge acquired for practical problem solving in the field of research and innovation, in the multidisciplinary context of biological chemistry and molecular materials.
- **CG2:** Know how to apply the scientific method and acquire skills for developing the necessary protocols for the design and critical assessment of chemical experiments.
- **CG3**: Be able to discuss and communicate ideas, in both oral and written form, to specialized and non-specialized audiences (congresses, conferences, etc.) in a clear and reasoned way.
- **CG4:** Be able to understand the social and ethical responsibilities linked to the use of knowledge or judgements in research, development, and innovation in the field of biological chemistry and molecular materials.
- **CG5**: Have the skills that allow students to develop an autonomous method for studying and learning.
- **CG6:** Have leadership, creativity, initiative, and entrepreneurship abilities.
- **CG7:** Be capable of working in multidisciplinary teams and collaborating with other specialists, both nationally and internationally.
- **CG8**: Be able to use scientific literature and develop the judgement needed for its interpretation and use.
- **CG10:** Be able to develop the different research stages (from the conception of an idea and the literature search through to target setting, experiment design, analysis of the results and drawing conclusions).

Transversal

- **CT1**: Develop teamwork skills: cooperation, leadership and good listening skills. Adapt to multidisciplinary teams.
- **CT2**: Draft scientific and technical reports and defend them publicly.
- **CT3:** Perform day-to-day research or professional activity in an independent and efficient manner.
- **CT4**: Apply the concepts, principles, theories and models related to Biological Chemistry and Molecular Materials to new or little-known environments within multidisciplinary contexts.
- **CT5**: Appreciate the value of good quality and continuous improvement by acting rigorously, responsibly and ethically.
- **CT6:** Be capable of adapting to changes by being self-motivated when applying new and advanced technologies and other relevant developments.
- **CT7**: Show critical and self-critical reasoning when seeking scientific rigour and quality. Handle IT tools and information and communication technology (ICT), as well as on-line access to databases.

Specific

- **CE1:** Know the impact of chemistry, biological chemistry and molecular materials on the industry, environment, health, agrofood and renewable energies.
- **CE4:** Know and understand the chemical tools and analytical techniques used for biological chemistry and molecular materials.
- **CE5:** Know how to analyze and use the data obtained autonomously in complex laboratory experiments by relating them to the suitable chemical, physical or biological techniques
- **CE6:** Know the physicochemical bases of biological processes.
- **CE7:** Students should acquire knowledge on advanced techniques for the structural characterization of macromolecules, supramolecules and colloids which are relevant in the field of biological chemistry and molecular materials.
- **CE8:** Gain technical skill for carrying out the structural characterization of molecules, biomolecules, supramolecules and nanoparticles and interpreting the experimental data obtained.
- **CE9:** Use advanced instrumentation related to research on biological chemistry and molecular materials.
- **CE11:** Be familiar with the basics of biological and cellular chemistry.
- **CE12:** Understand the weak interaction forces that control supramolecular processes and know how to apply them for obtaining new materials and biological functions.
- **CE20:** Know how to plan and carry out new laboratory experiments in an autonomous and independent manner.

OBJECTIVES OF TRAINING

- Know the basic and advanced techniques in the fields of molecular biology, cell and research with laboratory animals.

- Know the possible applications of the different techniques of manipulation of the coding capacity of the cell in industry and research.
- Understand the bases of the methodology of research with animals in laboratory.
- Understand the relevance that the choice of organism may have in the research and / or production

COURSE CONTENTS

1. Useful microorganisms Molecular Biology and Biotechnology

Types of microbiological cultures. Basic microbiology techniques (2.5h, including 1h laboratory).

2. Cell culture

Types of cultures and growth media. Cell lines. Stem cells, cell cloning. 2D and 3D cultures (1.5h).

3. Genetic Engineering techniques

Molecular cloning. Manipulation and purification of nucleic acids (4.5h, including 1.5h laboratory).

4. Polymerase chain reaction (PCR)

PCR basics. Useful variations of PCR and practical applications (2.5h, including 1h laboratory).

5. Expression of recombinant proteins

Basics of protein expression. Fusion proteins. Protein expression in bacteria. Protein expression in eukaryotes. In vitro expression methods. Creation of cell lines expressing a protein of choice. (4h, including 1h laboratory)

6. Protein purification

Basic techniques for protein purification and analysis. Quality control of purified proteins. Functional assays (5h, including 2h laboratory).

7. Control of gene expression

Systems to regulate or control gene expression. Up-regulation, down-regulation and gene knock-outs. Genome edition of cultured cells. RNA interference and CRISPR (2h).

8. Animal models

Introduction to model organisms. Clonic animals. Genetically modified animals. Transgenics animals. Handling and imaging of live animals: techniques and applications (2h).

COURSE BIBLIOGRAPHY

1. Basic

1.- Molecular Biology of the Cell, 5th ed, B. Alberts et al., Garland Science, 2014.
2.- Wilson and Walker´s Principles and Techniques of Biochemistry and Molecular Biology, 8th ed, A. Hofmann and S. Clokie, Cambridge University Press 2018.
3.- Molecular Biotechnology: Principles and Applications of Recombinant DNA, 5th ed, B.R. Glick and C.L. Patten, ASM Press 2017.

2. Complementary

- Specific scientific manuscripts will be provided for the relevant topics
- Molecular Cloning: A laboratory manual, 4th ed, M. Green and J. Sambrook, CSH Press 2012.

STUDENT WORKLOAD

The training activities will be distributed according to the following table.

	Activity	hours	% presential
Presential classes	Lectures and conferences	12	100%
	Seminars and classroom exercises	3	100%
	Tutorials	1	100%
	Practical classes	7	100%
	Oral presentations	0	0%
	Final exam	2	100%
Non Presential	Preparation and study of problems	10	0%
	Elaboration of individual work	36	0%
	Literature searching and so on	5	0%
	TOTAL	75	

TEACHING METHODOLOGY

- Interactive classes encouraging student participation.
- Combined use of computer and blackboard methods.
- Use of fast and anonymous response methods in class (clickers) to know the degree of following-up of the subject.

- Promotion of self-learning of the student by proposing challenges and posing questions.
- Resolution of practical exercises (problems, questions type test, interpretation and processing of information, evaluation of scientific publications, etc.).
- Oral presentations of previously prepared topics, including the debate with their classmates and teachers.
- Work in the laboratory: sample preparation and observation.

ASSESSMENT SYSTEM

- The evaluation process will not only serve to know if the student has acquired the programmed competences but also to review the teaching methodology.
- Written test on theoretical and practical basic contents of the subject.
- Continuous evaluation associated with active participation and autonomous learning.

Weightings between evaluation methods: minimum weighting (MiW) - maximum weighting (MaW)
Written exam: 50% -70%
Oral presentations: 10% -20%.
Lab work / activities: 15% -30%
Tutoring: 0% -10%

FACULTY DATA

Faculty	Contact	Semester	Class
José M. Martínez Costas jose.martinez.costas@usc.es	15733	2nd	Math (3rd floor)*
Miguel González Blanco miguel.gonzalez.blanco@usc.es	15386		Biol. Faculty

** Laboratory classes will be conducted at laboratory P3L6 at the CiQUS*

IDENTIFICATION FORM

Course Data

Course number	**P1**
Subject	*Biophysic*
Title	Chemistry at the interface with Biology and Materials Science (ChemBio&Mat)
Course Level	Master
Credits	3.0
Module	**II (Biological Chemistry)**
Academic Year	2020-2021

Titulation

Title	Center	Course	Semester
ChemBio&Mat	FACULTAD de QUÍMICA/CiQUS	1	second

Subject

Title	Course Title	Course type
ChemBio&Mat	Biophysic	Optative

Coordination

Name	Department	Contact
Francisco Rivadulla	Physical Chemistry	f.rivadulla@usc.es

SUMMARY

This subject deals with the understanding of how applies approaches and methods traditionally used in physics to study biological phenomena. Biophysics covers all scales of biological organization, from molecular to macroscopic level. Biophysical research shares significant overlap with biochemistry, molecular biology, physical chemistry, nanotechnology, bioengineering, computational biology, biomechanics, systems biology and so on.

PREREQUISITES

Relation with other topics of the Master

No enrollment restrictions have been specified with other subjects of the curriculum.

Other requirements

No enrollment restrictions have been specified with other subjects of the curriculum. Broad knowledge of general organic and inorganic chemistry is required, especially in its synthetic and structural aspects.

COMPETENCES

Basic

- **CB6**: Possess and understand the knowledge that provides a basis or an opportunity for being creative and unique in the development and/or implementation of ideas, often in a research context.
- **CB7**: Students should know how to use the knowledge acquired and their problem-solving capacity in new or little known environments within wider (or multidisciplinary) contexts related to their field of study.
- **CB8**: Students should be able to integrate knowledge and deal with the complexity of making judgements from information which – being incomplete or limited – includes reflections on the social and ethical responsibilities linked to the use of their knowledge or judgements.
- **CB9**: Students should know how to communicate their findings and the knowledge and underlying reasons underpinning them to specialised and non-specialised audiences in a clear and unambiguous way.
- **CB10**: Students should have the learning skills that allow them to carry on studying in such a way that should be mainly self-directed or autonomous.

General

- **CG2**: Know how to apply the scientific method and acquire skills for developing the necessary protocols for the design and critical assessment of chemical experiments.
- **CG3**: Be able to discuss and communicate ideas, in both oral and written form, to specialised and non-specialised audiences (congresses, conferences, etc.) in a clear and reasoned way.
- **CG5**: Have the skills that allow students to develop an autonomous method for studying and learning.
- **CG7:** Be capable of working in multidisciplinary teams and collaborating with other specialists, both nationally and internationally.
- **CG8**: Be able to use scientific literature and develop the judgement needed for its interpretation and use.
- **CG11:** Be able to adapt efficiently to future doctoral studies in multidisciplinary areas.

Transversal

- **CT1**: Develop teamwork skills: cooperation, leadership and good listening skills. Adapt to multidisciplinary teams.
- **CT2**: Draft scientific and technical reports and defend them publicly.
- **CT4**: Apply the concepts, principles, theories and models related to Biological Chemistry and Molecular Materials to new or little-known environments within multidisciplinary contexts.
- **CT7**: Show critical and self-critical reasoning when seeking scientific rigour and quality. Handle IT tools and information and communication technology (ICT), as well as on-line access to databases.

Specific

- **CE2**: Be capable of comparing experimental data and theoretical assumptions in a critical manner.
- **CE4:** Know and understand the chemical tools and analytical techniques used for biological chemistry and molecular materials.
- **CE6:** Know the physicochemical bases of biological processes.
- **CE7**: Students should acquire knowledge on advanced techniques for the structural characterization of macromolecules, supramolecules and colloids which are relevant in the field of biological chemistry and molecular materials.
- **CE8:** Gain technical skill for carrying out the structural characterization of molecules, biomolecules, supramolecules and nanoparticles and interpreting the experimental data obtained.

OBJECTIVES OF TRAINING

- Understand the physical basis of biological processes.
- Know the role of Thermodynamics in biological processes.
- Know the most usual physical techniques in the study of biological processes.
- Understand the phenomena of transport through cell membranes.
- Obtain a comprehensive and multidisciplinary vision of this area of knowledge and its relationship with other fields of Chemistry.

COURSE CONTENTS

1. Molecular structure and biological systems

Free energy, entropy, temperature and Boltzmann distribution as factors that determine the structure of macromolecules and processes of biological interest.

2. Energetic and Dynamics of Biological Systems

Self-assembling. Thermodynamics of Systems Far from Equilibrium

3. Physical factors of the environment

Friction processes in fluids: suspension and sedimentation. Viscosity and Reynolds number. Movement in biological systems. Diffusion: description of the simple solutions of the diffusion equation in biological systems and their consequences on molecular transport in cells.

4. The kinetics of biological systems

The kinetics of biological processes: enzymatic and polymerization reactions.

5. Transport in biological systems

Adsorption. The electric double layer model. Electric transport and membrane action potentials. Passive Transport of Substances Across Membranes. Channels and Carriers. Active Transport

COURSE BIBLIOGRAPHY

1. Basic

1.- Biophysics A Physiological Approach. Patrick F. Dillon, Cambridge Univ. Press 2012
2.- Fundamentals of Biophysics. Andrey B. Rubin. Scrinvener Publishing. Wiley. 2014
3.- Biophysics: an introduction. Cotterill, R. John Wiley&sons, 2003.

2. Complementary

STUDENT WORKLOAD

The training activities will be distributed according to the following table.

	Activity	hours	% presential
Presential classes	Lectures and conferences	15	100%
	Seminars and classroom exercises	4	100%
	Tutorials	1	100%
	Practical classes	0	100%
	Oral presentations	2	100%
	Final exam	2	100%
Non Presential	Preparation and study of problems	10	0%
	Elaboration of individual work	36	0%
	Literature searching and so on	5	0%
	TOTAL	75	

TEACHING METHODOLOGY

- Interactive classes encouraging student participation.
- Combined use of computer methods, and the blackboard.
- Use of fast and anonymous response methods in class (clickers) to evaluate the subject following-up.
- Promotion of student self-learning by proposing challenges and posing questions.

- Resolution of practical exercises (problems, tests, interpretation and information processing, evaluation of scientific publications, etc.).
- Oral presentations of previously prepared topics, including debates with their classmates and teachers.

ASSESSMENT SYSTEM

General considerations

- The evaluation process will be used to know if the student has acquired the scheduled skills and to review the teaching methodology.
- Written exam on theoretical and practical basic contents of the subject.
- Continuous evaluation associated with active participation and autonomous learning.

Evaluation weights: Minimum weighting (MiW)- Maximum weight (MaW)
Written Exam: 50%-70%
Oral presentations: 25%-40%
Other Activities: 10%-40%
Tutoring: 0%-10%

FACULTY DATA

Faculty	Contact	Semester	Class
Francisco Rivadulla	15724	2nd	Maths room (Third floor)
Manuel Souto			

IDENTIFICATION FORM

Course Data

Course number	**P1251107**
Subject	*Nanostructured Materials*
Title	Chemistry at the interface with Biology and Materials Science (ChemBio&Mat) **P1251V01**
Course Level	Master
Credits	3.0
Module	**Module III: Functional Materials**
Academic Year	2023-2024

Titulation

Title	Center	Course	Semester
ChemBio&Mat	FACULTAD de QUÍMICA/CiQUS	1	First

Subject

Title	Course Title	Course type
ChemBio&Mat	Nanostructured Materials	Compulsory

Coordination

Name	Department	Contact
Massimo Lazzari	Physical Chemistry	massimo.lazzari@usc.es/15723

SUMMARY

The emphasis in this course is to introduce nanoscience and nanotechnology, with a special attention for nanostructured materials, their chemical and fundamental properties, as well as fabrication methodologies. Preparation and applications of nanostructured soft materials will also be discussed.

PREREQUISITES

Relation with other topics of the Master

No enrollment restrictions have been specified with other subjects of the curriculum.

Other requirements

No enrollment restrictions have been specified with other subjects of the curriculum. Broad knowledge of material science is required.

COMPETENCES

Basic

- **CB6:** Possess and understand the knowledge that provides a basis or an opportunity for being creative and unique in the development and/or implementation of ideas, often in a research context.
- **CB7:** Students should know how to use the knowledge acquired and their problem-solving capacity in new or little known environments within wider (or multidisciplinary) contexts related to their field of study.

General

- **CG1**: Know how to use the knowledge acquired for practical problem solving in the field of research and innovation, in the multidisciplinary context of biological chemistry and molecular materials.
- **CG3**: Be able to discuss and communicate ideas, in both oral and written form, to specialised and non-specialised audiences (congresses, conferences, etc.) in a clear and reasoned way.
- **CG7**: Be able of working in multidisciplinary teams and collaborating with other specialists, both nationally and internationally.
- **CG8**: Be able to use scientific literature and develop the judgement needed for its interpretation and use.

Transversal

- **CT1**: Develop teamwork skills: cooperation, leadership and good listening skills. Adapt to multidisciplinary teams.
- **CT6**: Be capable of adapting to changes by being self-motivated when applying new and advanced technologies and other relevant developments.

Specific

- **CE13**: Know the magnitudes that determine materials' properties at the nanoscale.
- **CE15**: Students should be familiarized with nanotechnology methods and usefulness for studying processes of medical and biological interest.

OBJECTIVES OF TRAINING

- a global and multidisciplinary vision of nanomaterials
- know the commercial and potential applications of nanostructured materials.

COURSE CONTENTS

1. Introduction to nanoscience and nanotechnology

2. Fundamentals of nanomaterials

Classification, size effects on optical, electrical, catalytic, magnetic and thermal properties, etc.

3. Synthesis of nanomaterials

1-D / 2-D nanomaterials and 3-D nanomaterials.

4. Self-assembly

Principles and applications.

5. Nanostructured soft materials

Biologically based nanomaterials (biopolymers, nanoscale biological assemblies, biomimetic materials), polymeric-based nanostructured materials (polymer composites and nanocomposites), (block copolymers: preparation and applications), organic/inorganic hybrid materials.

COURSE BIBLIOGRAPHY

1. Basic

- Essentials in Nanoscience and Nanotechnology, N. Kumar and S. Kumbhat, 2016 John Wiley & Sons.
- Advanced Nanomaterials, K. E. Geckeler, H. Nishide, 2010 John Wiley & Sons.
- Fundamentals, Properties, and Applications of Polymer Nanocomposites, J. H. Koo, 2016 Cambridge University Press.
- Introduction to Soft Matter: Synthetic and Biological Self-Assembling Materials. HAMLEY, I. W., Ed. John Wiley & Sons, Chichester, UK, 2007.
- Nanostructured Materials, Processing, Properties and Applications. 2nd Edition, C. C. Koch Elsevier. 2007.
- Physical Properties of Materials. M.A. White, 2n Edition, CRC Press, 2011.

2. Complementary

- Design of Nanostructures: Self-Assembly of Nanomaterials, H. B. Bohidar, K. Rawat, 2016 John Wiley & Sons.
- Nanobiomaterials, Nanostructured Materials for Biomedical Applications. 1st Edition. R. Narayan, Woodhead Publishing, 2017.

STUDENT WORKLOAD

The training activities will be distributed according to the following table.

	Activity	hours	% presential
Presential classes	Lectures and conferences	14	100%
	Seminars and classroom exercises	4	100%
	Tutorials	1	100%
	Practical classes	0	100%
	Oral presentations	2	100%
	Final exam	3	100%
Non Presential	Preparation and study of problems	10	0%
	Elaboration of individual work	36	0%
	Literature searching and so on	5	0%
	TOTAL	75	

TEACHING METHODOLOGY

Attendance to these classes is compulsory and non-attendance will have a negative effect on the summative assessment. The methodology consists in:

a. Large-group lectures: teaching sessions conducted by a lecturer covering different aspects (theory, problems and/or examples, course guidelines…). The topics covered in the lectures will be based on the contents of the recommended bibliography in the syllabus of the course.
b. Interactive classes (Seminars): classes in which specific topics and eventual exercises are proposed and discussed. In some of the seminars, assessment activities will be carried out. The marks obtained in these activities will be part of the student assessment.
c. Tutorials: Students attend tutorials scheduled by the lecturer. This activity will involve discussion of questions or difficulties related to the course contents. This class may include assessment activities.
d. Presentations by students on topics previously proposed, including discussion with fellows.

ASSESSMENT SYSTEM

Scenario 1.

1. Student assessment will have two components:
1.1. Summative assessment (50 %), consisting of:
• Seminars work (40 %)
• Presentation and Tutorial work (10 %)
1.2. Final Exam (50 %)
2. Assessment of seminars, presentation by students and tutorials will be based on the results of the different assessment activities carried out during the course.
3. The final examination consists in a series of questions aiming to assess students' knowledge and competencies.

4. The final mark will be the result of equation:
Final mark = max(0.5 x N1+ 0.5 x N2, N2)
where:
N1 = Summative assessment mark
N2 = Final exam mark
Competence assessment
seminars: CB7, CG3, CG8, CT1, C13, C15
presentations and tutorials: CB6, CB7, CG3, CG7, CG8, CT1, CT7, C13
final exam: CB6, CG3, C13, C15

FACULTY DATA

Faculty	Contact	Semester	Class
Massimo Lazzari	15723	1st	Maths (3rd floor)
Beatriz Pelaz	15908		

IDENTIFICATION FORM

Course Data

Course number	**P1251108**
Subject	*Molecular Materials*
Title	Chemistry at the interface with Biology and Materials Science (ChemBio&Mat)
Course Level	Master
Credits	3.0
Module	**III (Functional Materials)**
Academic Year	2023-2024

Titulation

Title	Center	Course	Semester
ChemBio&Mat	FACULTAD de QUÍMICA/CiQUS	1	First

Subject

Title	Course Title	Course type
MolMat	Molecular Materials	Compulsory

Coordination

Name	Department	Contact
Diego Peña	Organic Chemistry	diego.pena@usc.es

SUMMARY

This course will introduce the student to the field of molecular materials with a chemical perspective and special emphasis on the structure/properties relation. Within the course we will study representative structures such as fullerenes, carbon nanotubes, graphene and 2D materials, and advanced polymers among other materials. Some of the most remarkable properties and applications of these molecular materials will be discussed during the course.

PREREQUISITES

Relation with other topics of the Master

No enrollment restrictions have been specified with other subjects of the curriculum.

Other requirements

No enrollment restrictions have been specified with other subjects of the curriculum. Broad knowledge of general organic, inorganic and physical chemistry is required.

COMPETENCES

Basic

- **CB6**: Possess and understand the knowledge that provides a basis or an opportunity for being creative and unique in the development and/or implementation of ideas, often in a research context.
- **CB7**: Students should know how to use the knowledge acquired and their problem-solving capacity in new or little-known environments within wider (or multidisciplinary) contexts related to their field of study.
- **CB8**: Students should be able to integrate knowledge and deal with the complexity of making judgements from information which – being incomplete or limited – includes reflections on the social and ethical responsibilities linked to the use of their knowledge or judgements.
- **CB10**: Students should have the learning skills that allow them to carry on studying in such a way that should be mainly self-directed or autonomous.

General

- **CG1**: Know how to use the knowledge acquired for practical problem solving in the field of research and innovation, in the multidisciplinary context of biological chemistry and molecular materials.
- **CG5**: Have the skills that allow students to develop an autonomous method for studying and learning.
- **CG8**: Be able to use scientific literature and develop the judgement needed for its interpretation and use.
- **CG11**: Be able to adapt efficiently to future doctoral studies in multidisciplinary areas

Transversal

- **CT1**: Develop teamwork skills: cooperation, leadership and good listening skills. Adapt to multidisciplinary teams.
- **CT2**: Draft scientific and technical reports and defend them publicly.
- **CT3**: Perform day-to-day research or professional activity in an independent and efficient manner.
- **CT4**: Apply the concepts, principles, theories and models related to Biological Chemistry and Molecular Materials to new or little-known environments within multidisciplinary contexts.
- **CT5**: Appreciate the value of good quality and continuous improvement by acting rigorously, responsibly and ethically.
- **CT7**: Show critical and self-critical reasoning when seeking scientific rigour and quality. Handle IT tools and information and communication technology (ICT), as well as on-line access to databases.

Specific

- **CE1**: Know the impact of chemistry, biological chemistry and molecular materials on the industry, environment, health, agro-food and renewable energies.
- **CE15**: Students should be familiarized with nanotechnology methods and usefulness for studying processes of medical and biological interest.
- **CE16**: Know the most relevant catalysis processes in the field of biological chemistry and molecular materials

OBJECTIVES OF TRAINING

- Understand the basic concepts in the field of molecular materials.
- Know most representative structures in the field.
- Understand the structure/property relations in molecular materials.
- Learn about active research lines and most promising applications in the field.

COURSE CONTENTS

1. Introduction to molecular materials

Introduction to characterization techniques, fabrication of thin films and liquid crystals. Optoelectronic properties and organic semiconductors. Introduction to on-surface science.

2. Representative structures of molecular materials

Polycyclic aromatic compounds. Fullerenes and carbon nanotubes. Graphene and 2D materials. Conjugated polymers. Foldamers and helical polymers. Dendrimers. Molecular machines. Nanoparticles and atomic clusters. Porous materials.

3. Devices and applications

Field-effect transistors. Light-emitting diodes. Photovoltaic cells. Sensors.

COURSE BIBLIOGRAPHY

- Molecular Electronics: From Principles to Practice. M. C. Petty, John Wiley & Sons, 2007
- Dekker Encyclopedia of Nanoscience and Nanotechnology. J. A. Schwarz, C. I. Contescu, Karol Putyera (eds.). New York: Marcel Dekker, 2004
- Handbook of Conducting Polymers. T. A. Skotheim, J. R. Reynolds (eds), 3rd ed., Boca Raton: CRC Press, 2007.
- Carbon-Rich Compounds. M. M. Haley, R. R. Tykwinski (eds), Wiley VCH, 2006.

- Fullerenes: principles and applications. F. Langa, J.-F. Nierengarten (eds), Royal Society of Chemistry, 2008.
- Carbon Nanotubes: Synthesis, Structure, Properties and Applications. M. S. Dresselhaus, G. Dresselhaus, P. Avouris (eds), Springer-Verlag, 2001.
- Organic Optoelectronic Materials. Y. Li (ed), Springer, 2015
- Organic Photovoltaics: Materials, Device Physics, and Manufacturing Technologies. C. Brabec, U. Scherf, V. Dyakonov, (eds), 2nd ed., Weinheim: Wiley-VCH, 2014
- Organic Photovoltaics: Mechanism, Materials and Devices. S.-S. Sun, N. S. Sariciftci, (eds.) Boca Raton: Taylor & Francis, cop. 2005
- Light-Emitting Diodes. E. F. Schubert, Cambridge: Cambridge University Press, 2003
- Introduction to Liquid Crystals Chemistry and Physics. P. J. Collings, London: Taylor & Francis, 2001

STUDENT WORKLOAD

The training activities will be distributed according to the following table.

	Activity	hours	% presential
Presential classes	Lectures and conferences	14	100%
	Seminars and classroom exercises	4	100%
	Tutorials	1	100%
	Practical classes	0	100%
	Oral presentations	2	100%
	Final exam	3	100%
Non Presential	Preparation and study of problems	10	0%
	Elaboration of individual work	36	0%
	Literature searching and so on	5	0%
	TOTAL	75	

TEACHING METHODOLOGY

The Virtual Campus will be used for delivering the necessary material to the students, according to the professor criterion. This material will include: the course program, exercises and problems to be solved, copies of the classroom presentations, etc.
Along the course, the student should participate in various formative activities, with the aim of acquiring the established knowledge and skills.
Lectures: Explanation of theoretical contents supplemented by audiovisual aids. The active participation of the students will be intended, through the formulation of appropriate questions that they should try to answer.
Seminars: Dedicated to problem resolution. Encourage the self-learning through scientific articles and challenges
Tutorial: Dedicated to review concepts and/or clarify doubts.

Presentation of individual works on some topics related to the subject, including the debate with his classmates and teachers.

ASSESSMENT SYSTEM

In order to evaluate the knowledge related to the master classes and the problem-solving ability of the students, one exam and will be performed (70%).
With the aim of encouraging the constant student work to favor the learning, a continuous evaluation will be applied (30%). This may include to solve some exercises and hand them in at the scheduled date and demonstrate skills related with oral presentations of selected articles.
To pass the course, it will be mandatory obtaining 5 points out of 10.

FACULTY DATA

Faculty	Contact	Semester	Class
Diego Peña	15718	1st	Maths (3rd floor)
Félix Freire	15742		

IDENTIFICATION FORM

Course Data

Course number	**P1251203**
Subject	*Molecular Magnetism*
Title	Chemistry at the interface with Biology and Materials Science (ChemBio&Mat) **P1251V01**
Course Level	Master
Credits	3.0
Module	**III (Functional Materials)**
Academic Year	2023-2024

Titulation

Title	Center	Course	Semester
ChemBio&Mat	FACULTAD de QUÍMICA/CiQUS	1	Second

Subject

Title	Course Title	Course type
ChemBio&Mat	Molecular Magnetism	Optative

Coordination

Name	Department	Contact
María del Carmen Giménez-López	Inorganic Chemistry	maria.gimenez.lopez@usc.es; 15905

SUMMARY

Most magnetic materials are inorganic, mostly based on transition-metal alloys or crystalline oxides. However, in the last two decades organic and molecular materials have become also increasingly present in magnetic studies, particularly after the long-range magnetic order increased until high temperatures (particularly above liquid nitrogen). The possibility of applying synthetic chemistry techniques to form a very large variety of molecules in which transition-metal ions are used to provide the magnetic moment, and organic ligand groups mediate the interactions, open enormous possibilities to study. This strategy produced magnetic materials with a large variety of structures: chains (1D), layers (2D), and networks (3D), some of which show ordering at room temperature and high coercivity. Recently, single molecule magnets (0D), small magnetic clusters, were prepared, showing macroscopic quantum tunneling of their magnetization, which may find important applications in quantum computation.

PREREQUISITES

Relation with other topics of the Master

No enrollment restrictions have been specified with other subjects of the curriculum.

Other requirements

No enrollment restrictions have been specified with other subjects of the curriculum. Broad knowledge of general physical and inorganic chemistry is required.

COMPETENCES

Basic and General

- **CE1** To know the impact of chemistry, biological chemistry and molecular materials in the industry, the environment, health, agri-food and renewable energies.
- **CE2** To be able to critically compare the experimental data and the theoretical hypotheses.
- **CE6** To know the physicochemical bases of biological processes.

Transversal

- **CT4** To apply the concepts, principles, theories or models related to Biological Chemistry and Molecular Materials to new or little known environments, within contexts multidisciplinary.

Specific

- **CG1** To know how to apply the knowledge acquired to solve practical problems in the field of research and innovation in the multidisciplinary context of chemistry biological and molecular materials.
- **CG3** Being able to discuss and communicate their ideas, orally and in writing, to audiences specialized and non-specialized (congresses, etc.) in a clear and reasoned way.
- **CG8** Manage advanced scientific literature from primary sources and acquire the tools needed develop their critical interpretation, with the ability to establish the state of art ("state of the art") of novel thematic lines in the fields of chemistry biological and molecular materials.

OBJECTIVES OF TRAINING

The main objectives are that the student acquires the following competences:

- Acquisition of the basic knowledge necessary for the analysis of properties of the molecular-based magnets and their design.
- Knowledge of recent advances in molecular magnetism in the field of spintronics and quantum computing.

COURSE CONTENTS

1. - Definitions, units and basic concepts

Magnetization, magnetic susceptibility, experimental measurement techniques, types of magnetic behavior, Curie's law (Curie-Weiss), fundamental and Hamiltonian equations of spin.

2. Magnetism of isolated and interacting ions

Zeeman effect, spinorbit coupling, magnetic anisotropy, etc.

3. Cooperative magnetism

Types of long-range ordering (ferromagnetism, antiferromagnetism, ferrimagnetism and metamagnetism) and in unordered systems (superparamagnetismo and spin glasses).

4. Molecular-based magnets

Mono molecular, ionic and chain based molecular magnets. Synthesis and basic magnetic properties.

5. Applications of molecular magnets.

Molecular spintronics and quantum computing based on molecular magnets.

COURSE BIBLIOGRAPHY

1. Basic

– Cristiano Benelli and Dante Gatteschi. Introduction toMolecular Magnetism:From Transition Metals to lanthanides. 2015 Wiley-VCH Verlag GmbH & Co. KGaA, Boschstr. 12, 69469 Weinheim, Germany.

2. Complementary

– Kahn, Olivier, Molecular magnetism. VCH Publishers, Inc. 220 East 23rd Street New York N.Y, ISBN 1-56081-566-3

STUDENT WORKLOAD

The training activities will be distributed according to the following table.

	Activity	hours	% presential
Presential classes	Lectures and conferences	12	100%
	Seminars and classroom exercises	6	100%
	Tutorials	1	100%
	Practical classes	0	100%
	Oral presentations	2	100%
	Final exam	3	100%
Non Presential	Preparation and study of problems	10	0%
	Elaboration of individual work	36	0%
	Literature searching and so on	5	0%
	TOTAL	75	

TEACHING METHODOLOGY

The Virtual Campus will be used for delivering the necessary material to the students, according to the professor criterion. This material will include: the course program, exercises and problems to be solved, copies of the classroom presentations, etc.
Along the course, the student should participate in various formative activities, with the aim of acquiring the established knowledge and skills.
Master classes: Explanation of theoretical contents supplemented by audiovisual aids. The active participation of the students will be intended, through the formulation of appropriate questions that they should try to answer.
Seminars: There will be two classroom hours before the partial exams dedicated to review concepts and/or clarify doubts.
Presentation of individual works on some topics related to the subject, including the debate with his classmates and teachers.
Group and individual tutoring.

ASSESSMENT SYSTEM

With the aim of encouraging the constant student work to favor the learning, a continuous evaluation will be applied. This methodology will inform the professor about the content's assimilation by the student as well as their ability to apply them to problem solving. The evaluation will be individual.
Along the course, on professor criterion, the students will have to solve some exercises and hand them in at the scheduled date. Performing short tests in classroom is also foreseen. (40%)
In order to evaluate the knowledge related to the master classes and the problem-solving ability of the students, one exam and/or individual oral presentation will be performed. (60%)

The students who did not pass the continuous evaluation will have the opportunity to perform a second-chance exam. To pass the course, it will be mandatory obtaining 5 points out of 10.
The continuous evaluation grade will only be obtained through "active" participation in the activities that make up said evaluation (class presentations, class problem solving, ...), in order to demonstrate that the knowledge set for each of the such activities.
The final exam will include theoretical questions and problems related to the subject included in the subject's program, regardless of whether the subject was worked in the expository, interactive or practical classes. The exam will be graded on a total of 10 points.
In cases of fraudulent performance of exercises or tests, the provisions of the *"Regulations for evaluating student academic performance and reviewing grades"* will apply.
SCENARIO 2. Distance (with partial restrictions on physical attendance)
The evaluation system does not undergo any modification with respect to what has already been indicated in the section corresponding to scenario 1. The same percentages of continuous evaluation and exam are maintained to obtain the final grade for the course.
The "active" participation in the activities that make up the continuous evaluation will depend on the attendance to the face-to-face sessions, the involvement and participation during the telematic sessions and the deliveries made through the virtual Classroom.
The final exam of the subject will be done electronically using the Virtual Classroom Questionnaires tool combined with simultaneous session in MS Teams. The contents that will be evaluated in the exam will be the same as those indicated for scenario 1.
SCENARIO 3. Closure of facilities (impossibility of teaching face-to-face)
The evaluation system does not undergo any modification with respect to what has already been indicated in the section corresponding to scenario 1. The same percentages of continuous evaluation and exam are maintained to obtain the final grade for the course.
The "active" participation in the activities that make up the continuous evaluation will depend on the involvement and participation during the telematic sessions and the deliveries made through the virtual Classroom.
The final exam of the subject will be done electronically using the Virtual Classroom Questionnaires tool combined with simultaneous session in MS Teams. The contents that will be evaluated in the exam will be the same as those indicated for scenario 1.

COMMENTS

Classes will be taught in English

FACULTY DATA

Faculty	Contact	Semester	Class
Rafael Ramos Amigo	15724	2nd	Maths (3rd floor)
Maria Giménez	15905		Chem

IDENTIFICATION FORM

Course Data

Course number	**P1251204**
Subject	*Nanobiotechnology*
Title	Chemistry at the interface with Biology and Materials Science (ChemBio&Mat) **P1251V01**
Course Level	Master
Credits	3.0
Module	**III (Functional Materials)**
Academic Year	2023-2024

Titulation

Title	Center	Course	Semester
ChemBio&Mat	FACULTAD de QUÍMICA/CiQUS	1	Second

Subject

Title	Course Title	Course type
ChemBio&Mat	Nanobiotechnology	Optional

Coordination

Name	Department	Contact
Pablo del Pino	Condensed Matter Physics	pablo.delpino@usc.es/15711

SUMMARY

Nanobiotechnology is the application of nanotechnologies in biological fields. The nanotechnologies are commonly fed by multidisciplinary, application-driven collaborations among chemists, physicists, biologists, among others. One result is the hybrid field of nanobiotechnology that uses biological starting materials, biological design principles or has biological or medical applications.
While biotechnology deals with metabolic and other physiological processes of biological subjects including microorganisms, in combination with nanotechnology, nanobiotechnology provides many useful tools in the study of life. Although the integration of nanomaterials with biology has led to the development of diagnostic devices, contrast agents, analytical tools, therapy, and drug-delivery vehicles, bionanotechnology research is still in its infancy.

PREREQUISITES

Relation with other topics of the Master

No enrollment restrictions have been specified with other subjects of the curriculum.

Other requirements

No enrollment restrictions have been specified with other subjects of the curriculum. Broad knowledge of general organic and inorganic chemistry is required, especially in its synthetic and structural aspects.

COMPETENCES

Basic

- **CB9**: Students should know how to communicate their findings and the knowledge and underlying reasons underpinning them to specialised and non-specialised audiences in a clear and unambiguous way.

General

- **CG3**: Be able to discuss and communicate ideas, in both oral and written form, to specialised and non-specialised audiences (congresses, conferences, etc.) in a clear and reasoned way.
- **CG7**: Be capable of working in multidisciplinary teams and collaborating with other specialists, both nationally and internationally

Transversal

- **CT1**: Develop teamwork skills: cooperation, leadership and good listening skills. Adapt to multidisciplinary teams.
- **CT4**: Apply the concepts, principles, theories and models related to Biological Chemistry and Molecular Materials to new or little-known environments within multidisciplinary contexts.

Specific

- **CE4**: Know and understand the chemical tools and analytical techniques used for biological chemistry and molecular materials.
- **CE6**: Know the physicochemical bases of biological processes.
- **CE12**: Know the weak interaction forces that dominate the supramolecular processes and that can apply them to obtain new materials and biological functions.
- **CE13**: Know the magnitudes that determine the properties of materials at the nanoscale.
- **CE15**: Know the methods and the utility of the nanotechnology for the study of the processes of medical and biological interest.

OBJECTIVES OF TRAINING

- Understand the basic concepts on which nanobiotechnology is based.

- Acquire and understand the different design and synthesis strategies of biofunctional nanomaterials.
- Obtain a comprehensive and multidisciplinary vision of the area, in the context of other scientific areas.
- Get an overview of the most commonly used experimental methods and techniques to study nanomaterials in the biological and medical context.
- Know the possible applications of nanobiotechnology.

COURSE CONTENTS

1. The "nano" scale in biology and medicine

Introduction to the nanobiotechnologies, history and basic fundaments. Bio-nano-interactions, strength and properties.

2. Bio-applications of plasmonic nanoparticles in biosensing, imaging and therapy

Plasmonic nanomaterials synthesis and bio-functionalization; plasmon resonance; surface enhanced Raman spectroscopy (SERS); dark-field microscopy; photothermal effect; bionanoplasmonics.

3. Bio-applications of magnetic nanoparticles in biosensing, imaging and therapy

Superparamagnetism; monodomain magnetic nanoparticles; magnetic bionanosensing; magnetic resonance imaging; magnetic fluid hyperthermia.

4. Bio-applications of photoluminescent nanoparticles in biosensing and imaging

Bioimaging; labeling in vitro and in vivo; QDs, upconverting NPs; resonance energy transfer.

5. Bio-applications of polymeric nanostructures in biosensing, therapy and imaging

Drug delivery; nanomedicines based on polymeric scaffolds; theragnostic agents

6. Encapsulation of drugs in nanostructures

Loading efficiency and drug loading; drug leaking and stability; preserving the activity of drugs; interactions of drug and nanostructures (loading mechanisms).

7. Stimuli-controlled release of drugs

Ultrasounds; light; magnetic fields; biological environments/triggers.

8. In vitro studies: nanotoxicology, the protein corona and the interactions of nanoparticles with cells

Quantification of NP-uptake by cells and cell viability tests; unspecific absorption of proteins by NPs; correlation of NP-uptake, viability and protein corona.

9. In vivo studies: pharmacokinetics and biodistribution, vectorization and clinical applications

Active and passive targeting; cancer nanomedicines; clinical trials; current challenges for nanomedicine translation.

COURSE BIBLIOGRAPHY

1. Basic

– Nanobiotechnology: Concepts, Applications and Perspectives (2004); Edited by Christof M. Niemeyer & Chad A. Mirkin; ISBN: 978-3-527-30658-9

2. Complementary

– State of the art literature will be provided.

STUDENT WORKLOAD

The training activities will be distributed according to the following table.

	Activity	hours	% presential
Presential classes	Lectures and conferences	14	100%
	Seminars and classroom exercises	4	100%
	Tutorials	1	100%
	Practical classes	0	100%
	Oral presentations	2	100%
	Final exam	3	100%
Non Presential	Preparation and study of problems	10	0%
	Elaboration of individual work	36	0%
	Literature searching and so on	5	0%
	TOTAL	75	

TEACHING METHODOLOGY

The Virtual Campus will be used for delivering the necessary material to the students, according to the professor criterion. This material will include: the course program, exercises and problems to be solved, copies of the classroom presentations, etc.
Along the course, the student should participate in various formative activities, with the aim of acquiring the established knowledge and skills.
Master classes: Explanation of theoretical contents supplemented by audiovisual aids. The active participation of the students will be intended, through the formulation of appropriate questions that they should try to answer.
Seminars: There will be two hours of class before the partial exams dedicated to review concepts and/or clarify doubts.
Use of fast and anonymous response methods in class (clickers) to know the degree of follow-up of the subject.
Presentation of individual works on some topics related to the subject, including the debate with classmates and professor.
Group and individual tutoring.

ASSESSMENT SYSTEM

With the aim of encouraging the constant student work to favor the learning, a continuous evaluation will be applied. This methodology will inform the professor about the content's assimilation by the student as well as their ability to apply them to problem solving. The evaluation will be individual.
Along the course, on professor criterion, the students will have to solve some exercises and hand them in at the scheduled date. Performing short tests in classroom is also foreseen. (30%)
In order to evaluate the knowledge related to the master classes and the problem-solving ability of the students, one exam and/or individual oral presentation will be performed. (70%)
The students who did not pass the continuous evaluation will have the opportunity to perform a second-chance exam. To pass the course, it will be mandatory obtaining 5 points out of 10.

FACULTY DATA

Faculty	Contact	Semester	Class
Pablo del Pino	15746	2nd	Math (3rd Floor)
Eduardo Fernández-Megía	15727		

IDENTIFICATION FORM

Course Data

Course number	**P1251106**
Subject	*Catalysis*
Title	Chemistry at the interface with Biology and Materials Science (ChemBio&Mat) **P1251V01**
Course Level	Master
Credits	3.0
Module	**Module IV: Reactivity and Synthesis**
Academic Year	2023-2024

Titulation

Title	Center	Course	Semester
ChemBio&Mat	FACULTAD de QUÍMICA/CiQUS	1	First

Subject

Title	Course Title	Course type
ChemBio&Mat	Catalysis	Compulsory

Coordination

Name	Department	Contact
Moisés Gulías	Organic Chemistry	moises.gulias@usc.es

SUMMARY

A large majority of the industrial chemicals are made through catalytic processes. The presence of a catalyst offers an alternative, and more energetically favorable mechanism to the non-catalytic reactions and enables to carry out many reactions under milder conditions. They are also in connection with the principles of atom economy and green chemistry. Remarkably catalyst design allows to improve the control over chemo- regio- and stereoselectivity of the processes.

Catalysts come in a multitude of forms, varying from small organic molecules or organometallic complexes to large structures such as zeolites or enzymes. They also operate under a different variety of mechanisms. In this course a review the main types of catalytic transformations and the main principles behind these transformations.

PREREQUISITES

Relation with other topics of the Master

No enrollment restrictions have been specified with other subjects of the curriculum.

Other requirements

No enrollment restrictions have been specified with other subjects of the curriculum. Broad knowledge of general organic and inorganic chemistry is required, especially in its synthetic and structural aspects.

COMPETENCES

Basic

- **CB6**: Possess and understand the knowledge that provides a basis or an opportunity for being creative and unique in the development and/or implementation of ideas, often in a research context.
- **CB7**: Students should know how to use the knowledge acquired and their problem-solving capacity in new or little known environments within wider (or multidisciplinary) contexts related to their field of study.
- **CB9**: Students should know how to communicate their findings and the knowledge and underlying reasons underpinning them to specialized and non-specialized audiences in a clear and unambiguous way.
- **CB10**: Students should have the learning skills that allow them to carry on studying in such a way that should be mainly self-directed or autonomous.

General

- **CG1**: Know how to use the knowledge acquired for practical problem solving in the field of research and innovation, in the multidisciplinary context of biological chemistry and molecular materials.
- **CG3**: Be able to discuss and communicate ideas, in both oral and written form, to specialized and non-specialized audiences (congresses, conferences, etc.) in a clear and reasoned way.
- **CG4:** Be able to understand the social and ethical responsibilities linked to the use of knowledge or judgements in research, development and innovation in the field of biological chemistry and molecular materials.
- **CG6:** Have leadership, creativity, initiative and entrepreneurship abilities
- **CG8**: Be able to use scientific literature and develop the judgement needed for its interpretation and use.
- **CG9:** Be capable of handling chemical substances safely and work in a chemical laboratory without risks.

Transversal

- **CT1**: Develop teamwork skills: cooperation, leadership and good listening skills. Adapt to multidisciplinary teams.
- **CT3**: Perform day-to-day research or professional activity in an independent and efficient manner

- **CT4**: Apply the concepts, principles, theories and models related to Biological Chemistry and Molecular Materials to new or little-known environments within multidisciplinary contexts.
- **CT6**: Be capable of adapting to changes by being self-motivated when applying new and advanced technologies and other relevant developments.
- **CT7**: Show critical and self-critical reasoning when seeking scientific rigour and quality. Handle IT tools and information and communication technology (ICT), as well as on-line access to databases.

Specific

- **CE1**: Know the impact of chemistry, biological chemistry and molecular materials on the industry, environment, health, agrofood and renewable energies.
- **CE3:** Know the rules on risk prevention in the laboratory and within the chemistry-related industry.
- **CE5**: Know how to analyze and use the data obtained autonomously in complex laboratory experiments by relating them to the suitable chemical, physical or biological techniques.
- **CE16**: Know the most relevant catalysis processes in the field of biological chemistry and molecular materials.
- **CE17**: Be able to establish relationships between structure and reactivity.
- **CE19**: Know how to carry out, submit and defend individually, and once all curriculum credits are obtained, a comprehensive research project on Biological Chemistry and Molecular Materials which synthesizes the skills learnt in the Masters course.
- **CE20**: Know how to plan and carry out new laboratory experiments in an autonomous and independent manner.

OBJECTIVES OF TRAINING

- Understand the importance of catalysis and its general principles.
- Know and understand the different types of catalysis, included metallic-, organo-, bio- and surface catalysis; and the main characteristics and mechanisms they are based on.
- Obtain an overview of how to apply catalysis for the synthesis of organic molecules
- Learn the advanced applications of this field of science in chemical industry and drug discovery.

COURSE CONTENTS

1. Catalysis, types and physical and chemical principles related to the kinetics of the catalytic reactions

Catalysis, definition, types. Catalysis and *Green Chemistry*. The chemical Industry. Kinetics. The rate Equation and power rate laws. Reactions of different orders. Temperature dependence of the rate.

2. Principles and fundamentals of the heterogeneous catalysis

Introduction to the principles of the heterogeneous catalysis. Description of the main types of heterogeneous catalysts. Introductory review of most important heterogeneous catalytic reactions and processes.

3. Homogeneous catalysis. Catalysis with organometallic complexes

Introduction to the factors which influence the homogenous organometallic catalysis. Main mechanistic steps in organometallic reactions. Cross-coupling reactions: Suzuki, Negishi, Kumada, etc.. Reactions of η^3-allyl complexes. Reactions of metal-carbene complexes. Reactions of η^2-alkyne and alkene complexes. C-H functionalization reactions.

4. Homogeneous catalysis. Catalysis with organic molecules (organocatalysis) chemistry

Asymmetric Synthesis. Relevance and different approaches.
Asymmetric Organocatalysis: definition, historical perspective.
Modes of activation: Non-covalent and covalent organocatalysis; C-C and C-heteroatom bond forming reactions
Dual and / or cooperative catalysis: Organo + Photoredox catalysis, Organo + transition metal catalysis

5. Principles and fundamentals of the biocatalysis

Introduction. Enzymes, classification (oxidoreductases, lyases, isomerases, …). Most relevant applications and case studies

6. Relevant synthetic applications of the catalytic processes.

Applications of synthetic catalytic processes in fine chemical industry and drug discovery. Case studies

COURSE BIBLIOGRAPHY

1. Basic

– *Catalysis: An Integrated Textbook for Students*, Ulf Hanefeld (Ed), Leon Lefferts (Ed), Wiley: 2018.

2. Complementary

– *Concepts of Modern Catalysis and Kinetics*, I. Chorkendorff (Ed), J. W. Niemantsverdriet (Ed). John Wiley & Sons, **2003**

- *Homogeneous Catalysts: Activity - Stability ¨C Deactivation*; John C. Chadwick (Ed), Piet W. N. M. van Leeuwen (Ed), Wiley-VCH, **2011**
- *Homogeneous Catalysis for Unreactive Bond Activation*, Zhang©\Jie Shi (Ed), Wiley-VCH, **2014**
- *Bridging Heterogeneous and Homogeneous Catalysis: Concepts, Strategies, and Applications*, Li Can Liu Yan (Ed), Wiley-VCH, 2014
- *Enantioselective Organocatalysis: Reactions and Experimental Procedures*, P. I. Dalko, Ed., Wiley-VCH: Weinheim, **2007**
- *Stereoselective Organocatalysis, Bond Formation Methodologies and Activation Modes*, Rios, R. (Ed.), Wiley-VCH, **2013**
- *Applications of Transition Metal Catalysis in Drug Discovery and Development: An Industrial Perspective*, M. L. Crawley (ED.), B. M. Trost (Ed.) john Wiley and Sons, **2012**
- *Organometallics as Catalysts in the Fine Chemical Industry*, Beller, M., Blaser, H.-U. (Eds.) Topics in Organometallic Chemistry, Springer-Verlag Berlin, **2012**

STUDENT WORKLOAD

The training activities will be distributed according to the following table.

	Activity	hours	% presential
Presential classes	Lectures and conferences	14	100%
	Seminars and classroom exercises	4	100%
	Tutorials	1	100%
	Practical classes	0	100%
	Oral presentations	2	100%
	Final exam	3	100%
Non Presential	Preparation and study of problems	10	0%
	Elaboration of individual work	36	0%
	Literature searching and so on	5	0%
	TOTAL	75	

TEACHING METHODOLOGY

The Virtual Campus will be used for delivering the necessary material to the students, according to the professor criterion. This material will include: the course program, exercises and problems to be solved, copies of the classroom presentations, etc.
Along the course, the student should participate in various formative activities, with the aim of acquiring the established knowledge and skills.
Master classes: Explanation of theoretical contents supplemented by audiovisual aids. The active participation of the students will be intended, through the formulation of appropriate questions that they should try to answer.
Seminars: There will be two classroom hours before the partial exams dedicated to review concepts and/or clarify doubts.

Use of fast and anonymous response methods in class (clickers) to know the degree of follow-up of the subject.
Presentation of individual works on some topics related to the subject, including the debate with his classmates and teachers.
Group and individual tutoring.

ASSESSMENT SYSTEM

With the aim of encouraging the constant student work to favor the learning, a continuous evaluation will be applied. This methodology will inform the professor about the content's assimilation by the student as well as their ability to apply them to problem solving. The evaluation will be individual.
In order to evaluate the knowledge related to the master classes and the problem-solving ability of the students, one exam and/or individual oral presentation will be performed. [60 % of the final mark]. Evaluated competences: CG1, CB6, CT3, CE1, CE3, CE5, CE16, CE17, CE19 and CE20]
Individual oral presentation will be performed. [25 % of the final mark]. Evaluated competences: CG2, CG3, CG6, CB9, CT1 and CE1]
Along the course, on professor criterion, the students will have to solve some exercises and hand them in at the scheduled date. Performing short tests in classroom is also foreseen. [15 % of the final mark]. Evaluated competences: CG2, CG5, CB10, CB7, CT1, CT3, CT4, CT6 and CT7
"In cases of fraudulent performance of exercises or tests, the provisions of the "Regulations for evaluating the academic performance of students and reviewing grades" will apply.

FACULTY DATA

Faculty	Contact	Semester	Class
Moisés Gulías Costa	15790	1st	Maths (3rd floor)
Fernando J. López García	15781		

IDENTIFICATION FORM

Course Data

Course number	**P1251110**
Subject	*Chemical Synthesis*
Title	Chemistry at the interface with Biology and Materials Science (ChemBio&Mat) **P1251V01**
Course Level	Master
Credits	3.0
Module	**IV (Reactivity and Synthesis)**
Academic Year	2023-2024

Titulation

Title	Center	Course	Semester
ChemBio&Mat	FACULTAD de QUÍMICA/CiQUS	1	First

Subject

Title	Course Title	Course type
ChemBio&Mat	Chemical Synthesis	Compulsory

Coordination

Name	Department	Contact
F. Javier Sardina	Organic Chemistry	javier.sardina@usc.es/15715

SUMMARY

The synthesis of new molecules and materials is the most fundamental tool to achieve any significant progress in the Chemical Sciences, whether basic or applied. New molecules and materials are needed to create new functions and properties in fields ranging from Biology and Medicine to Electronics and Photonics. Understanding and learning to use the strategies, tactics and basic tools for devising synthesis of new molecules and materials, or improved synthesis of existing interesting molecules and materials, are the central objectives of this course.

In their first part of the course, we shall survey the basic and classical concepts involved in synthesis planning, such as retrosynthetic analysis, focused on the preparation of a single organic compound (Target Oriented Synthesis), as well as more recently developed methodologies to achieve the synthesis of a focused library of organic compounds (Diversity Oriented Synthesis). We shall also deal with more specific synthetic themes, such as the asymmetric synthesis of chiral molecules.

The second part of the course will deal with the intricacies and tools required for the synthesis of organometallic compounds and of molecular frameworks (MOFs and COFs).

PREREQUISITES

Relation with other topics of the Master

No enrollment restrictions have been specified with other subjects of the curriculum.

Other requirements

No enrollment restrictions have been specified with other subjects of the curriculum. Broad knowledge of general organic and inorganic chemistry is required, especially in its synthetic and structural aspects.

COMPETENCES

Basic

- **CB6**: Possess and understand the knowledge that provides a basis or an opportunity for being creative and unique in the development and/or implementation of ideas, often in a research context.
- **CB7**: Students should know how to use the knowledge acquired and their problem-solving capacity in new or little known environments within wider (or multidisciplinary) contexts related to their field of study.
- **CB8**: That students are able to integrate knowledge and face the complexity of making judgments based on information that, being incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of their knowledge and judgments
- **CB9**: Students should know how to communicate their findings and the knowledge and underlying reasons underpinning them to specialised and non-specialised audiences in a clear and unambiguous way.
- **CB10**: Students should have the learning skills that allow them to carry on studying in such a way that should be mainly self-directed or autonomous.

General

- **CG2**: Know how to apply the scientific method and acquire skills for developing the necessary protocols for the design and critical assessment of chemical experiments.
- **CG3**: Be able to discuss and communicate ideas, in both oral and written form, to specialised and non-specialised audiences (congresses, conferences, etc.) in a clear and reasoned way.
- **CG5**: Have the skills that allow students to develop an autonomous method for studying and learning.
- **CG6**: To have the ability for leadership, creativity, initiative and entrepreneurial spirit.
  CG7: To be able to work as part of multidisciplinary teams and collaborate with other professionals, both nationally and internationally.
- **CG8**: To be able to use scientific literature and develop the judgement needed for its interpretation and use.

- **CG10**: To be able to develop the different stages involved in a research (from conceiving an idea and doing a bibliographical search to the approach of the objectives, the design of the experiment, the analysis of the results and the deduction of the corresponding conclusions).
- **CG11**: To be able to adapt efficiently to future doctoral studies in multidisciplinary

Transversal

- **CT2**: Draft scientific and technical reports and defend them publicly.
- **CT3**: To work autonomously and efficiently in the daily practice of research or professional activity.
- **CT4**: Apply the concepts, principles, theories and models related to Biological Chemistry and Molecular Materials to new or little-known environments within multidisciplinary contexts.
- **CT5**: Appreciate the value of good quality and continuous improvement by acting rigorously, responsibly and ethically.
- **CT6**: To be able to adapt to changes, being able to apply with initiative new and advanced technologies and other relevant developments.
- **CT7**: Show critical and self-critical reasoning when seeking scientific rigour and quality. Handle IT tools and information and communication technology (ICT), as well as on-line access to databases.

Specific

- **CE20**: To understand the necessity and importance of chemical synthesis.
- **CE21**: To know the most relevant chemical synthesis methods, including the fundamentals of stereoselective processes in chemistry, and be able to design synthetic routes of complex molecules.

OBJECTIVES OF TRAINING

- To provide a solid, balanced and current training in chemical synthesis and in the theoretical tools that facilitate its success.
- Simultaneous and complementary learning of the most common synthetic strategies and tactics to provide students with a comprehensive and current view of this fundamental area of chemistry.
- To provide an overview of the methods of synthesis of individual molecules, libraries of organic molecules, organometallic complexes and inorganic compounds.
- To analyze the available methodologies for performing asymmetric synthesis.
- To deepen the synthetic methodology used in the preparation of complex organic, inorganic and organometallic compounds.
- To develop skills that allow the future professional application of the knowledge provided.

COURSE CONTENTS

1. Overview of the course

- Synthesis of organic substances:
  - Target-Oriented synthesis (TOS)
  - Diversity-Oriented synthesis (DOS)
- Synthesis of organometallic complexes
- Synthesis of materials (MOF's and COF's)

2. Basic tools for the synthesis of organic compounds

- Structure(s)
- Reactions
- Retrosynthetic analysis

3. Strategy

- Target-Oriented synthesis
  - Transform-based strategies
  - Structure-based and topological strategies
  - Functional group-based strategies
  - Stereochemical strategies
  - Computer-Assisted Synthetic Planning: Human vs. Machine or Human + Machine?
- Diversity-Oriented synthesis
  - Multicomponent reactions
  - Cycloaddition reactions
  - Tandem reactions
  - Functional group pairing strategies
  - Privileged structures
  - Ring-closing metathesis

4. Asymmetric synthesis

- Chiral pool
- Chiral auxiliaries
- Chiral catalysis

5. Synthesis of organometallic complexes

- Necessity for the synthesis of organometallic complexes: preparation of metal catalysts and study of reaction mechanisms

- Metal-X complexes
  - Hydrocarbyl (alkyl, aryl, vinyl) complexes
  - π-allyl complexes
  - Metal-hydride complexes
  - Metal-porphyrin, amido and alkoxo complexes
  - Metal-boryl complexes
- Metal-carbene complexes
  - Types
  - Reactivity: metathesis
- Metal imido and metal-oxo complexes: synthesis and applications (e.g. dioxygen and dinitrogen activation in biological systems; metalloenzymes)

6. Synthesis of MOF's and COF's

- Definition and concept of MOF's and COF's
- Synthetic strategies:
  - Metal geometry
  - Linkers
  - Design and control over pore size and functionality
- Applications

COURSE BIBLIOGRAPHY

1. Basic

• R. E. Gawley, J. Aubé;, Principles of Asymmetric Synthesis, 2nd Ed., Elsevier: Oxford, 2012.
• Asymmetric Synthesis, The Essentials, M. Christmann and S. Bräse, Eds. Wiley-VCH: Weinheim, 2007.
• J. Clayden, N. Greeves, S. Warren, Organic Chemistry, 2nd Ed., Oxford University Press: Oxford, 2012.
• S. G. Warren, P. Wyatt, Organic Synthesis: The Disconnection Approach, 2nd. Ed., Wiley, 2009.
• P. Wyatt, S. Warren, Organic Synthesis: Strategy and Control, Wiley, 2007.
• E. J. Corey, X.-M. Cheng, The Logic of Chemical Synthesis, Wiley, 1989.
• A. Trabocchi, Ed., Diversity-Oriented Synthesis, Basics and Applications in Organic Synthesis, Drug Discovery and Chemical Biology, Wiley 2013.
• Hartwig, J. F. *Organotransition Metal Chemistry: From Bonding to Catalysis*, 1st Ed.; University Science Books. Sausalito, USA 2010.

2. Complementary

• Enantioselective Organocatalysis: Reactions and Experimental Procedures, P. I. Dalko, Ed., Wiley-VCH: Weinheim, 2007.
• Stereoselective Organocatalysis: Bond Formation Methodologies and Activation Modes, R. Rios Torres, Ed., John Wiley and Sons: New Jersey, 2013.
• Organic Synthesis Workbook, J. A. Gewert, J. Görlitzer, S. Götze, J. Looft, P. Menningen, T. Nöbel, H. Schirock, C. Wulff, Wiley- VCH: Weinheim, 2000.
• Organic Synthesis Workbook II, C. Bittner, A. S. Busemann, U. Griesbach, F. Haunert, W.-R. Krahnert, A. Modi, J. Olschimke, P. L. Steck, Wiley-VCH: Weinheim, 2001.

STUDENT WORKLOAD

The training activities will be distributed according to the following table.

	Activity	hours	% presential
Presential classes	Lectures and conferences	14	100%
	Seminars and classroom exercises	4	100%
	Tutorials	1	100%
	Practical classes	0	100%
	Oral presentations	2	100%
	Final exam	3	100%
Non Presential	Preparation and study of problems	10	0%
	Elaboration of individual work	36	0%
	Literature searching and so on	5	0%
	TOTAL	75	

TEACHING METHODOLOGY

The Virtual Campus will be used for delivering the necessary material to the students, according to the professor criterion. This material will include: the course program, exercises and problems to be solved, copies of the classroom presentations, etc.
Along the course, the student should participate in various formative activities, with the aim of acquiring the established knowledge and skills.
Master classes: Explanation of theoretical contents supplemented by audiovisual aids. The active participation of the students will be intended, through the formulation of appropriate questions that they should try to answer.
Seminars: There will be two classroom hours before the partial exams dedicated to review concepts and/or clarify doubts.
Use of fast and anonymous response methods in class (clickers) to know the degree of follow-up of the subject.

Presentation of individual works on some topics related to the subject, including the debate with his classmates and teachers.
Group and individual tutoring.

ASSESSMENT SYSTEM

With the aim of encouraging the constant student work to favor the learning, a continuous evaluation will be applied. This methodology will inform the professor about the content's assimilation by the student as well as their ability to apply them to problem solving. The evaluation will be individual.
Along the course, on professor criterion, the students will have to solve some exercises and hand them in at the scheduled date. Performing short tests in classroom is also foreseen. (30%)
In order to evaluate the knowledge related to the master classes and the problem-solving ability of the students, one exam and/or individual oral presentation will be performed. (70%)
The students who did not pass the continuous evaluation will have the opportunity to perform a second-chance exam. To pass the course, it will be mandatory obtaining 5 points out of 10.

FACULTY DATA

Faculty	Contact	Semester	Class
F. Javier Sardina López	15715	1st and 2nd	Maths (3rd floor)
Martín Fañanás Mastral	15787		

IDENTIFICATION FORM

Course Data

Course number	**P1251205**
Subject	*Determination of Reaction Mechanisms*
Title	Chemistry at the interface with Biology and Materials Science (ChemBio&Mat) **P1251V01**
Course Level	Master
Credits	3.0
Module	**IV (Reactivity and Synthesis)**
Academic Year	2023-2024

Titulation

Title	Center	Course	Semester
ChemBio&Mat	FACULTAD de QUÍMICA/CiQUS	1	Second

Subject

Title	Course Title	Course type
ChemBio&Mat	Determination with Reaction Mechanisms	Optative

Coordination

Name	Department	Contact
Jesús Ángel Varela Carrete	Organic Chemistry	jesus.varela@usc.es

SUMMARY

The aim of this course is the study of reactions from the point of view of their mechanism and the relationship between structure and reactivity. For this purpose, the determination of the products of the reaction is just the starting point of any mechanistic investigation, being necessary to know everything which happens between reactants and products. This include not only the formation of intermediates and transition structures, the mapping out of reaction trajectories and the free energy changes that occur along the reaction path, but also our attempts at understanding why a reaction “choose” a particular mechanism.

PREREQUISITES

Relation with other topics of the Master

No enrollment restrictions have been specified with other subjects of the curriculum. The topics of this course are very related with the other subjects of the module IV (reactivity and synthesis): catalysis, chemical synthesis and computational chemistry.

Other requirements

No enrollment restrictions have been specified with other subjects of the curriculum. Broad knowledge of general organic and inorganic chemistry is required, especially in its synthetic and structural aspects.

COMPETENCES

Basic

- **CB6**: Possess and understand the knowledge that provides a basis or an opportunity for being creative and unique in the development and/or implementation of ideas, often in a research context.
- **CB7**: Students should know how to use the knowledge acquired and their problem-solving capacity in new or little known environments within wider (or multidisciplinary) contexts related to their field of study.

General

- **CG1**: Know how to use the knowledge acquired for practical problem solving in the field of research and innovation, in the multidisciplinary context of biological chemistry and molecular materials.
- **CG2**: Know how to apply the scientific method and acquire skills for developing the necessary protocols for the design and critical assessment of chemical experiments.
- **CG3**: Be able to discuss and communicate ideas, in both oral and written form, to specialised and non-specialised audiences (congresses, conferences, etc.) in a clear and reasoned way.
- **CG5**: Have the skills that allow students to develop an autonomous method for studying and learning.
- **CG8**: Be able to use scientific literature and develop the judgement needed for its interpretation and use.

Transversal

- **CT2**: Draft scientific and technical reports and defend them publicly.
- **CT5**: Appreciate the value of good quality and continuous improvement by acting rigorously, responsibly and ethically.
- **CT7**: Show critical and self-critical reasoning when seeking scientific rigour and quality. Handle IT tools and information and communication technology (ICT), as well as on-line access to databases.

Specific

- **CE2**: Be capable of comparing experimental data and theoretical assumptions in a critical manner.
- **CE17**: Be able to establish relationships between structure and reactivity

OBJECTIVES OF TRAINING

- Know the main reaction mechanisms, the effects of the different experimental variables, as well as the methods used for their study.
- Ability to understand and evaluate mechanistic investigations described in the chemical bibliography.
- Ability to design experiments that allow to elucidate the mechanism of a determined chemical reaction.

COURSE CONTENTS

1. Basic kinetic concepts and their application to the study of reaction mechanisms

Introduction to the basic kinetic concepts, reaction orders, experimental methods for investigating kinetics.

2. The use of isotopes in the determination of reaction mechanisms

Non kinetic uses. Kinetic isotopic effects. Solvent kinetic effect.

3. Free energy linear relationships

Electronic properties of the substituents. Steric properties of the substituents. Solvents properties. Nucleophilicity and electrophilicity.

4. Introduction to the computational study of reaction mechanisms.

Computational methods. Potential energy surfaces (PES).

5. Study of the mechanisms of chemical reactions through the bibliographic analysis of mechanistic investigations and the resolution of exercises.

Case studies using the acquired knowledge.

COURSE BIBLIOGRAPHY

1. Basic

- E. V. Anslyn, D. A. Dougherty, Modern Physical Organic Chemistry, University Science: Sausalito, 2006

2. Complementary

- H. Maskill Ed., The Investigation of Organic Reactions and Their Mechanisms, Blackwell Publishing, Oxford, 2006.
- T. H. Lowry, K. S. Richardson, Mechanism and Theory in Organic Chemistry, 3a edición. Harper and Row, New York, 1987.

STUDENT WORKLOAD

The training activities will be distributed according to the following calendar.

	Activity	hours	% presential
Presential classes	Theoretical classes	6	100%
	Seminars and classroom exercises	10	100%
	Tutorials	1	100%
	Computer practical classes	2	100%
	Oral presentations	2	100%
	Final exam	3	100%
Non Presential	Preparation and study of problems	10	0%
	Elaboration of individual work	36	0%
	Literature searching and so on	5	0%
	TOTAL	75	

TEACHING METHODOLOGY

The Virtual Campus will be used for delivering the necessary material to the students, according to the professor criterion. This material will include: the course program, exercises and problems to be solved, copies of the classroom presentations, etc.
Along the course, the student should participate in various formative activities, with the aim of acquiring the established knowledge and skills.
Master classes: Explanation of theoretical contents supplemented by audiovisual aids. The active participation of the students will be intended, through the formulation of appropriate questions that they should try to answer.
Seminars: There will be two classroom hours before the partial exams dedicated to review concepts and/or clarify doubts.
Use of fast and anonymous response methods in class (clickers) to know the degree of follow-up of the subject.
Presentation of individual works on some topics related to the subject, including the debate with his classmates and teachers.
Group and individual tutoring.

ASSESSMENT SYSTEM

With the aim of encouraging the constant student work to favor the learning, a continuous evaluation will be applied. This methodology will inform the professor about the content's assimilation by the student as well as their ability to apply them to problem solving. The evaluation will be individual.
Along the course, on professor criterion, the students will have to solve some exercises and hand them in at the scheduled date. Performing short tests in classroom is also foreseen. (50%)
In order to evaluate the knowledge related to the master classes and the problem-solving ability of the students, one exam and/or individual oral presentation will be performed. (50%)
The students who did not pass the continuous evaluation will have the opportunity to perform a second-chance exam. To pass the course, it will be mandatory obtaining 5 points out of 10.
In cases of fraudulent performance of exercises or tests, the provisions of the regulations for evaluating student academic performance and reviewing qualifications will apply.

COMMENTS

Revise basic biochemistry and physics concepts

FACULTY DATA

Faculty	Contact	Semester	Class
José Ramón Leis Fidalgo	joseramon.leis@usc.es	2nd	Maths (3rd floor)
Jesús Ángel Varela Carrete	jesus.varela@usc.es		

IDENTIFICATION FORM

Course Data

Course number	**P1251106**
Subject	*Computational chemistry*
Title	Chemistry at the interface with Biology and Materials Science (ChemBio&Mat) **P1251V01**
Course Level	Master
Credits	3.0
Module	**IV (Reactivity and Synthesis)**
Academic Year	2023-2024

Titulation

Title	Center	Course	Semester
ChemBio&Mat	FACULTAD de QUÍMICA/CiQUS	1	Second

Subject

Title	Course Title	Course type
ChemBio&Mat	Computational Chemistry	Optative

Coordination

Name	Department	Contact
Rebeca García Fandiño	Organic Chemistry rebeca.garcia.fandino@usc.es/15708	

SUMMARY

The objective of this subject is to understand the basic concepts of computational chemistry. It is intended that the student knows and understands the different methodologies that can be used to solve a problem using computational chemistry. The theoretical bases of these methodologies will be studied, with special emphasis on a considerable number of applications that will allow the student to know the most used programs and methods to perform computational calculations of molecular properties and chemical reactivity, currently essential to contrast and predict results in a rigorous and faster and cheaper than the experimental. Given the transversal role of these computational methodologies, the student will be shown an integral and multidisciplinary view of computational chemistry within the area, in the context of other branches of science. Knowing the applications of this branch of chemistry, the student will understand the synergy between experimental methods and theoretical and computational chemistry.

PREREQUISITES

Relation with other topics of the Master

No enrollment restrictions have been specified with other subjects of the curriculum.

Other requirements

Although it is not mandatory, basic knowledge of Linux and / or programming is recommended. However, all the necessary knowledge for the correct comprehension of the contents of the subject will be imparted to the students.

COMPETENCES

Basic

- **CB7:** Students should know how to use the knowledge acquired and their problem-solving capacity in new or little known environments within wider (or multidisciplinary) contexts related to their field of study.
- **CB9:** Students should know how to communicate their findings and the knowledge and underlying reasons underpinning them to specialised and non-specialised audiences in a clear and unambiguous way.
- **CB10:** Students should have the learning skills that allow them to carry on studying in such a way that should be mainly self-directed or autonomous.

General

- **CG1:** Know how to use the knowledge acquired for practical problem solving in the field of research and innovation, in the multidisciplinary context of biological chemistry and molecular materials.
- **CG3:** Be able to discuss and communicate ideas, in both oral and written form, to specialised and non-specialised audiences (congresses, conferences, etc.) in a clear and reasoned way.
- **CG5:** Have the skills that allow students to develop an autonomous method for studying and learning.
- **CG7:** Be capable of working in multidisciplinary teams and collaborating with other specialists, both nationally and internationally

Transversal

- **CT1:** Develop teamwork skills: cooperation, leadership and good listening skills. Adapt to multidisciplinary teams.
- **CT2:** Draft scientific and technical reports and defend them publicly.

- **CT4**: Apply the concepts, principles, theories and models related to Biological Chemistry and Molecular Materials to new or little-known environments within multidisciplinary contexts.

Specific

- **CE2:** Be capable of comparing experimental data and theoretical assumptions in a critical manner.
- **CE6**: Know the physicochemical bases of biological processes.
- **CE8:** Gain technical skill for carrying out the structural characterization of molecules, biomolecules, supramolecules and nanoparticles and interpreting the experimental data obtained.

OBJECTIVES OF TRAINING

- Understanding the basis of computational chemistry.
- Knowing and understanding the different methodologies that can be used to solve a problem using computational chemistry.
- Obtaining a comprehensive and multidisciplinary vision of the area, in the context of other branches of science.
- Understanding the existing synergy between experimental methods and theoretical and computational chemistry.
- Knowing the applications of computational chemistry

COURSE CONTENTS

1. Introduction to Computational Chemistry. Quantum methods and classical methods. Basic tools.

Introduction to Computational Chemistry. Quantum methods and classical methods: advantages and limitations. Basic computational tools: Linux, Bash and Python languages. Molecular visualizers and constructors.

2. Quantum mechanics. General concepts and application to the study of reaction mechanisms and the prediction of molecular properties

Methods of the electronic structure: semi-empirical, DFT and ab initio methods. Potential energy surface (SEP): Stationary points and geometric optimization. Obtaining molecular properties from the electronic structure: dipole moments, electrostatic potential, atomic charges, polarizability and hyperpolarizability. Partition functions and calculation of thermodynamic functions such as enthalpy, entropy and Gibbs free energy. Estimation of the velocity constant of a chemical reaction: calculating kinetic constants using the transition state theory.

3. Molecular Mechanics and Molecular Dynamics. Theoretical bases and applications in organic chemistry and biological chemistry.

Theoretical basis of classical methods and presentation of the computational methodologies most used today in this field: Molecular Mechanics, Docking, Virtual Screening and Molecular Dynamics. Molecular Dynamics: fundamental basis and applications. Carrying out Molecular Dynamics simulations using the GROMACS package: setting-up, execution and analysis.

4. Docking and QM / MM: General concepts. Applications to enzymatic catalysis

Locating the active center of an enzyme: Fundamentals of the Docking technique (rigid and flexible). Carrying out docking using Autodock Vina package. Fundamental bases of hybrid QM / MM methods. Applications to the study of reaction mechanisms in biological and supramolecular systems.

COURSE BIBLIOGRAPHY

1. Lesson 1

Material deposited in the virtual classroom.
Introduction to Computational Chemistry:
-Molecular Modeling. Principles and Applications (Ed Pearson Education, 2001), Andrew R. Leach
-Introduction to Computational Chemistry (Ed Wiley), Frank Jensen.
Introduction to Linux and Bash:
-https://computernewage.com/2018/09/16/scripting-linux-introduction/
-https://www.howtoforge.com/tutorial/linux-shell-scripting-lessons/
-https : //linuxconfig.org/bash-scripting-tutorial-for-beginners
Introduction to Python:
-https://www.python.org/about/gettingstarted/
-https://www.learnpython.org/en/
Molecular Viewers :
-http://cheminf.cmbi.ru.nl/molden/
-http://www.cambridgesoft.com/support/ProductHomePage.aspx?KBCatID=112
-http://www.ks.uiuc.edu/Training /Tutorials/vmd-index.html
-http://pymol.sourceforge.net/newman/user/toc.html
-https://avogadro.cc/

2. Lesson 2

Material deposited in the virtual classroom.
-IN Levine, Quantum Chemistry, 5th Ed., Pearson Education (2001).
- CJ Cramer, Essentials of Computational Chemistry, John Wiley & Sons (2002).
- F. Jensen, Introduction to Computational Chemistry, 2nd Edition, John Wiley & Sons (1999).

- PW Atckins, RS Friedman, Molecular Quantum Mechanics, 3rd Ed., Oxford Univ. Press (1997).
- PW Atkins, RS Friedman, Solutions Manual for Molecular Quantum. Oxford Univ. Press (1997).
- A. Szabo, NS Ostlund, Modern Quantum Chemistry. Introduction to Advanced Electronic Structure Theory, Dover Pub., Inc. (1996).
- T. Helgaker, P. Joergensen, J. Olsen, 'Molecular Electronic-Structure Theory', John Wiley & Sons (2000).
- J. Simons, J. Nichols, Quantum Mechanics in Chemistry, Oxford Univ. Press (1997).
- JB Foresman, Æleen Frisch, Exploring Chemistry with Electronic Structure Methods, 2nd Ed., Gaussian, Inc. (1995-96).

3. Lesson 3

Material deposited in the virtual classroom.
-Molecular Modeling. Principles and Applications (Ed Pearson Education, 2001), Andrew R. Leach
-Introduction to Computational Chemistry (Ed Wiley), Frank Jensen.
MOLECULAR DYNAMICS:
http://www.gromacs.org/Documentation/Terminology/Molecular_Dynamics_Simulations
http://www.mdtutorials.com/gmx/
http://www.gromacs.org/Documentation/Tutorials
http://cgmartini.nl /index.php/tutorials

4. Lesson 4

Material deposited in the virtual classroom.
-Molecular Modeling. Principles and Applications (Ed Pearson Education, 2001), Andrew R. Leach
-Introduction to Computational Chemistry (Ed Wiley), Frank Jensen.
DOCKING:
http://autodock.scripps.edu/faqs-help/tutorial
http://vina.scripps.edu/manual.html
QM / MM:
http://www.gromacs.org/Documentation/How-tos/ QMMM
https://gaussian.com/oniom/

STUDENT WORKLOAD

The training activities will be distributed according to the following table.

	Activity	hours	% presential
Presential classes	Lectures and conferences	10	100%
	Seminars and classroom exercises	2	100%
	Tutorials	1	100%
	Practical classes	8	100%
	Oral presentations	2	100%
	Final exam	3	100%
Non Presential	Preparation and study of problems	15	0%
	Elaboration of individual work	34	0%
	TOTAL	75	

TEACHING METHODOLOGY

The Virtual Campus will be used for delivering the necessary material to the students, according to the professor criterion. This material will include: the course program, exercises and problems to be solved, copies of the classroom presentations, etc.

Along the course, the student should participate in various formative activities, with the aim of acquiring the established knowledge and skills.

A) Theoretical-practical sessions: This subject is divided into nine sessions of 2 hours each. Each session combines expository and practical classes, as shown in the scheme of the previous section. This methodological scheme intends to replace the lectures where the student barely intervenes, by theoretical-practical sessions that encourage self-learning of the student, relating the assimilation of theoretical concepts to the resolution of problems and practical situations that could be found in their possible professional future. During these sessions, the teachers will combine explanations of theoretical concepts, the approach and resolution of practical exercises with instructions directly related to the practice that the student will carry out within the same session. The teachers will have the support of audiovisual and computer media. A computer will be available to students, although it is recommended that they bring their own laptops, where they can install the programs used in the practices, and thus be used during non-presential work. During each session, the student must carry out a practical part independently. For this, they will have a Reference Manual, which will include an introduction to computer work and, in particular, its application to computational calculations, as well as a script for each of the practices to be performed, which will consist of a brief presentation of the theoretical foundations of the practice and the indication of the calculations to be made and the results to be presented. The student will do the practices individually and will present the results to be evaluated at the end of the sessions (2 hours of oral expositions of the students supported by audiovisual material). Attendance at these nine sessions (Session 1-9) is mandatory. The absences must be documentary justified, accepting reasons of examination and health, as well as those cases contemplated in the current university regulations.

B) Seminars and practical blackboard classes: The aim of these sessions is to resolve doubts about the theory, practices and exercises proposed in Bulletins 1-3, with the active participation of the student: delivery of exercises to the teacher, resolution of exercises in the classroom, etc. Attendance at these classes is mandatory.

C) Tutorials scheduled by teachers and coordinated by the Center. The aim of these sessions is to resolve any doubts that students may have regarding any content of the subject. Attendance to this class is not mandatory.

ASSESSMENT SYSTEM

1. Attendance

Attendance at the 9 theoretical-practical sessions is mandatory. The absences must be documentary justified, accepting reasons of examination and health, as well as those cases contemplated in the current university regulations.

2. The evaluation will consist of two parts (% final grade):

2.1. Continuous evaluation (50%), consisting of:

i. Tests delivered to the teacher (15%)

ii. Computer practices (20%)

iii. Oral exposure (15%)

2.2. Final exam (50%)

The final exam will consist of a theoretical part (test questions, duration: 30 minutes) and a practical part of computing (in which exercises similar to those carried out during the practices will be considered, duration 2.5 hours).

The qualification of the student will not be inferior to the one of the final examination nor to the obtained one pondering it with the one of continuous evaluation. In any case, to pass the subject, it will be an essential requirement to have the qualification of APTO in computer practices. Repeating students will have the same attendance regime for classes as those who take the subject for the first time.

FACULTY DATA

Faculty	Contact	Semester	Class
Rebeca García Fandiño	15708	2nd	Maths (3rd floor)
Antonio Fernández Ramos	15705		
Jessica Rodríguez			

IDENTIFICATION FORM

Course Data

Course number	**P1251112**
Subject	*Introductory Research Project*
Title	Chemistry at the interface with Biology and Materials Science (ChemBio&Mat) **P1251V01**
Course Level	Master
Credits	15.0
Module	**V (Research)**
Academic Year	2023-2024

Titulation

Title	Center	Course	Semester
ChemBio&Mat	FACULTAD de QUÍMICA/CiQUS	1	Second

Subject

Title	Course Title	Course type
ChemBio&Mat	Introductory Research Project	Compulsory

Coordination

Name	Department	Contact
Juan R. Granja	Organic Chemistry	juanr.granja@usc.es/15746

SUMMARY

The objective of this subject is to put the student in the context of an experimental work destined to gain work experience prior to the realization of the research project of the final master's project. The student can carry out this project in a research laboratory of the center, in other research laboratories, both national and international, or in key companies. In this context, is offered an internship that enables you to put theory into practice and use the work experience to complete and further shape your study program at a different context of the CiQUS. It provides a unique opportunity to competent and motivated students to work on relevant tasks and projects at international or industrial level.

PREREQUISITES

Relation with other topics of the Master

No enrollment restrictions have been specified with other subjects of the curriculum.

Other requirements

No enrollment restrictions have been specified with other subjects of the curriculum.

COMPETENCES

Basic

- **CB6**: Possess and understand the knowledge that provides a basis or an opportunity for being creative and unique in the development and/or implementation of ideas, often in a research context.
- **CB7**: Students should know how to use the knowledge acquired and their problem-solving capacity in new or little known environments within wider (or multidisciplinary) contexts related to their field of study.
- **CB9**: Students should know how to communicate their findings and the knowledge and underlying reasons underpinning them to specialised and non-specialised audiences in a clear and unambiguous way.
- **CB10**: Students should have the learning skills that allow them to carry on studying in such a way that should be mainly self-directed or autonomous.

General

- **CG1**: Know how to use the knowledge acquired for practical problem solving in the field of research and innovation, in the multidisciplinary context of biological chemistry and molecular materials.
- **CG2**: Know how to apply the scientific method and acquire skills for developing the necessary protocols for the design and critical assessment of chemical experiments.
- **CG3**: Be able to discuss and communicate ideas, in both oral and written form, to specialised and non-specialised audiences (congresses, conferences, etc.) in a clear and reasoned way.
- **CG6**: Have leadership, creativity, initiative and entrepreneurship abilities.
- **CG7**: Be capable of working in multidisciplinary teams and collaborating with other specialists, both nationally and internationally.
- **CG8**: Be able to use scientific literature and develop the judgement needed for its interpretation and use.
- **CG9**: Be capable of handling chemical substances safely and work in a chemical laboratory without risks.
- **CG10**: Be able to develop the different research stages (from the conception of an idea and the literature search through to target setting, experiment design, analysis of the results and drawing conclusions).

Transversal

- **CT1**: Develop teamwork skills: cooperation, leadership and good listening skills. Adapt to multidisciplinary teams.

- **CT2**: Draft scientific and technical reports and defend them publicly.
- **CT3**: Perform day-to-day research or professional activity in an independent and efficient manner.
- **CT5**: Appreciate the value of good quality and continuous improvement by acting rigorously, responsibly and ethically.
- **CT7**: Show critical and self-critical reasoning when seeking scientific rigour and quality. Handle IT tools and information and communication technology (ICT), as well as on-line access to databases.

Specific

- **CE3**: Know the rules on risk prevention in the laboratory and within the chemistry-related industry.
- **CE9**: Use advanced instrumentation related to research on biological chemistry and molecular materials.
- **CE20**: Know how to plan and carry out new laboratory experiments in an autonomous and independent manner.

OBJETIVES OF TRAINING

- Knowledge of the methodology to be followed for the development of a research project: literature search, design, planning and development of experiments, data analysis, proposals for improvement and conclusions of the work.
- Learn the handling of specialized laboratory instruments and materials for the synthesis, characterization, purification and / or analysis of chemical products, nanomaterials, biomolecules or cell samples.
- Learn to treat the experimental data obtained and relate them to the appropriate physical, chemical and biological theories, using primary bibliographic sources.
- Recognition of the risks associated with the development of an experimental project, and the appropriate security measures.

For the realization of this work the student will select experimental (computer) works proposed by the postgraduate commission, previous offer of the CiQUS researches together with the subject.

COURSE CONTENTS

COURSE BIBLIOGRAPHY

1. Basic

2. Complementary

STUDENT WORKLOAD

The training activities will be distributed according to the following calendar.

	Activity	hours	% presential
Presential classes	Tutorials of orientation for the planning and monitoring of the project	4	100%
	Experimental work on the techniques of synthesis, analysis and study of the properties that are used today in both university research laboratories and in the chemical and / or biotechnology industry	280	100%
	Analysis and data evaluation	30	100%
	Presentation and public defense of the work	1	100%
Non Presential	Use of literature searches and database	10	0%
	Preparation of inform and thesis defense	50	0%
	TOTAL	**375**	

TEACHING METHODOLOGY

Taking into account a student's dedication of 25 hours of total work per ECTS credit, a face-to-face work of approximately 375 hours will be carried out. Along the course, the student should participate in various formative activities, with the aim of acquiring the established knowledge and skills.

– Individual experimental (or computational) work under supervision, with adequate infrastructure and necessary means to achieve the proposed objectives.
– Tutorials for work planning, supervision of experimental work and analysis of results.
– Use of specialized software, databases and web resources. Online teaching support (Virtual Campus).
– Preparation of a brief report / research report.
– Presentation and defense of the work done.

ASSESSMENT SYSTEM

General considerations
- Experimental work done.
- Written report detailing the most relevant results of the work performed and the skills acquired.
- Oral exhibition and defense of the work done and the skills acquired.

In cases of fraudulent performance of exercises or tests, the provisions of the *"Regulations for evaluating student academic performance and reviewing grades"* will apply.

The evaluation system will be exactly the same regardless of the type of teaching used (in classroom or

virtual), with the only difference that the evaluation activities will be carried out, as established by the competent authorities, either in person in the classroom or remotely through the telematic means available at the USC. (*Scenario 1*: Final in classroom exam. Scenario 2 and 3: Final remote exam).

FACULTY DATA

Faculty	Contact	Semester	Class
Juan R. Granja	16746	1st and 2nd	N/A

IDENTIFICATION FORM

Course Data

Course number	**P1251113**
Subject	*Master dissertation*
Title	Chemistry at the interface with Biology and Materials Science (ChemBio&Mat) **P1251V01**
Course Level	Master
Credits	30.0
Module	**V (Research)**
Academic Year	2023-2024

Titulation

Title	Center	Course	Semester
ChemBio&Mat	FACULTAD de QUÍMICA/CiQUS	2	First

Subject

Title	Course Title	Course type
ChemBio&Mat	Master Dissertation	Compulsory

Coordination

Name	Department	Contact
Juan R. Granja	Organic Chemistry	juanr.granja@usc.es/15746

SUMMARY

The MA dissertation is the culmination of the Master programme. It is a piece of independent writing carried out by Master students under faculty supervision on a topic chosen by the student in coordination with his tutor. It is undertaken with the guidance of a faculty supervisor and involves an extended period of research which is finally reflected in a written document.
Masters Dissertation requires students to engage with their subject area in a more critical manner than they will have done at the undergraduate level. Students are expected to have a solid knowledge on their topic of interest, demonstrate a general grasp of the relevant literature and the various disciplinary contributions, as well as an understanding of the concepts and methods used to address the research questions.

PREREQUISITES

Relation with other topics of the Master

No enrollment restrictions have been specified with other subjects of the curriculum.

Other requirements

No enrollment restrictions have been specified with other subjects of the curriculum.

COMPETENCES

Basic

- **CB6**: Possess and understand the knowledge that provides a basis or an opportunity for being creative and unique in the development and/or implementation of ideas, often in a research context.
- **CB7**: Students should know how to use the knowledge acquired and their problem-solving capacity in new or little-known environments within wider (or multidisciplinary) contexts related to their field of study.
- **CB9**: Students should know how to communicate their findings and the knowledge and underlying reasons underpinning them to specialised and non-specialised audiences in a clear and unambiguous way.
- **CB10**: Students should have the learning skills that allow them to carry on studying in such a way that should be mainly self-directed or autonomous.

General

- **CG1**: Know how to use the knowledge acquired for practical problem solving in the field of research and innovation, in the multidisciplinary context of biological chemistry and molecular materials.
- **CG2**: Know how to apply the scientific method and acquire skills for developing the necessary protocols for the design and critical assessment of chemical experiments.
- **CG3**: Be able to discuss and communicate ideas, in both oral and written form, to specialised and non-specialised audiences (congresses, conferences, etc.) in a clear and reasoned way.
- **CG6**: Have leadership, creativity, initiative and entrepreneurship abilities.
- **CG7**: Be capable of working in multidisciplinary teams and collaborating with other specialists, both nationally and internationally.
- **CG8**: Be able to use scientific literature and develop the judgement needed for its interpretation and use.
- **CG9**: Be capable of handling chemical substances safely and work in a chemical laboratory without risks.
- **CG10**: Be able to develop the different research stages (from the conception of an idea and the literature search through to target setting, experiment design, analysis of the results and drawing conclusions).

Transversal

- **CT1**: Develop teamwork skills: cooperation, leadership and good listening skills. Adapt to multidisciplinary teams.
- **CT2**: Draft scientific and technical reports and defend them publicly.
- **CT3**: Perform day-to-day research or professional activity in an independent and efficient manner.
- **CT5**: Appreciate the value of good quality and continuous improvement by acting rigorously, responsibly and ethically.
- **CT7**: Show critical and self-critical reasoning when seeking scientific rigour and quality. Handle IT tools and information and communication technology (ICT), as well as on-line access to databases.

Specific

- **CE2**: Be capable of comparing experimental data and theoretical assumptions in a critical manner.
- **CE3**: Know the rules on risk prevention in the laboratory and within the chemistry-related industry.
- **CE5**: Know how to analyse and use the data obtained autonomously in complex laboratory experiments by relating them to the suitable chemical, physical or biological techniques.
- **CE9**: Use advanced instrumentation related to research on biological chemistry and molecular materials.
- **CE19**: Know how to carry out, submit and defend individually, and once all curriculum credits are obtained, a comprehensive research project on Biological Chemistry and Molecular Materials which synthesizes the skills learnt in the Masters course.
- **CE20**: Know how to plan and carry out new laboratory experiments in an autonomous and independent manner.

OBJETIVES OF TRAINING

- Knowledge of the steps and the methodology to develop a research project: the bibliographic search, the design, the planning and the development of the experiments, the data analysis, the proposals for improvement and conclusions of the work.
- Use of databases and specialized bibliography to analyze, critically, the background, originality, interest and viability of a research project.
- Ability to integrate the previously acquired knowledge, and to apply it to the planning, development and analysis of the results of the research work.
- Acquisition of experience in the experimental techniques and / or computational methods necessary to carry out a research project in the field of chemical synthesis, biological chemistry or materials chemistry.
- Recognition of the risks associated with the development of an experimental project and of the appropriate security measures.
- Be able to prepare a report of the work done and the results obtained in a research work, in the appropriate format for a scientific document.

– Ability to present and defend, before a specialized audience, the development, results and conclusions of a research project.

The experimental work is carried out by the student individually under the supervision of a CiQUS tutor. Its purpose is for the student to apply the knowledge acquired throughout the Bachelor's and Master's degree in the realization of a technical work that have relation with some of the contents of the degree and the activities professionals for whom you are trained.

For the realization of this work the student will select experimental (computer) works proposed by the postgraduate commission, previous offer of the CiQUS researches together with the subject. Students will submit their application for assignment of research work with an order of preference. The offer will be broad enough to guarantee the assignment to all students enrolled.

COURSE CONTENTS

1. Introduction to master thesis

Guidelines. Tutors. Work development. Memory. Final presentation.

2. Project under tutor guidance

Topic selection. Literature searching. Proposal of a working plan. Chronogram.

3. Project development

Experimental work. Progress report and periodical tutor’s meetings. Achievements.

4. Finishing thesis

Writing thesis. Oral presentation and defense of experimental work

COURSE BIBLIOGRAPHY

1. Basic

2. Complementary

STUDENT WORKLOAD

The training activities will be distributed according to the following calendar.

	Activity	hours	% presential
Presential classes	Tutorials of orientation for the planning and monitoring of the project	15	100%
	Experimental work (or computational) associated to the development of the project	580	100%
	Analysis and data evaluation	50	100%
	Oral presentation in seminars of the research progress	3	100%
	Presentation and public defense of the work	2	100%
Non Presential	Use of literature searches and database	15	0%
	Preparation of reports and informs	60	0%
	Preparation of seminar oral presentation	5	0%
	Preparation of thesis defense	20	0%
	TOTAL	750	

TEACHING METHODOLOGY

Taking into account a student's dedication of 25 hours of total work per ECTS credit, a face-to-face work of approximately 750 hours will be carried out. Along the course, the student should participate in various formative activities, with the aim of acquiring the established knowledge and skills.
Introductory class: the coordinator explains the generalities about the development and objectives of the master dissertation and preparation of the final report.
Meetings with the assigned tutor: In the initial meeting the approach will be outlined of the project, the scientific literature and the chronogram for the development of the work. In the follow-up meetings will be evaluated of progress of the work, difficulties encountered, and objectives achieved.
Work development. The methodological procedure will be outlined in the initial research proposals.
Preparation of the final report. A written document and an oral presentation and defense of the experimental work carried out**.**

ASSESSMENT SYSTEM

The evaluation of the Master's Thesis will be carried out by a committee appointed for this purpose, which will be made up of three professors who teach in the Master.
The student must present a report that will include:

- A brief introduction on background
- The objectives and the work plan
- The results with a critical and reasoned discussion of them
- The conclusions
- The bibliography consulted

The memory will have a maximum of fifty pages in A4 size written to a space in Arial font of twelve dots per inch.

The student will also make a public presentation of the experimental work, presentations will not be longer than fifteen minutes.

The committee will evaluate the oral presentation of the work carried out, the written report and its public defense.

The final grade awarded by the Court will be obtained taking into account:

- Tutor's report (50%)
- The elaborated memory (30%)
- The oral presentation, its defense and the knowledge demonstrated by the student (20%)

The ratings will be based on the absolute score over 10 points and in accordance with the scale established in RD 1125/2003.

FACULTY DATA

Semester	Class
3rd	N/A

IDENTIFICATION FORM

Course Data

Course number	**P1251111**
Subject	*Tutored Training Activities*
Title	Chemistry at the interface with Biology and Materials Science (ChemBio&Mat) **P1251V01**
Course Level	Master
Credits	3.0
Module	**V (Research)**
Academic Year	2023-2024

Titulation

Title	Center	Course	Semester
ChemBio&Mat	FACULTAD de QUÍMICA/CiQUS	1	1st and 2nd

Subject

Title	Course Title	Course type
ChemBio&Mat	Tutored Training Activities	Compulsory

Coordination

Name	Department	Contact
Juan R. Granja	Organic Chemistry	juanr.granja@usc.es/15746

SUMMARY

The main objective of this subject is to provide tools to acquire a general view of the state of the art in the scientific fields of the master. In addition, it is also aimed to get a general view of relevant and current scientific aspects. A variety of academic activities, seminars, lectures, courses and other activities will be provided by the centers related to master with this goal.

PREREQUISITES

Relation with other topics of the Master

No enrollment restrictions have been specified with other subjects of the curriculum.

Other requirements

No enrollment restrictions have been specified with other subjects of the curriculum.

COMPETENCES

Basic

- **CB6**: Possess and understand the knowledge that provides a basis or an opportunity for being creative and unique in the development and/or implementation of ideas, often in a research context.
- **CB7**: Students should know how to use the knowledge acquired and their problem-solving capacity in new or little known environments within wider (or multidisciplinary) contexts related to their field of study.
- **CB8**: Students should be able to integrate knowledge and deal with the complexity of making judgements from information which – being incomplete or limited – includes reflections on the social and ethical responsibilities linked to the use of their knowledge or judgements.
- **CB9**: Students should know how to communicate their findings and the knowledge and underlying reasons underpinning them to specialised and non-specialised audiences in a clear and unambiguous way.
- **CB10**: Students should have the learning skills that allow them to carry on studying in such a way that should be mainly self-directed or autonomous.

General

- **CG3**: Be able to discuss and communicate ideas, in both oral and written form, to specialised and non-specialised audiences (congresses, conferences, etc.) in a clear and reasoned way.
- **CG4**: Be able to understand the social and ethical responsibilities linked to the use of knowledge or judgements in research, development and innovation in the field of biological chemistry and molecular materials.
- **CG8**: Be able to use scientific literature and develop the judgement needed for its interpretation and use.
- **CG10**: Be able to develop the different research stages (from the conception of an idea and the literature search through to target setting, experiment design, analysis of the results and drawing conclusions).

Transversal

- **CT3**: Perform day-to-day research or professional activity in an independent and efficient manner.
- **CT5**: Appreciate the value of good quality and continuous improvement by acting rigorously, responsibly and ethically.

Specific

- **CE1**: Know the impact of chemistry, biological chemistry and molecular materials on the industry, environment, health, agri-food, and renewable energies.
- **CE2**: Be capable of comparing experimental data and theoretical assumptions in a critical manner.
- **CE4**: Know and understand the chemical tools and analytical techniques used for biological chemistry and molecular materials.
- **CE15**: Students should be familiarized with nanotechnology methods and usefulness for studying processes of medical and biological interest.

OBJETIVES OF TRAINING

- The main objective of this subject is to provide tools to acquire a general view of the state of the art in the scientific fields of the degree.
- To get a general vision of relevant and current scientific aspects through the participation in conferences, lectures, research seminars organized by the centers related to master.
- Strengthen the knowledge acquired in the other modules by triggering the attendance at different scientific/educational events [national and international schools in which CiQUS members participate (national school of materials, Moreno Mañas school, etc.)].
- Proficiency in the techniques of writing, presentation and exposition of scientific works.
- Acquisition of skills related to employability and entrepreneurship.
- Acquisition of other transversal competences, under the supervision of a tutor.

COURSE CONTENTS

- The contents of the activities offered could be different in each academic year.
- The contents to which each student would access will be different depending on the specific offer and the recommendations of the tutor.
- In any case, these contents will include: current state of research in biological chemistry / nanoscience / materials science (through prestigious guest lecturers), scientific communication and debate (research seminars); skills in employability and entrepreneurship, etc.

COURSE BIBLIOGRAPHY

1. Basic

2. Complementary

STUDENT WORKLOAD

The training activities will be distributed according to the following calendar.

	Activity	hours	% presential
Presential classes	Conferences given by prestigious international professors/researchers, on the themes of the Master	10	100%
	Group and CiQUS research seminars	10	100%
	Workshops on employability and entrepreneurship	Up to 10	100%
	Attendance at courses, workshops, national schools, etc.	Up to 15	100%
	Other training activities recommended by the tutor	Up to 10	100%
	Tutoring with subject coordinator and scientific tutor	3	100%
Non Presential	Preparation of tests and directed work	25	0%
	Study and personal work of the student	5	0%
	Bibliographic search and use of databases	5	0%
	TOTAL	**75**	

TEACHING METHODOLOGY

- Organization of programs of conferences, seminars and workshops (coordinator of the Master / CiQUS staff).
- Personalized advice on the possible activities to be carried out (scientific tutor and / or course coordinator).
- Supervision of the assistance and use of the activities carried out, through the virtual and on-site tutorials (Virtual Campus) (scientific tutor and / or course coordinator).
- Preparation of a brief report highlighting the most relevant activities carried out (student).

ASSESSMENT SYSTEM

The assessment process will not only serve to know if the student has acquired the programmed competences but also to overview the teaching methodology.
- Accredited assistance to conferences and organized workshops.
- Assistance and active participation in research seminars.
- Participation in national and international schools, courses and workshops on topics related to biological chemistry and molecular materials.
- Written memory, personal debate and / or public presentation of the activities carried out and the competences acquired.

The acquisition of competences will be evaluated through the different systems: Evaluation weights: Minimum weighting (MiW)- Maximum weight (MaW)
Memory and/or presentation activities: 20%-30%
Oral presentations: 10%-20%
Training activities carried out: 25%-40%
Transversal competences evaluation: 0%-20%
Tutor report: 30%-50%

FACULTY DATA

Faculty	Contact	Semester	Class
Juan R. Granja	15746	1st and 2nd	N/A

TEACHING STAFF 2023/2024

Prof. Juan R. Granja · CiQUS PI
Master ChemBio&Mat Coordinator
University Professor · Dept. of Organic Chemistry
More Info: USC Research Portal

Prof. Francisco Rivadulla · CiQUS PI
Master ChemBio&Mat Secretary
University Professor · Dept. of Physical Chemistry
More Info: USC Research Portal

Prof. José Luis Mascareñas · CiQUS PI
CiQUS Scientific Director
University Professor · Dept. of Organic Chemistry
More Info: USC Research Portal

Prof. Dolores Pérez · CiQUS PI
CiQUS Deputy Director
University Professor · Dept. of Organic Chemistry
More Info: USC Research Portal

Prof. Pablo del Pino · CiQUS PI
Senior University Lecturer · Dept. of Particle Physics
More Info: USC Research Portal

Prof. Jose M. Martínez-Costas· CiQUS PI
University Professor · Dept. of Biochemistry and Molecular Biology
More Info: USC Research Portal

Prof. Miguel Vázquez · CiQUS PI
Senior University Lecturer · Dept. of Inorganic Chemistry
More Info: USC Research Portal

Prof. Juan C. Estévez · CiQUS PI
University Professor · Dept. of Organic Chemistry
More Info: USC Research Portal

Prof. Eduardo Fernández-Megía · CiQUS PI
University Professor · Dept. of Organic Chemistry
More Info: USC Research Portal

Prof. Félix Freire · CiQUS PI
University Professor · Dept. of Organic Chemistry
More Info: USC Research Portal

Prof. Rebeca García-Fandiño · CiQUS PI
Senior University Lecturer · Dept. of Organic Chemistry
More Info: USC Research Portal

Prof. Martín Fañanás-Mastral · CiQUS PI
Senior University Lecturer · Dept. of Organic Chemistry
More Info: USC Research Portal

Prof. Antonio Fernández-Ramos · CiQUS PI
University Professor · Dept. of Physical Chemistry
More Info: USC Research Portal

Prof. María del Carmen Giménez-López · CiQUS PI
PhD Hired Professor · Dept. of Inorganic Chemistry
More Info: USC Research Portal

Prof. Concepción González-Bello · CiQUS PI
University Professor · Dept. of Organic Chemistry
More Info: USC Research Portal

Prof. Enrique Guitián· CiQUS PI
Emeritus Professor · Dept. of Organic Chemistry
More Info: USC Research Portal

Prof. Massimo Lazzari · CiQUS PI
University Professor · Dept. of Physical Chemistry
More Info: USC Research Portal

Prof. Javier Montenegro · CiQUS PI
Senior University Lecturer · Dept. of Organic Chemistry
More Info: USC Research Portal

Prof. Diego Peña · CiQUS PI
University Professor · Dept. of Organic Chemistry
More Info: USC Research Portal

Prof. Moisés Gulías · CiQUS PI
Senior University Lecturer · Dept. of Organic Chemistry
More Info: USC Research Portal

Dr. Fernando López · CiQUS PI
Researcher CSIC-USC
More Info: USC Research Portal

Dr. Beatriz Pelaz · CiQUS PI
Hired Researcher Ramón y Cajal · Dept. of Inorganic Chemistry
More Info: USC Research Portal

Prof. Emilio Quiñoá · CiQUS PI
University Professor · Dept. of Organic Chemistry
More Info: USC Research Portal

Prof. Carlos Saá · CiQUS PI
University Professor · Dept. of Organic Chemistry
More Info: USC Research Portal

Dr. Manuel Souto · CiQUS PI
Researcher Oportunius
More Info: USC Research Portal

Prof. F. Javier Sardina· CiQUS PI
University Professor · Dept. of Organic Chemistry
More Info: USC Research Portal

Prof. Jesús Varela · CiQUS PI
University Professor · Dept. of Organic Chemistry
More Info: USC Research Portal

Prof. Eugenio Vázquez · CiQUS PI
University Professor · Dept. of Organic Chemistry
More Info: USC Research Portal

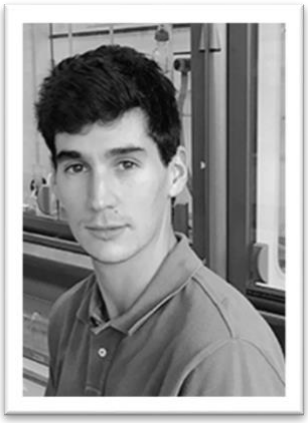
Dr. Beatriz Orosa · CiQUS Junior Scientist
Hired Researcher Ramón y Cajal · Dept. of Plant Physiology
More Info: USC Research Portal

Dr. Ester Polo · CiQUS Junior Scientist
Hired Researcher Ramón y Cajal · Dept. of Biochemistry and Molecular Biology
More Info: USC Research Portal

Dr. Rafael E. Ramos · CiQUS Junior Scientist
Hired Researcher Ramón y Cajal · Dept. of Physical Chemistry
More Info: USC Research Portal

Dr. María Tomás · CiQUS Junior Scientist
Hired Researcher Ramón y Cajal · Dept. of Organic Chemistry
More Info: USC Research Portal

Dr. Julián Bergueiro
Hired Researcher Ramón y Cajal · Dept. of Organic Chemistry
More Info: USC Research Portal



Dr. Rafael Rodríguez
Hired Researcher Juan de la Cierva · Dept. of Organic Chemistry
More Info: USC Research Portal

Dr. Jose M. Vila Fungueiriño
Hired Researcher Juan de la Cierva · Dept. of Physical Chemistry
More Info: USC Research Portal

Dr. Jaime Mateos
Hired Researcher Juan de la Cierva · Dept. of Organic Chemistry
More Info: USC Research Portal

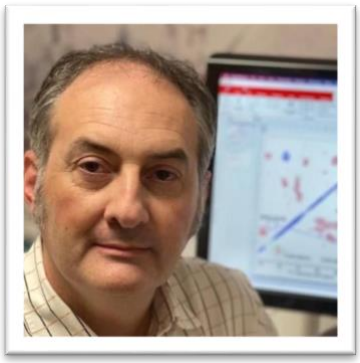
Dr. Jessica Rodríguez
Hired Researcher Juan de la Cierva · Dept. of Organic Chemistry
More Info: USC Research Portal

Prof. Manuel Amorín
Senior University Lecturer · Dept. of Organic Chemistry
More Info: USC Research Portal

Prof. José Ramón Leis
University Professor · Dept. of Physical Chemistry
More Info: USC Research Portal

Prof. Carlos Vázquez
Senior University Lecturer · Dept. of Physical Chemistry
More Info: USC Research Portal

Prof. Miguel González Blanco
Senior University Lecturer · Dept. of Biochemistry and Molecular Biology
More Info: USC Research Portal



Prof. Víctor M. Sánchez Pedregal
Senior University Lecturer · Dept. of Organic Chemistry
More Info: USC Research Portal

Teaching Timetable

ACADEMIC YEAR 2023-24: Teaching timetable

PLACE: Chemistry Faculty (maths room, third floor)

SEPTEMBER 2023

Monday	Tuesday	Wednesday	Thursday	Friday	Sat	Sun
4	**5**	**6**	**7**	**8**	**9**	**10**
11 16h-17:30h **MolMat** 17:30h-19h **Catal**	**12** 16h-17:30h **MagRes** 17:30h-19h **SupraChem**	**13** 16h-17:30h **MolMat** 17:30h-19h **Catal**	**14** 9:30-12h **Safety training course** 16h-17:30h **MagRes** 17:30h-19h **SupraChem**	**15** 10:30h Master presentation JRG 16h-17:30h **MolMat** 17:30h-19h **Catal**	**16**	**17**
18 16h-17:30h **MolMat** 17:30h-19h **Catal**	**19** 16h-17:30h **MagRes** 17:30h-19h **SupraChem**	**20** 16h-17:30h **MolMat** 17:30h-19h **Catal**	**21** 16h-17:30h **MagRes** 17:30h-19h **SupraChem**	**22** 16h-17:30h **MolMat** 17:30h-19h **Catal**	**23**	**24**
25 16h-17:30h **MolMat** 17:30h-19h **Catal**	**26** 16h-17:30h **MagRes** 17:30h-19h **SupraChem**	**27** 16h-17:30h **MolMat** 17:30h-19h **Catal**	**28** 16h-17:30 **MagRes** 17:30h-19h **SupraChem**	**29** 16h-17:30 **MolMat** 17:30h-19h **Catal**	**30**	

SUBJECTS ACRONYMS: **Catal –** Catalysis; **MagRes –** Magnetic Resonance; **EspecTech** – Espectroscopic and Espectrometric Techniques; **MolMat** – Molecular Materials; **SupraChem** – Supramolecular Chemistry.

PLACE: Chemistry Faculty (maths room, third floor)

OCTOBER 2023

Monday	Tuesday	Wednesday	Thursday	Friday	Sat	Sun
						1
2 16h-17:30h **MolMat** 17:30h-19h **Catal**	3 16h-17:30h **MagRes** 17:30h-19h **SupraChem**	4 16h-17:30h **MolMat** 17:30h-19:30h **Catal**	5 17:30h-19h **SupraChem**	6 16h-17:30h **MolMat** 17:30h-19:30h **Catal**	7	8
9 16h-17:30h **MolMat** 17:30h-19h **Catal**	10 16h-17:30h **MagRes** 17:30h-19h **SupraChem**	11 16h-19h **MolMat**	12 FESTIVITY	13	14	15
16 16h-19h **Catal**	17 16h-17:30h **EspecTech** 17:30h-19h **SupraChem**	18	19 17:30h-19h **SupraChem**	20 16h-19h **Catal (Ex)**	21	22
23	24 16h-17:30h **EspecTech** 17:30h-19h **SupraChem**	25 16h-19h **MolMat (Ex)**	26 10h-13:00h **EspecTech** (exp. pract.)	27 16h-19h **MagRes (Ex)**	28	29
30 16h-17:30 **NanoEstMat** 17:30h-19h **BioCelChem**	31 16h-17:30h **EspecTech** 17:30h-19h **SupraChem**					

SUBJECTS ACRONYMS: **Catal** – Catalysis; **MagRes** – Magnetic Resonance; **EspecTech** – Espectroscopic and Espectrometric Techniques; **MolMat** – Molecular Materials; **Microscop** – Microscopy; **SupraChem** – Supramolecular Chemistry; **BioCelChem** – Biological and Cellular Chemistry; **NanoEstMat** – Nanoestructured.

PLACE: Chemistry Faculty (maths room, third floor)

NOVEMBER 2023

Monday	Tuesday	Wednesday	Thursday	Friday	Sat	Sun
		1 FESTIVITY	2 16h-17:30h **EspecTech** 17:30h-20:30h **SupraChem**	3 16h-17:30 **NanoEstMat** 17:30h-19h **BioCelChem**	4	5
6 16h-17:30 **NanoEstMat** 17:30h-19h **BioCelChem**	7 16h-17:30h **EspecTech** 17:30h-19h **Microscop**	8 16h-17:30 **NanoEstMat** 17:30h-19h **BioCelChem**	9 16h-17:30h **EspecTech** 17:30h-19h **Microscop**	10 16h-19h **SupraChem (Ex)**	11	12
13 16h-17:30 **NanoEstMat** 17:30h-19h **BioCelChem**	14 16h-17:30h **CollntChar** 17:30h-19h **ChemSyn**	15 16h-17:30 **NanoEstMat** 17:30h-19h **BioCelChem**	16 16h-17:30h **CollntChar** 17:30h-19h **ChemSyn**	17 FESTIVITY	18	19
20 16h-17:30h **NanoEstMat** 17:30h-19h **BioCelChem**	21 16h-17:30h **Microscop** 17:30h-19h **ChemSyn**	22 16h-17:30h **NanoEstMat** 17:30h-19h **BioCelChem**	23 16h-17:30h **Microscop** 17:30h-19h **ChemSyn**	24 16h-17:30h **NanoEstMat** 17:30h-19h **BioCelChem**	25	26
27 16h-17:30h **NanoEstMat** 17:30h-19h **BioCelChem**	28 16h-17:30h **CollntChar** 17:30h-19h **ChemSyn**	29 16h-17:30h **NanoEstMat** 17:30h-19h **BioCelChem**	30 16h-17:30h **CollntChar** 17:30h-19h **ChemSyn**			

SUBJECTS ACRONYMS: **EspecTech** – Espectroscopic and Espectrometric Techniques; **BioCelChem** – Biological and Cellular Chemistry; **NanoEstMat** – Nanoestructured Materials; **ChemSyn** – Chemical Synthesis; **Microscop** – Microscopy; **SupraChem** – Supramolecular Chemistry; **CollntChar** – Coloidal and Interface Characterization; **GrafDes** – Graphic Design curse.

PLACE: Chemistry Faculty (maths room, third floor)

DECEMBER 2023

Monday	Tuesday	Wednesday	Thursday	Friday	Sat	Sun
				1 16h-17:30h **NanoEstMat** 17:30h-19h **BioCelChem**	2	3
4 16h-19h **BioCelChem**	5 16h-17:30h **ColIntChar** 17:30h-19h **ChemSyn**	6 FESTIVITY	7	8 FESTIVITY	9	10
11 16h-17:30h **Microscop** 17:30h-20:25h **NanoEstMat**	12 16h-17:30h **ColIntChar** 17:30h-19h **ChemSyn**	13 16h-17:30h **Microscop**	14 17:30h-19h **ChemSyn**	15 16h-17:30h **ColIntChar**	16	17
18 16h-17:30h **Microscop**	19 16h-17:30h **ColIntChar**	20 16h-17:30h **Microscop**	21	22 16h-19h **BioCelChem (Ex)**	23	24
CHRISTMAS BREAK						

SUBJECTS ACRONYMS: **BioCelChem –** Biological and Cellular Chemistry; **NanoEstMat** – Nanoestructured Materials; **Microscop –** Microscopy; **ChemSyn** – Chemical Synthesis; **ColIntChar** – Coloidal and Interface Characterization.

PLACE: Chemistry Faculty (maths room, third floor)

MASTER CHEM BIO&MAT CHEMISTRY at the Interface with BIOLOGY and MATERIALS Science

JANUARY 2024

Monday	Tuesday	Wednesday	Thursday	Friday	Sat	Sun
CHRISTMAS BREAK					6	7
8	9 16h-19h **EspecTech (Ex)**	10	11 16h-19h **NanoEstMat (Ex)**	12	13	14
15 16h-19h **ColIntChar (Ex)**	16	17	18	19 16h-19h **Microscop (Ex)**	20	21
22 17h-18:30h **MolMag** 18:30h-20h **DetReacMec**	23 16h-17:30h **NanoBioTech** 17:30h-19h **ChemSyn**	24 17h-18:30h **MolMag** 19:30h-20h **DetReacMec**	25 16h-17:30h **NanoBioTech** 17:30h-19h **ChemSyn**	26 FESTIVITY	27	28
29 12h-14h **CompChem*** 17h-18:30h **MolMag** 18:30h-20h **DetReacMec**	30 16h-17:30h **NanoBioTech** 17:30h-19h **ChemSyn**	31 17h-18:30h **MolMag** 18:30h-20h **DetReacMec**				

SUBJECTS ACRONYMS: **EspecTech** – Espectroscopic and Espectrometric Techniques; **Microscop –** Microscopy; **BioCelChem –** Biological and Cellular Chemistry; **NanoEstMat** – Nanoestructured Materials; **MagRes –** Magnetic Resonance; **TecBiolMol** – Experimental Techniques in Molecular Biology and Biomedicine; **ChemSyn** – Chemical Synthesis; **MolMag –** Molecular Magnetism; **CompChem** – Computational Chemistry*; **NanoBioTec** – Nanobiotechnology.

* The computational Chemistry classes will take place in room number 3.11 (third floor of Chemistry building)

PLACE: Chemistry Faculty (maths room, third floor)

FEBRUARY 2024

MASTER CHEM BIO&MAT — CHEMISTRY at the Interface with BIOLOGY and MATERIALS Science

Monday	Tuesday	Wednesday	Thursday	Friday	Sat	Sun
			1 16h-19h **ChemSyn**	2 12h-14h **CompChem*** 17h-18:30h **MolMag** 18:30h-20h **DetReacMec**	3	4
5 12h-14h **CompChem*** 17h-18:30h **MolMag** 18:30h-20h **DetReacMec**	6 16h-17:30h **NanoBioTech** 17:30h-19h **Biophys†**	7 17h-18:30h **MolMag** 18:30h-20h **DetReacMec**	8 16h-17:30h **NanoBioTech** 17:30h-19h **Biophys** 19h-20:15h **ExpTechMBM**	9 12h-14h **CompChem*** 17h-18:30h **MolMag** 18:30h-20h **DetReacMec**	10	11
12 FESTIVITY	13 FESTIVITY	14 16h-17:30h **DetReacMec** 17:30h-19h **MolMag**	15 16h-17:30h **NanoBioTech** 17:30h-19h **Biophys** 19h-20:15h **ExpTechMBM**	16 12h-14h **CompChem*** 16h-17:30h **DetReacMec** 17:30h-19h **MolMag**	17	18
19 12h-14h **CompChem*** 16h-17:30h **DetReacMec** 17:30h-19h **MolMag**	20 16h-17:30h **NanoBioTech** 17:30h-19h **Biophys**	21 16h-17:30h **DetReacMec** 17:30h-19h **MolMag**	22 16h-17:30h **NanoBioTech** 17:30h-19h **Biophys** 19h-20:15h **ExpTechMBM**	23 12h-14h **CompChem*** 16h-17:30h **ExpTechMBM**	24	25
26 12h-14h **CompChem*** 16h-17:30h **ExpTechMBM**	27 16h-17:30h **NanoBioTech** 17:30h-19h **Biophys**	28 16h-17:30h **NanoBioTech** 17:30h-20:20h **DetReacMec**	29 16h-17:30h **ExpTechMBM** 17:30h-19h **Biophys**			

SUBJECTS ACRONYMS: **ExpTechMBM** – Experimental Techniques in Molecular Biology and Biomedicine; **ChemSyn** – Chemical Synthesis; **MolMag** – Molecular Magnetism; **DetReacMec** – Determination of Reaction Mechanism; **NanoBioTech** – Nanobiotechnology; **CompChem** – Computational Chemistry; **Biophys** – Biophysic.

* The computational Chemistry classes will take place in room number 3.11 (third floor of Chemistry building)

PLACE: Chemistry Faculty (maths room, third floor)

MARCH 2024

Monday	Tuesday	Wednesday	Thursday	Friday	Sat	Sun
				1 12h-14h **CompChem*** 16h-18:30h **ExpTechMBM (lab)**	2	3
4 12h-14h **CompChem*** 16h-17:30h **ExpTechMBM**	5 16h-17:30h **NanoBioTech** 17:30h-19h **Biophys**	6 16h-17:30h **ExpTechMBM** 17:30h-20:20h **MolMag**	7 16h-17:30h **ExpTechMBM** 17:30h-19h **Biophys**	18 12h-14h **CompChem*** 16h-18:30h **ExpTechMBM (lab)**	9	10
11 16h-17:30h **ExpTechMBM**	12 16h-17:30h **NanoBioTech**	13 16h-18:30h **ExpTechMBM (lab)**	14 16h-19h **Biophys**	15 16h-19h **NanoBioTech**	16	17
18 16h-19h **CompChem (Exam)**	19	20 16h-19h **ChemSynt (Exam)**	21	22 16h-19h **DetReacMec (Exam)**	23	24
25 EASTER BREAK	26 EASTER BREAK	27 EASTER BREAK	30 EASTER BREAK	29 EASTER BREAK		

SUBJECTS ACRONYMS: **ChemSyn** – Chemical Synthesis; **MolMag –** Molecular Magnetism; **DetReacMec** – Determination of Reaction Mechanism; **NanoBioTech** – Nanobiotechnology; **CompChem** – Computational Chemistry; **ExpTechMBM –** Experimental Techniques in Molecular Biology and Biomedicine; **Biophys** – Biophysic.

* The computational Chemistry classes will take place in room number 3.11 (third floor of Chemistry building)

PLACE: Chemistry Faculty (maths room, third floor)

APRIL 2024

Monday		Tuesday		Wednesday		Thursday		Friday		Sat	Sun
1	16h-19h **MolMag (Exam)**	2		3	16h-19h **NanoBioTech (Exam)**	4		5	16h-19h **Biophys (Exam)**	6	7
8		9	16h-19h **ExpTechMBM (Exam)**	10		11		12		13	14

SUBJECTS ACRONYMS: **NanoBioTech** – Nanobiotechnology; **MolMag –** Molecular Magnetism; **ExpTechMBM –** Experimental Techniques in Molecular Biology and Biomedicine; **Biophys** – Biophysic.

Exams

	Topic	Date	time	Room	
1st QUARTER	MagRes	27/10/23	16h-19h	Mathematics room (3rd floor)	
	EspecTech	09/01/24	16h-19h	Mathematics room (3rd floor)	
	Microscop	19/01/24	16h-19h	Mathematics room (3rd floor)	
	ColIntChar	15/01/24	16h-19h	Mathematics room (3rd floor)	
	MolMat	25/10/23	16h-19h	Mathematics room (3rd floor)	
	Catal	20/10/23	16h-19h	Mathematics room (3rd floor)	
	SupraChem	10/11/23	16h-19h	Mathematics room (3rd floor)	
	BioCelChem	22/12/23	16h-19h	Mathematics room (3rd floor)	
	NanoEstMat	11/01/24	16h-19h	Mathematics room (3rd floor)	
2nd QUARTER	ChemSyn	20/03/24	16h-19h	Mathematics room (3rd floor)	
	NanoBioTech	3/04/24	16h-19h	Mathematics room (3rd floor)	
	ExpTechMBM	9/04/24	16h-19h	Mathematics room (3rd floor)	
	MolMag	1/04/24	16h-19h	Mathematics room (3rd floor)	
	DetReacMec	22/03/24	16h-19h	Mathematics room (3rd floor)	
	CompChem	18/03/24	16h-19h	Mathematics room (3rd floor)	
	Biophys	5/04/24	16h-19h	Mathematics room (3rd floor)	

ACRONYMS OF THE SUBJECTS: **MagRes** – Magnetic Resonance; **EspecTech** – Espectroscopic and Espectrometric Techniques; **Microscop** – Microscopy; **ColIntChar** – Coloidal and Interface Characterization; **SupraChem** – Supramolecular Chemistry; **Catal** – Catalysis; **MolMat** – Molecular Materials; **BioCelChem** – Biological and Cellular Chemistry; **NanoEstMat** – Nanoestructured Materials; **ExpTechMBM** – Experimental Techniques in Molecular Biology and Biomedicine; **ChemSyn** – Chemical Synthesis; **MolMag** – Molecular Magnetism; **DetReacMec** – Determination of Reaction Mechanism; **NanoBioTech** – Nanobiotechnology; **CompChem** – Computational Chemistry; **Biophys** – Biophysic.