EUROPEAN UNIVERSITY FOR CUSTOMISED EDUCATION

Excellence Programme

STUDY GUIDE

BIOINSPIRED CHEMISTRY

Coordinated by

University of Mons

1. IDENTIFYING DATA.	
· Programme Name.	Master in Bioinspired Chemistry (Master 2 level)
· Coordinating University.	University of Mons - UMONS
· Partner University Involved.	Poznan University of Technology (PUT), University of Catania (UNICT), University of Mons - UMONS
· Programme Field(s).	Bioinspired systems, Biomimetics, Supramolecular Chemistry, Biomaterials, Biophysical chemistry, Functional Macromolecules, Nanomedicine, Biointerfaces, Sustainable & Environmental Chemistry, Smart Materials, Clean Energy, Catalysis
· ISCED Code.	ISCED 0531 (Master level)
· SDG.	Goal 3 Good Health and Well-Being Goal 7 Affordable and Clean Energy Goal 9 Industry, Innovation and Infrastructures Goal 10 Reduced Inequalities within and among countries Goal 12 Responsible Production and Consumption Goal 13 Climate Action

· Mode of Delivery.	On-campus, Hybrid, Summer School, Labs, Seminars, Research internship
· Language of Instruction.	English 100%
· Programme Dates.	September 2025 – August 2026
· Key Words.	Bioinspiration, Sustainable Chemistry

· Prerequisites and co-requisites.	Enrolled in a Master 1 (1st year of Master) Background in Chemistry/Physics/Biology/Engineering
· Number of EUNICE students that can attend the Programme.	From 10 to 20 students

2. CONTACT DETAILS.	
· Departments.	Poznan University of Technology, University of Catania, University of Mons
· Name of Lecturers.	Prof. Philippe Dubois, Recteur de l'Université de Mons, UMONS, Belgique
· E-mail.	philippe.dubois@umons.ac.be

3. PROGRAMME CONTENT.

The Master Program in Bioinspired Chemistry explores and takes inspiration from structures and assemblies found in Nature to design new approaches for facing challenges in health, energy, information technologies, materials, and catalysis. This emerging area implies a multidisciplinary approach gathering domains of (bio)chemistry, (bio)materials, supramolecular systems, macromolecules, nanomedicine, self-organization, and nanosciences. This master's degree aims at offering an educational background connecting the laboratory environment and the living world to mimic complex strategies elaborated by Nature, which represents infinite scientific and technological challenges. These challenges will be taken up through bioinspiration and biomimicry angles keeping in mind environmental awareness and ethics, while responding to ecological and sustainable transition challenges. This program offers a unique opportunity to explore and get inspired by living systems to develop cutting-edge technologies.

Programme Structure: full-fledged to be implemented when all legalities, operations, funding, accreditation, binding, and commitment are in place by EUNICE (60 credits):

A total of 60 credits (on-line and face to face) with:

- 6 credits for the autumn school

A one-week summer/autumn school will be organized at the beginning of the academic year (September) during which basic seminars in the field of Bioinspired Chemistry and research activities that are developed in each University will be presented. Students will also be involved in a project based on existing literature. At the end of the school, students will be able to choose the topic of their Master thesis and to work on the related SOTA.

- 24 credits of elective courses

To choose in a EUNICE list constituted by courses from each partner University (see Section 4). Students can customize their course program by choosing 24 credits from this list (at least 12 credits in their home University). Courses will be given during the period from September to January, either face-to-face (local courses) or online (partners courses).

- 30 credits for the Master Thesis

The Master thesis involves research that must be conducted in one of the partner Universities, with a physical mobility of 3 to 5 months during the period February-June. The research topic should be chosen in agreement between the home institution and the host University.

4. LEARNING OUTCOMES.

The Learning Outcomes on each course will be developed on individual Course Study Guides. The learning outcomes will include a methodology process with selected courses in each item, to guarantee success for targeted Competence-based learning. Experimental courses in labs as well as industrial internships and/or visits in industries including a deep exchange with specialists in bio-technologies and bio-materials, will be developed to strengthen the bridge between academical knowledge and the private sector, making conditions for potential increase of capacity building. Exhibition, technology survey with oral defense for evaluation will allow graduate students to valorise their outcomes in a specific field.

The sector of bioinspired chemistry has a potential leading role to play in addressing some of the most important challenges that humanity must solve, such as developing new biomaterials for health, drug-delivery systems, adaptive materials with life-like properties, improved catalysts that function in water, high-density information storage systems, etc., while responding to ecological and

sustainable transition challenges. By working in this field, graduates can play a relevant role in social transformation, while developing professionally.

5. JOB, OCCUPATION.

Graduates of the Excellence Programme in Bioinspired Chemistry will find employment in both the private and public sectors. They will act as experts or project managers/officers in private companies from different sectors, such as: R&D engineers, biomaterials, pharmaceutics, nanomedicine, catalysis, etc. They will also be ready to be employed in the public sector and be ideally prepared for starting PhD studies in the field of bioinspired chemistry and biomaterials after graduation, ideally within the EUNICE consortium.

6. PROGRAMME ORGANISATION.

MODULES.

Institution	Course	ECTS
UNICT	**Advanced biochemistry by Vincenzo Giuseppe NICOLETTI** The course provides students with in-depth knowledge of particularly interesting biochemical processes relating to various physio-pathological aspects. For example: bioenergetic management from bacteria to higher eukaryotes; glycemic control in humans and management of energy reserves; advanced glycation end products; molecular basis of protein conformational disorders; angiogenesis in tumors and neurodegenerative diseases; metabolism of certain amino acids; fundamentals of nutritional biochemistry.	6
UNICT	**Nanomedicine and Theranostics by Cristina SATRIANO** The course provide students the necessary tools for understanding various types of interactions that occur at the nano-biointerfaces, including that between cells and tissues and their natural or artificial surroundings, the thermodynamic and kinetic aspects of biomolecule-biomaterial interface, with insights into the fundamental role of water at biointerfaces, biomimetic and bioinspired systems (e.g., supported lipid bilayers, nanozymes). The influence of mechanical (viscoelasticity), physical (topography) and chemical (surface free energy, composition and structure) properties of surfaces on cellular processes such as adhesion, differentiation and proliferation and how these can be modulated, particularly at the nanoscale, to obtain 'smart' systems that respond to environmental conditions (chemical, physical and/or biological stimulus) for application in nanomedicine and theranostics (therapy+diagnosis/imaging).	6
UNICT	**Principles of biological physical chemistry by Carmelo LA ROSA** Recalls of thermodynamics, kinetics and spectroscopy, the structure of liquid water, hydrophobic effect, and liquid crystals. Differential Scanning Calorimetry. Circular Dichroism. Statistical Thermodynamics. Molecular Dynamics. Solid-state NMR. ESR. X-ray diffraction. Fourier Transform. Biological membranes.Proteins. Nucleic acids.	6 (4+2)

UMONS	**Bioinspired supramolecular chemistry by Mathieu SURIN, Julien DE WINTER and Pascal GERBAUX** The objective of this course is to initiate the students to the field of Bioinspired Chemistry. We will explore and be inspired from living organisms, biomolecular structures and natural processes (e.g. self-organization, cooperativity, biomineralization), in order to design new approaches of chemistry to be applied to the domains energy, catalysis, health, (bio)materials, and information technologies. The course is divided in 3 parts: I. Biomimicry and Bioinspiration Examples of bioinspired structures and materials Principles of recognition, self-assembly, self-organisation, cooperativity DNA-inspired structures, Peptide-inspired structures, molecular receptors, and molecular machines II. Analytical methods for biomolecular systems III. Applications : Biomineralization, Supramolecular Polymers, Artificial Photosynthesis, Artificial Enzymes	4
UMONS	**Physical chemistry of life sciences by Sylvain GABRIELE** Introduction to the basic concepts of cell-substrate interactions, a description of the cytoskeletal components and molecular motors, concepts of cell mechanics and tensegrity, and the main experimental techniques for probing cell forces and surface micropatterning.	4
UMONS	**Biomacromolecular engineering – Part I by Rosica MINCHEVA** Introduction to biomaterials describing each polymer (synthetic or natural) in its chemistry and application (with notions on definitions and legislation), and to designing biomaterials as nanocarriers (micelles, polymersomes and LbL) or hydrogels (from definition to challenges).	4
UMONS	**Biomacromolecular engineering – Part II by Sylvain GABRIELE** Description of recent developments in advanced hydrogels (PEG, PAAm, GelMA, etc.) and cutting-edge biomaterials for probing cellular responses to physicochemical modifications of the cell microenvironment (rigidity, viscoelasticity, cell-ligand density, etc.).	4
PUT	**An elective subject – one of these two is selected by majority of the students in September:** **(**A) Accidents in the process industry (15 h) or (B) Risk analysis in the chemical industry (15 h) (A) The aim of the course is to familiarize students with accidents that occurred in the process industry (chemical, petrochemical, food and related industries) and with the analysis of their causes and effects as well as with the possibilities of calculating the substance releases to the environment. (B) The main goal of the course is to broaden the student's knowledge of the safe use of apparatus and industrial fittings through the identification and analysis of industrial risk with assistance of qualitative, semi-quantitative and quantitative methods in determination of: the quantitative threat of environmental contamination with chemical substances, fire hazards, explosion hazards.	1

	A particularly important aspect of the course is the description of the dispersion of chemicals released from an industrial installation. In addition, the student is acquainted with the analysis of the causes and effects of accidents encountered in the chemical, petrochemical and food industries.	
PUT	**Characterization techniques of materials - lectures (15 h, min. 70% attendance required) + practical classes (15 h) + laboratory (15 h, an online version for students on the BIC programme)** The aim of the course is to provide students with knowledge on techniques for characterization of compounds, nanomaterials and elements; the method of selecting a specific technique for the type of sample or information to be obtained after the test, detailing the technological progress in the tests carried out. Material characterization techniques: 1. Diffraction techniques (X-ray diffraction, low energy electron diffraction, high energy electron diffraction, neutronography. 2. Optical spectroscopy (infrared, visible and ultraviolet spectroscopy, ellipsometry, Raman spectroscopy, luminescence, transmission, absorption, reflection, nonlinear optical spectroscopy). 3. Electron microscopy and spectroscopy (scanning electron microscopy, transmission electron microscopy, photoemission, Auger spectroscopy). 4. Surface microscopy (atomic force microscopy, scanning tunneling microscopy). 5. Methods of material composition analysis (absorption and transmission atomic spectrometry, X-ray fluorescence analysis, mass spectrometry).	4
PUT	**Biomaterials – lectures (15 h, min. 70% attendance required) and laboratory (15 h, an online version for students on the BIC programme)** The aim of the course is to provide students with the basic information about modern materials used in medical sciences. Issues related to ceramic, metallic, polymer, composite and natural biomaterials will be discussed. Students will gain knowledge related to the phenomena of biomaterial/environment interactions and factors influencing the biomaterial/tissue interactions. The aim of the course is to acquire knowledge in the field of practical application of modern materials used in orthopedics, cardiology, ophthalmology and dentistry. Additionally, the methods of producing selected groups of materials and the analysis of their properties will be discussed.	2
PUT	**Introduction to biotechnology – lectures (30 h, min. 70% attendance required) and laboratory (30 h, an online version for students on the BIC programme)** The aim of this course is to provide students with fundamental terms associated with biotechnology and to enhance their knowledge on the theoretical and practical aspects of working with microorganisms. The role of processes using microorganisms in different branches of biotechnology. Methods and techniques used for isolation and identification of microorganisms useful in biotechnology. Metabolic pathways as the basic principles of cellular biosynthesis. Relation between the growth phase of microorganisms and the products of their metabolism. Enzymes and biocatalysis.	5

7. ASSESSMENT METHODS AND CRITERIA.

- Students' assessment:

The evaluation of students will be course dependent. The modalities will be described in the related study guide at the beginning of each academic year, and be shared on the EUNICE Moodle platform. Internal rules shall be flexible considering the potential differences between assessment methods and timelines between IES universities.

The courses evaluation may comprise different components:

- An exam organized in-session or out-of-session by the University delivering the course, preferably in a synchronous mode (i.e. students following the course but staying at different Universities take the exam at the same time) or in asynchronous mode in case of agenda issues (this situation should be avoided as much as possible in order to prevent the increase of the burden for teachers). This exam shall be organized in hybrid mode (students taking the exam in F2F, others remotely): this could be done by favouring oral exams, or by using Digital tools such as Quizizz, Kahoot, Wooclap, or similar ones.

- A deliverable to be submitted by the students during the semester, or by the end of the semester: a report, an online presentation, etc. These deliverables could be related to lab sessions, projects, challenges, etc.

The Summer School could be evaluated through a short-term on-site challenge, during which the students could work by teams. The evaluation would be based on a pitch presentation by each of the student teams, in front of a jury made of the staff of the IES universities participating to the Summer School.

Master Theses would be prepared at the University of the main supervisor and evaluated according to the University rules. Co-supervision between partner Universities is very welcome: one supervisor for the main supervising University and a co-supervisor from another partner University to boost collaborations.

Given the differences between evaluation and teaching regulations in the respective Universities, a Pedagogical Workshop Preparation for the team members will be organized before the first intake of students.

- Programme assessment:

We will develop our assessment based on the learning objectives, outcomes of planned units, and programme Key Performance Indicators or KPIs (such as number of enrolled students from within the EU or outside the EU, number of applicants, number of scientific publications authored by our students, etc.). A board in charge of the internal quality monitoring of the programme will be established and will take care of these aspects. It will comprise representatives of each of the IES universities.

OBSERVATIONS.

> Selection procedure:

The Master is open to all European students. However, priority will be given to students from partner Universities and from Universities of the EUNICE network. Candidates shall provide the following documents when applying to the programme:

- a copy of the bachelor diploma/certificate

- a proof of enrolment in a Master program of a European University
- a transcript of records (ToR) of Bachelor level
- an English-Language certificate attesting their proficiency
- a one-page (A4) motivation letter

The access to the Master's program will be granted upon selection by a committee composed of teachers from partner Universities. The selection criteria will include an average grade of min. 70% in the Bachelor courses and proficiency in English (B2 level). The certification in English could be provided by the applicant's home University or based on an external evaluation such as TOEFL or Cambridge English Certificate.

> Diploma

After having successfully completed the Master in Bioinspired Chemistry, students will be granted Master with a diploma from their home University (i.e. where the student is enrolled), together with a certificate of success from this specific Excellence Program.

> Mobility

The program should be covered by an ERASMUS+ mobility agreement between the 10 EUNICE institutions to allow all EUNICE students to participate. For each student, a learning agreement will be generated following the ERASMUS+ rules allowing for a diploma in the home institution of the student.

Depending on the student enrolment two situations can appear:

1. The student is enrolled in one of the partner Universities: the learning agreement should cover the 12 ECTS of elective courses that will be provided by the other institutions + 30 ECTS research internship.
2. The student is enrolled in a EUNICE university which is not partner of the program or is coming from outside the EUNICE network: the learning agreement should cover a 60 ECTS mobility in one of the partner universities. In that case, it will not be compulsory for the student to realize his/her Master thesis in another university since he /she will already be in a mobility program.

8. BIBLIOGRAPHY AND TEACHING MATERIALS.

Provide a list of the (most important) literature that students are required or recommended to read.