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EUROPEAN UNIVERSITY FOR CUSTOMISED EDUCATION

STUDY GUIDE

BIOINSPIRED NANOMATERIALS & FUNCTIONAL SURFACES FOR HEALTH AND ENVIRONMENTAL SUSTAINABILITY

Organised by

University of Catania

1. IDENTIFYING DATA.	
· Course Name.	Bioinspired Nanomaterials and Functional Surfaces for Health and Environmental Sustainability
· Coordinating University.	UNICT
· Partner Universities Involved.	-
· Course Field(s).	Physical Chemistry Material Sciences, Biophysics, Chemical Engineering
· Related Study Programme.	Ph.D. programme in Chemical Sciences
· ISCED Code.	0531
· SDG.	1. SDG 3 – Good Health and Well-being *(Bioinspired nanomaterials can be used for medical applications such as drug delivery, diagnostics, and antimicrobial surfaces, all of which contribute to improving healthcare outcomes and disease prevention).* 2. SDG 6 – Clean Water and Sanitation *(Functional surfaces and nanomaterials can be applied in water purification systems, e.g., filtration membranes, antimicrobial coatings, improving access to safe drinking water and sanitation)* 3. SDG 13 – Climate Action *(Environmentally sustainable materials and processes inspired by nature can reduce reliance on fossil-based products, decrease greenhouse gas emissions, and support climate-resilient technologies).* 4. SDG 12 – Responsible Consumption and Production *(Emphasizing sustainability in material design reduces environmental impact, promotes the use of renewable sources, and fosters circular economy practices in material development).* 5. SDG 9 – Industry, Innovation and Infrastructure *(The development of advanced materials inspired by nature fosters innovation in healthcare, environmental engineering, and industrial applications).* 6. SDG 15 – Life on Land *(By reducing toxic material waste and encouraging eco-friendly alternatives, bioinspired materials contribute to preserving ecosystems and biodiversity).*
· Study Level.	D
· EUNICE Key Competencies	• Green – strongly • Orange- moderately • Red – partially • Blank cell - not at all

	Problem solving	
	Teamworking	
	Communication	
	Self-management	
	Cognitive flexibility	
	Digital competence	
	Technical competence	
	Global intercultural competence	

· Number of ECTS credits allocated.	3
· Mode of Delivery.	"Online" for non UNICT students, "Onsite" for UNICT students
· Language of Instruction.	English
· Course Dates.	2nd semester (March/April)
· Precise Schedule of the Lectures.	12 hrs
· Key Words.	Biomimicking; Nanomaterials; Hybrid BioInterfaces; Multifunctional materials
· Catchy Phrase.	Open your eyes to how nature-inspired nanotech can shape a sustainable future.

· Prerequisites and co-requisites.	- Students must have successfully completed graduate-level coursework in one or more of the following areas: Materials Science, Nanotechnology, Chemistry, Biomedical Engineering, Environmental Science or related fields A Master's degree (or equivalent) in a relevant discipline is typically required.

	Familiarity with basic principles of materials synthesis, surface science, and functional material characterization. Understanding of biological interfaces and environmental sustainability challenges is recommended. - This course is available for Doctoral students. - Required linguistic skills: English B2(CEFR) or equivalent.
· Number of EUNICE students that can attend the Course.	50
· Course inscription procedure(s).	[Indicate the registration procedures if it differs from the standard EUNICE process]

2. CONTACT DETAILS.	
· Department.	Chemical Sciences
· Name of Lecturer.	Cristina Satriano
· E-mail.	cristina.satriano@unict.it
· Other Lecturers.	-

3. COURSE CONTENT.

This PhD course provides an in-depth study of bioinspired approaches to designing nanomaterials and functional surfaces. Students will learn how principles from nature inspire innovations at the cutting edge of healthcare, such as drug delivery systems, biosensors and medical devices, as well as innovations in environmental sustainability, including self-cleaning materials, air and water purification and catalytic nanozymes. Through interdisciplinary insights and real-world applications, participants will gain a forward-looking perspective on how nanotechnology can contribute to a healthier, more sustainable future.

4. LEARNING OUTCOMES.

By the end of this course, students should be able to:
- **Understand and critically evaluate** the principles of bioinspiration and biomimicry in the design of nanomaterials and functional surfaces.
- **Demonstrate an advanced knowledge** of the fabrication techniques and characterisation methods employed in the production of bioinspired nanomaterials.
- **Analyse** the structure–function relationships in natural systems and apply these concepts to engineer novel materials with tailored properties.
- **Identify and assess** the applications of bioinspired nanomaterials in healthcare, such as drug delivery, biosensing and antimicrobial surfaces.

- **Explore** environmental applications, including water and air purification, self-cleaning coatings, and catalytic systems (e.g. nanozymes).
- **Critically assess** the sustainability aspects of nanomaterials, including their environmental impact, life cycle and safety.
- **Design interdisciplinary research approaches** by integrating concepts from materials science, biology, chemistry and environmental engineering.
- **Communicate** complex scientific ideas effectively in written, oral and visual formats suitable for academic and non-academic audiences.
- **Work collaboratively** in multidisciplinary teams to solve real-world challenges using bioinspired and sustainable nanotechnology.

5. OBJECTIVES.

1. To introduce the fundamental concepts of bioinspiration and biomimicry, emphasising their relevance in the design of advanced materials.
2. Foster a deep understanding of nanomaterials and surface engineering principles as applied to health and environmental challenges.
3. Provide hands-on experience of the key techniques used in synthesising, fabricating and characterising functional nanomaterials.
4. Highlight the latest applications of bioinspired nanotechnologies in medical devices, diagnostics, drug delivery and environmental remediation.
5. Encourage critical thinking on the ethical, environmental and sustainability implications of deploying nanotechnologies.
6. Develop interdisciplinary problem-solving skills by integrating approaches from biology, materials science, chemistry and engineering.
7. Promote scientific creativity and innovation in the design of functional materials inspired by nature's efficiency and adaptability.
8. Prepare students to lead and collaborate on high-impact research projects, contributing to the development of sustainable nanotechnology solutions.

6. COURSE ORGANISATION.

UNITS	
1.	**Introduction to Bioinspiration and Biomimicry:** Definitions and principles of bioinspiration and biomimicry, Historical context and modern scientific relevance, Natural systems as models for material innovation
2.	**Fundamentals of Nanomaterials and Functional Surfaces:** Nanomaterials: types, synthesis methods, and key properties Surface engineering: wettability, roughness, and chemical functionality Characterization techniques (e.g., SEM, AFM, XPS, contact angle)
3.	**Bioinspired Materials for Healthcare Applications**: Drug delivery systems and smart nanocarriers

	Antibacterial and antifouling surfaces for medical devices Biosensors and diagnostic interfaces
4.	**Bioinspired Strategies for Environmental Sustainability:** Self-cleaning and photocatalytic surfaces (e.g., lotus effect, TiO_2 coatings) Nanomaterials for water and air purification Nanozymes and catalytic biomimetic materials
5.	**Safety, Ethics, and Sustainability of Nanomaterials:** Life cycle assessment and environmental impact Nanotoxicology and regulatory considerations Ethical implications of bioinspired technologies
6.	**Case Studies and Emerging Research Trends:** Real-world case studies from academia and industry Interdisciplinary approaches and future directions Student discussion: Designing a bioinspired nanomaterial for a specific challenge

LEARNING RESOURCES AND TOOLS.
Lecture slides. Links to selected, updated scientific literature.
PLANNED LEARNING ACTIVITIES AND TEACHING METHODS.
Lectures, Case study discussion, Group work

7. ASSESSMENT METHODS, CRITERIA AND PERIOD.
A presentation + oral exam at the end of the course
OBSERVATIONS.

8. BIBLIOGRAPHY AND TEACHING MATERIALS.
Lecture slides in PDF format, distributed per module. Handouts and in-depth notes on case studies and specific techniques. Links to selected, updated scientific literature.