Course guide
295621 - 295MB021 - Advanced Biomaterials

Last modified: 15/07/2025

Unit in charge: Barcelona East School of Engineering
Teaching unit: 702 - CEM - Department of Materials Science and Engineering.

Degree: MASTER'S DEGREE IN ADVANCED BIOMEDICAL TECHNOLOGIES (Syllabus 2025). (Compulsory subject).

Academic year: 2025 **ECTS Credits:** 6.0 **Languages:** Catalan

LECTURER

Coordinating lecturer: Canal Barnils, Cristina

Others: Pegueroles Neyra, Marta
Mas Moruno, Carlos
Gil Mur, Javier

PRIOR SKILLS

Knowledge of the fundamental concepts and principles of the application of biomaterials and be able to apply them to problems in the field of biomedical engineering. Understanding of the fundamental criteria that must be met for a material to be implanted. Fundamental knowledge of functional biomaterials, and drug release.

LEARNING RESULTS

Knowledges:
K1. Relate advanced knowledge of biomechanics, biomaterials, implants and prostheses to the design of medical devices.
K3. Relate advanced knowledge of healthcare products and technological innovation concepts.
K2. Recognise advanced data analysis and modelling structures.

Skills:
S1. Develop kinematic and dynamic analyses of biomechanical systems using the finite element method.
S10. Use common analysis tools in technological innovation to evaluate business opportunities and develop innovation proposals in the field of biomedical technologies.
S9. Plan the stages, tasks and activities involved in designing and developing biomedical devices and sensors or processing biomedical data.
S2. Appropriately use techniques for manufacturing, analysing and characterising biomaterials to choose them correctly and process them according to their properties and potential application.

Competences:
C3. Identify and analyse problems that require making autonomous, informed and reasoned decisions in order to act with social responsibility following ethical values and principles.
C1. Assume responsibilities in work teams in production management, as just another member or in a leadership role.
C4. Use information resources effectively, manage the acquisition, structure, analysis and visualisation of data and information in the area of specialisation and critically assess the results.
C5. Use scientific and technical information to respond to any demand for modification, innovation or improvement of devices, products and processes linked to biomedical engineering for new scientific or technological applications.

TEACHING METHODOLOGY

AF.1.- Presentation of theoretical content.
AF.3.- Practical work sessions in the laboratory.
AF.4.- Discussion of cases and scientific articles.
AF.5.- Participation in seminars and conferences.
AF.6.- Completion of individual and cooperative work.

LEARNING OBJECTIVES OF THE SUBJECT

- Analyze the advanced properties of biomaterials to adapt them to specific clinical needs.
- Understand the dynamic interactions between biomaterials and biological systems.
- Apply innovative technologies for the design and modification of biomaterials.
- Propose solutions to medical challenges through the use of advanced biomaterials.

STUDY LOAD

Type	Hours	Percentage
Self study	94,0	62.67
Hours small group	28,0	18.67
Hours large group	28,0	18.67

Total learning time: 150 h

CONTENTS

Advanced Biomaterials

Description:
Topic 1: Introduction and background
1. Types, properties and applications of biomaterials.
2. Advanced properties adapted to clinical needs.
3. Dynamic interactions between biomaterials and biology.
4. Pioneering applications and future of biomaterials.
Topic 2: Biomaterials in plasma medicine
1. Introduction to Plasma Medicine: definition and classification of plasma, methods of plasma diagnosis and mechanisms of biological interactions of plasma.
2. Modification of the plasma surface of biomaterials: Mechanisms of surface modification, hard materials and soft materials, examples and practical cases of implants and biomaterials modified with plasma.
3. Applications of Plasma Medicine with Biomaterials. Plasma in wound healing and regeneration. Plasma therapy in cancer. Antimicrobial applications. Plasma in immunomodulation.
Topic 3: Biodegradable materials
1. Biodegradable polymers with shape memory. Physico-chemical properties, auxetic design, applications in medicine: implants for pediatrics.
2. Biodegradable metals. Degradation - mechanical properties and biocompatibility. Biodegradable metal alloys. Electrochemical tests.
3. Medical applications of biodegradable materials in orthopedic implants, bioabsorbable stents, tissue engineering, drug release and nerve regeneration.
Topic 4: Advanced Functional Biomaterials
1. Introduction. Evolution of materials and new needs. Mimetism, functionalization and dynamism in materials.
2. Biomaterials based on growth factors for tissue regeneration. Integrins, growth factors and the extracellular matrix. Growth factors in medical practice – limitations, Scavenger materials, immobilization and functionalization with mimetics of growth factors.
3. Multifunctional antibacterial biomaterials. Classic strategies – limitations. Multifunctionality, applications. Bactericidal nano-topographies and multifunctional peptides.
4. Intelligent stimulus-sensitive biomaterials - dynamic biomaterials. Intelligent hydrogels, Materials sensitive to pH and temperature, to enzymes. Practical case: Intelligent materials in infection control.
Topic 5: Regulatory and market withdrawals
1. Introduction to regulatory: Regulatory bodies and classification of biomaterials, medical devices.
2. Commercialization – considerations in sterilization and conditioning.
3. Withdrawals of biomaterials and medical devices: introduction and real cases. Intellectual property and marketing strategies.

Specific objectives:
- Analyze the advanced properties of biomaterials to adapt them to specific clinical needs.
- Understand the dynamic interactions between biomaterials and biological systems.
- Apply innovative technologies for the design and modification of biomaterials.
- Propose solutions to medical challenges through the use of advanced biomaterials.

Related activities:
Topic 1:
• Analysis of scientific articles.
• Exercises on advanced properties of biomaterials.
Topic 2:
• Discussion of practical cases.
• Laboratory sessions:
• P1. Surface modification with plasma
• P2. Diffusion of reactive species in tissues.
Topic 3:
• Interpretation of characterization results of biodegradable materials
• Laboratory sessions:
• P3. Degradation of metallic materials (Mg, Zn and Fe)
• P4. Adaptability of a shape-memory polymer and auxetic design
Topic 4:
• Discussion of scientific articles

• Laboratory sessions
Topic 5:
• Case method work
• Guest lecturer

Full-or-part-time: 150h
Theory classes: 32h
Laboratory classes: 24h
Self study : 94h

GRADING SYSTEM

Grades of directed activities = 15%
Grades of lab practice reports (AP) = 25%
Partial exam (EP) = 15%
Final Exam (EF) = 45%

Final grade (Nf): 0.15*AD + 0.25*AP+ 0.15*EP + 0.45*EF

BIBLIOGRAPHY

Basic:
- Redox biology in plasma medicine. Boca Raton, FL: CRC Press, 2024. ISBN 1003328059.
- Wagner, William R.; Sakiyama-Elbert, Shelly E.; Zhang, Guigen; Yaszemski, Michael J. Biomaterials science : an introduction to materials in medicine [on line]. Fourth edition. London, England: Academic Press, 2020 [Consultation: 10/09/2025]. Available on: https://www-sciencedirect-com.recursos.biblioteca.upc.edu/book/9780128161371/biomaterials-science. ISBN 0128161388.