# Teaching guide

## IDENTIFICATION DETAILS

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|---|---|
| Degree: | Biomedical Engineering |
| Field of Knowledge: | Science |
| Faculty/School: | Experimental Science |
| Course: | BIOMATERIALS |
| Type: | Compulsory |
| ECTS credits: | 6 |
| Year: | 3 |
| Code: | 2460 |
| Teaching period: | Sixth semester |
| Area: | Bioengineering |
| Module: | Disciplinary Training |
| Teaching type: | Classroom-based |
| Language: | English |
| Total number of student study hours: | 150 |

| Teaching staff | E-mail |
|---|---|
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## SUBJECT DESCRIPTION

A biomaterial comprises a group of substances designed to interact with biological systems for medical applications, either for treatment or for diagnostic. Biomaterials are directly used in regenerative medicine, prothesis and artificial organs. Design and fabrication of new biomaterials is one of the highlighted areas of Biological Engineering and the development of new biomaterials is of great interest specially paying attention to

the durability and cost.

This course aims to provide the student with the basic concepts regarding biomaterials: classes, preparation and applications, with special focus on medicine. This course includes knowledge of the different classes of biomaterials, attending to their different physico-chemical nature and applicability in medicine, with focus on their particular mechanical and chemical properties as well as their interaction with biological systems. Finally, this course intends to provide the students with recent advances on biomaterials in medicine, covering different clinic applications ranging from biomaterials for antibacterial applications to bio-compatible implants.

## GOAL

This Biomaterials course is focused on teaching students the engineering skills needed to solve challenges in the biomaterials and tissue engineering area. This course will provide students the opportunity to increase their knowledge in the areas of specific materials design, human body tissue construction, implantable materials, biological
response, assessment techniques, and local/international regulations (ISO/FDA/CE), all together focused for biomedical engineering and clinical applications.

This course covers basic concepts in material science, biological response to biomaterials, biomaterial applications, biomaterials in engineering design, with a special interest in those implantable materials, which include temporary or permanent implants, biodegradable materials, cell substrates, tailored tissue, bioactive materials, and drug delivery systems.

This course combines lectures, guest lectures, student presentations, practical sessions, and self-directed learning to examine the properties and applications of hard materials (ceramics, metals) and soft materials (polymers, hydrogels).

## PRIOR KNOWLEDGE

Students in this course are expected to have a fundamental knowledge of:
1. Understanding of laboratory materials and manufacturing techniques (Experimental Methods I)
2. Microsoft Office Suite, G Suite, and similar programs for written documents and oral presentations.
3. Cellular and Molecular Biology (Biología celular y molecular).
4. Basic principles of procaryotic cells, cell culture, and manipulation (Celular and molecular biology).
5. Cell response, biochemical and biophysical mediators (Celular and molecular biology y Biochemistry).
6. Human and living organism physiology (Human Physiology and Pathology)
7. 3D Printing (Experimental Methods I)
8. Technical or Intermediate Level of English Pre-requisites: Chemistry, Physics, and Cellular and Molecular Biology

## COURSE SYLLABUS

In this course, students will learn about design requirements and the of state-of-the-art processes in the field of Biomedical Engineering for biomaterials manufacturing, including ceramics, polymers, composites, and hydrogels. This course covers the fundamentals for material use in medical devices which are intended to directly interact with biological systems where the materials are expected to perform with an appropriate host response in specific applications. Topics covered in this course include lectures, literature reviews, practical sessions, case studies, assignments, and a final project.
Content:
Unit 1: Introduction to Biomaterials.

Unit 2: Mechanical properties of materials.
Unit 3: Biological materials.
Unit 4: Metallic materials.
Unit 5: Ceramic materials.
Unit 6: Polymeric materials.
Unit 7: Nanomaterials.
Unit 8: Biological response to biomaterials.
Unit 9: Fundamentals of microbiology and biofilm.

## EDUCATION ACTIVITIES

Course topics will be covered with different learning methodologies that include lectures, tutorials, practical sessions, flipped-classroom, discussions, and a team-based project.
The course also includes in-class discussions and debates for material selection (design, selection, assessment, implementation, follow-up, and publication)
As part of the learning activities of this course, students are expected to act as active members of the scientific community, who will plan, prepare, and develop a product (experimental plan or device) to investigate different biomaterials and their application in the field of biomedical engineering.
Moreover, students are expected to perform autonomous work by reading, asking questions, participating in class, performing background research, preparing assignments and activities to diffuse the acquired knowledge, and keeping up to date with classes.
For practical sessions (laboratory), the goal is for students to acquire the knowledge, skills, and tools to finish the lab assignments. The instructor will give demonstrations and short lectures to build students' skills, and students will spend the remaining time working on assignments.

## DISTRIBUTION OF WORK TIME

| CLASSROOM-BASED ACTIVITY | INDEPENDENT STUDY/OUT-OF-CLASSROOM ACTIVITY |
|---|---|
| 60 hours | 90 hours |

## SKILLS

### Basic Skills

Students must have demonstrated knowledge and understanding in an area of study that is founded on general secondary education. Moreover, the area of study is typically at a level that includes certain aspects implying knowledge at the forefront of its field of study, albeit supported by advanced textbooks

Students must be able to apply their knowledge to their work or vocation in a professional manner and possess skills that can typically be demonstrated by coming up with and sustaining arguments and solving problems within their field of study

Students must have the ability to gather and interpret relevant data (usually within their field of study) in order to make judgments that include reflections on pertinent social, scientific or ethical issues

Students must be able to convey information, ideas, problems and solutions to both an expert and non-expert audience

Students must have developed the learning skills needed to undertake further study with a high degree of independence

**General Skills**

to understand, apply, adapt and develop tools, techniques and experimental protocols with methodological rigour and safety, understanding the limitations of the experimental approach.

**Specific skills**

To know the principles and synergies offered by nanotechnology, biotechnology and pharmacology and their application in health care.

To use the technological and engineering tools necessary for the design of processes and the manufacture of tissue and biomaterials for application in Biomedical Engineering.

## LEARNING RESULTS

To identify different materials types in terms of their interaction with biological systems and their scale properties.

To study the fabrication processes of biomaterials, biomimetic materials, and nanoparticles: micro and nanostructures, and 3D structures.

To know the functionalization techniques that allow improvement of the interaction of materials with biological systems.

To design and fabricate three-dimensional structures: scaffolds.

To know the basic tasks of biotechnological processes in the production of biomedical devices

## LEARNING APPRAISAL SYSTEM

**ORDINARY EVALUATION SYSTEM**
The evaluation system of Biomaterials includes the assessment of all the activities carried out in the teaching-learning process of the course. A minimum grade of 5 (out of 10) is required to pass the course. This mark will be calculated with the percentages corresponding to each evaluation activity:
**EV1-Exam (70%):** Its objective is to evaluate the global learning of the contents exposed in class. The student will demonstrate the assimilation, comprehension, and ability to relate the contents exposed; as well as the analysis, calculation and resolution of problems framed in the subject. To pass the course, the student must obtain a minimum grade equal to 5 (out of 10) in the exam.

**Students who obtain a grade equal to or higher than 5 (out of 10) in the activity EV1, but do not pass the course in the ordinary exam, will keep their grade until the Extraordinary Exam in the same academic year.*

**EV2-Laboratory sessions (15%):** The aim of this activity will be to determine the student's degree of understanding of the experimental procedures and techniques applied in the laboratory sessions, their connection with the theoretical concepts covered in the subject, the calculations required to carry out the experimental work, the interpretation and discussion of the experimental results obtained, as well as the clarity, presentation and the correctness of the written expression. To pass the course, the student must obtain a minimum grade equal to 5 (out of 10) in the EV2 activity.

**Attendance at all laboratory sessions is compulsory (regardless of the place where they are held: laboratory, computer room, etc.). Absences must be duly justified to the Professor in Charge of the Course (PEC). Unjustified non-attendance at any of these sessions will result in the failure of the course in the Ordinary Exam.**

**Students who obtain a grade equal to or higher than 5 (out of 10) in the EV2 activity, but do not pass the course in the ordinary exam, will keep their grade until the Extraordinary Exam of the same academic year.*

**EV3-Continuous evaluation activities (15%):** The objective of these activities is the continuous evaluation of the learning acquired by the student throughout the subject. The completion of theoretical-practical tasks or projects corresponding to the topics in which the subject is structured will be proposed. To pass the course, the student must obtain a minimum grade equal to 5 (out of 10) in the EV3 activity.

**Students who obtain a grade equal to or higher than 5 (out of 10) in the EV3 activity, but do not pass the course in the ordinary exam, will keep their grade until the Extraordinary Exam of the same academic year.*

**Attendance at all lessons and sessions is compulsory (regardless of the place where they are held: laboratory, computer room, etc.). Absences must be duly justified to the Professor in Charge of the Course (PEC). Unjustified non-attendance to 20% of classroom-based lessons will result in the loose of continuous evaluation.**

**ALTERNATIVE EVALUATION SYSTEM**

The alternative evaluation system for second or successive enrolment students includes the same evaluation activities and percentages than the ordinary evaluation system.

Plagiarism, fabrication, falsification, or the use of illegitimate methods for presenting data, documents, reports, or any task related to the course, will be penalized as written in the Normativa de Evaluación and the Normativa de Convivencia of the University.

## BIBLIOGRAPHY AND OTHER RESOURCES

### Basic

Yitzhak Rosen, Noel Elman. Biomaterials science :an integrated clinical and engineering approach / Boca Raton, FL :CRC Press,c2012.