GENERAL CHARACTERISTICS*

Type: ☐Basic formation, ☑Compulsory, ☐Optional

☐Master Thesis, ☐External practices

Duration: Semester **Semester / s**: 2
Number of ECTS credits: 4
Languages: Spanish, Catalan, English

DESCRIPTION

BRIEF DESCRIPTION AND JUSTIFICATION

The course is basically presented as an introduction to the molecular foundations of Biomaterials. The idea is that the student is able to understand the relationship between the structure and the properties of the Biomaterials and based on this knowledge is able to design them to be used as superstructures (scaffolds) for the growth of cells and tissues, and for its use as drug delivery agents. That is why the topics related to the structural and mechanical part of these materials are omitted.

In the second part of the course the operational principles of those materials once implemented in instrumentation for biomedical applications are explained in detail.

COMPETENCES

- E12 - Possess advanced knowledge of biomaterials, as well as the most relevant techniques of preparation and processing, for their use in biomedical applications.
- E13 – Ability to select biomaterials and propose adequate characterization techniques, demonstrating, in a specialized context, a detailed and deep understanding of the theoretical and practical aspects and the work methodology.
- CG2 - The ability to perform a responsible practice of the profession.
- CB9 - To communicate conclusions and the reasons that sustain them, to specialized and non-specialized audiences in a clear and unambiguous way
- T3 -Ability to assess the impact of the use of materials on the sustainable development of society

PREREQUISITES*

The corresponding to access master studies

CONTENTS

1. **Molecular Design and synthesis of Biomaterials I: Biodegradable polymer systems**
   1.1. Chemistry and Chemistry-hydrolysis physics

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1.1.1. Relationship between the structure of the material and the hydrolysis
1.1.2. Theory of the erosion of polymers
1.2. Enzymatic degradation of materials In vivo degradation of solid polymers
1.3. Biological recognition in vivo.
1.3.1. Design of the biological recognition of solid polymers
1.3.2. Applications
1.4. Controlled release systems based on polymers.
1.4.1. Degradable materials such as controlled release systems.
1.4.2. Theory of drug release with different mechanisms of degradation.
1.4.3. Drug release systems.
1.4.4. Molecular design applied to the engineering of controlled release systems.

2. **Molecular design and synthesis of Biomaterials II: Hydrogels**
2.1. Structure of the hydrogels.
2.2. Methods of obtaining.
2.3. Design of hydrogels as extracellular matrix formers.
2.4. Formation of self-free injectable systems.
2.5. Hydrogels as controlled release systems.
2.6. Polyelectrolyte hydrogels.
3. **Molecular design and synthesis of Biomaterials III: Bioceramics and Biocomposites**
3.1. The bone as a nanocomposite.
3.2. Synthetic approaches to the bone structure.
3.3. Remodeling bioceramics in vivo.
3.4. Theory of synthetic biomineralization.
3.5. Biocomposites in applications such as controlled release agents and in biomedical instrumentation.
4. **Molecular design and synthesis of Biomaterials IV: Surface modification, cellular adhesion** and biocompatibility
4.1. Cellular adsorption on surfaces.
4.2. Cellular growth on modified surfaces.
4.3. Adsorption of proteins on surfaces.
4.4. Methods of surface modification.
5. **Biomaterials with response to a stimulus**
5.1. Classes of biomaterials sensitive to a stimulus.
5.2. Stimuli in living systems.
5.3. Thermo-sensitive biomaterials, UCST vs. LCST.
5.4. PH sensitive materials.
5.5. Biolelectronics: Chips for the release of drugs.
5.6. Photosensitive biomaterials.
5.7. Integrated systems: Nano, Bio, Info, Cogno (NBIC).
6. **Biomaterials and medical instrumentation**
6.1. Paradigm for the design of medical instrumentation and implants.
6.2. Functional requirements
6.3. Effects of instrumentation on the body.
6.4. Effects of the body on instrumentation.
6.5. European regulations and the US Food and Drug Administration.

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METHODOLOGY

LEARNING ACTIVITIES *

Learning Activities	ECTS credits	Competences
Lectures	0,93	E12, E13, CG2,T3
Seminars	0,07	E12, E13, CG2
Case and Problem-Solving Sessions	0,11	E12, E13, CG2
Personal study	2,67	E12, E13, CG2
Presentations	0,11	E12, E13, CG2
Assessment Tasks (Exams, Continuous Assessment...)	0,11	E12, E13, CG2
TOTAL	**4**	

TEACHING METHODOLOGY

- Lectures (possibly including demonstrations) by a professor.

- Resolution of exercises, approach / resolution of problems and exposition / discussion of cases by a lecturer with the active participation of students.

- Instruction made by a lecturer with the aim of reviewing, discussing and resolving doubts about the materials and topics presented in the sessions of exposition of concepts and sessions of resolution of exercises, problems and cases.

- Oral presentation to a lecturer and possibly other students by a student. It can be a work prepared by the student through searches in the published bibliography or a summary of a practical work or project undertaken by said student.

- Personal work of the student necessary to acquire the competences of each course and to assimilate the knowledge exposed in the lectures and Case and Problem-Solving Sessions, problems and cases, using, when necessary, the recommended bibliography.

- Assessment Tasks in form of oral/written exams during the academic period or once it has finished.

ASSESSMENT

ASSESSMENT METHODS *

Assessment methods	Weight	competences
Final exam	50%	E12, E13

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Reports and Presentations	20%	E12, E13,T3
Follow-up activities	25%	E12, E13
Participation	5%	CG2

LEARNING OUTCOMES

- The student must have updated knowledge of the families of biomaterials, their applications and the scientific bases that characterize their properties. (E12, CG2)
- The student must have a solid knowledge of the scientific bases that characterize the properties of biomaterials. (E12)
- The student must know the most relevant techniques of preparation and processing of biomaterials. (E12)
- The student must know a set of techniques for characterizing biomaterials and the management of advanced experimental equipment. (E13)
- The student must demonstrate knowledge of the properties of biomaterials in relation to the consequences derived from their misuse (T3)

QUALIFICATION

The evaluation of the course will consider all aspects listed in the evaluation table with its corresponding weight. The main weight of the grade lies in the final examination (50%). The reports and Presentations include classroom presentations and specific monographs that students prepare (20%). Follow-up activities include midterm exams or other deliverables (15%). Participation (5%) includes attitude, attendance and initiative shown by the student in the subject.

ASSESSMENT OF THE COMPETENCES (Define calculation expressions for each competency based assessment activities related.)

The grades of the final exam, the reports and presentations and the follow-up activities will be used as an indicator for the evaluation of the E12 and E13 competences.

The participation grade will be used as an indicator for the evaluation of CG2 competence

The reports and presentations grade will be used as an indicator for the evaluation of the T3 competence ,

BIBLIOGRAPHY (Recommended and accessible to students.)

- B. Ratner, et al., "*Biomaterials Science*, "., 2nd Ed., Elesevier Academic Press, Amsterdam, 2004.

- Y.C. Fung, "*Introduction to Bioenginering*", 1a Edición, World Scientific publications,

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Singapur, 2001.

- Martin Malmsten Editor, " *Biopolymers at Interfaces*" 2o Edición 2003, Marcel Dekker Inc. , New York, 2003.

DOCUMENT HISTORY

PREVIOUS CHANGES
September 20, 2016, Dr. Salvador Borrós and Dr. Victor Ramos
Octubre 2nd, 2015, Dr.Salvador Borrós

CURRENT REVISION
February 26, 2019, Dr. Salvador Borrós

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