Teaching guide

IDENTIFICATION DETAILS

Degree:	Biotechnology
Field of Knowledge:	Science
Faculty/School:	Experimental Science
Course:	BIOENGINEERING
Type:	Compulsory
ECTS credits:	3
Year:	3
Code:	2053
Teaching period:	Sixth semester
Area:	Biotechnological Process Engineering
Module:	Biotechnological Tools
Teaching type:	Classroom-based
Language:	English
Total number of student study hours:	75

Teaching staff	E-mail
Beatriz Loreto Rodilla González	beatriz.rodilla@ufv.es
Mª del Pilar Calvo Salve	pilar.calvo@ufv.es
José Pérez Rigueiro	jose.perez@ctb.upm.es
Gustavo Víctor Guinea Tortuero	gustavovictor.guinea@upm.es

SUBJECT DESCRIPTION

The subject has been designed to equip the student with a sound knowledge on aspects of engineering that are

relevant to its relationship with biotechnology. Particular emphasis is placed on the issues related to engineering materials applied in biological or biotechnological systems, including synthetic materials inspired by natural (biomimetic) ones. An extensive introduction is also given to two fields of growing interest: nanotechnology and early detection (biosensors), in particular, appreciating the influence of both fields in the development of biotechnology.

To achieve the above-mentioned knowledge, the subject is structured in three independent modules:

1. Biomaterials and biomimetics
2. Biosensors and Surface functionalization
3. Introduction to Nanotechnology

The combination of the three modules, offers a general picture of diverse scientific areas such as Engineering, Materials Science, Biochemistry or Microelectronics, among others. The course is organized so that the three modules complement and improve each other, highlighting the importance of interdisciplinarity in the present science.
This subject belongs to the module “Biotechnological tools” and it consists of 30 hours of master class and 75 hours of total student work. Within the curriculum, this subject is related to Fundamentals of Physics and Chemistry, Fundamentals of Biochemistry and Fundamentals of Mathematics. With regard to its relation with subjects of higher courses, it is necessary to emphasize its connection with Bioreactors and with Chemistry and Engineering of Proteins.

GOAL

This subject belongs to the Biotechnological Tools Module. The objective is to make the students familiar with the main applications of materials in Biotechnology, in particular biomimetism, surface modification and its applications in the development of devices for early disease detection and nanotechnology.
Likewise, the objective is that students can understand the importance of interdisciplinarity in the development of current science and its biotechnological applications.

The specific aims of the subject are:

Use of tension and deformation concepts in the description of the mechanical behavior of the materials.

Classification of biomaterials in metallic, ceramic, polymeric and natural.

Identification of the interactions responsible for conformations in biomolecules.

Use of self-assembly and hierarchical microstructure concepts in the context of Biomimicry.

Learn the concept of Biosensor and identify its constituent parts.

Understand the different classification categories of biosensors.

Study of the different biosensors classified by transducer.

Know the fundamental properties that characterize the behavior of materials at the nanoscale.

Know, identify and classify nanometric structures manufacturing techniques.

Knowing the applications of structures and devices in the biotechnology sector.

Understand the social and environmental implications of the progress of nanotechnology.

PRIOR KNOWLEDGE

The previous knowledge required to follow the subject corresponds to the basic subjects of previous courses related to Fundamentals in Physics, Biochemistry and Biology.

COURSE SYLLABUS

The subject is divided in three different modules: Biomaterials and biomimetics, Biosensors and Surface functionalization and Introduction to Nanotechnology.

PART I: BIOMATERIALS AND BIOMIMETICS (36%)
- Unit 1: Biomaterials: Metals and Ceramics. Biological polymers and biomaterials
- Unit 2: Biological fibers. Protein fibers. Polysaccharide fibers. Cellular fibers.
- Unit 3: Biological materials: hard and soft materials.
- Unit 4: Biomimetics. Self-assembly. Hierarchical structures.

PART II: FUNCTIONALIZATION AND BIOSENSORS (36%).
- Unit 1: Biosensor. Definition. Differences with Chemical Sensors. Components of a Biosensor. Biosensors classification. Characteristics of a Biosensor.
- Unit 2: Bioreceptors. Inmobilization. Development of a biosensor. Surface Functionalization and Fabrication. Surface Characterization Techniques.
- Unit 3: Electrochemical biosensors.
- Unit 4: Optical biosensors.
- Unit 5: Mass and nanomechanical biosensors.

PART III: INTRODUCTION TO NANOBIOTECHNOLOGY (28%)
- Unit 1: Nanoscience and Nanotechnology.
- Unit 2: Imaging and manipulation Instruments.
- Unit 3: Nanomaterials: Nanoparticles, Nanofibers, Dendrimers, Nanostructures, Nanotubes.
- Unit 4: Nanobiotechnology in Biosensors for Diagnosis.
- Unit 5: Nanobiotechnology in Regenerative Medicine.
- Unit 6: Nanobiotechnology in Drug Release.
- Unit 7: Nanotechnology and society.

EDUCATION ACTIVITIES

Expository and participative teaching.
Seminars, round tables, workshops, tutorials, debates.
Evaluation.

DISTRIBUTION OF WORK TIME

CLASSROOM-BASED ACTIVITY	INDEPENDENT STUDY/OUT-OF-CLASSROOM ACTIVITY
35 hours	40 hours
Expository and participative teaching. • Seminars, round tables, workshops, tutorials,	Autonomous study: theoretical study and preparation of face-to-face activities.

debates. • Evaluation.	• Virtual network work.

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 the fundamental laws and principles of physics, mathematics, chemistry and biology as the foundation for the mental structure of a biotechnician.

To acquire the skills needed for experimental work: design, preparation, the compilation of results and the obtainment of conclusions, understanding the limitations of an experimental approach.

Specific skills

To understand the foundations and applications of microarrays in biotechnology.

To study biological and biomimetic materials and their biotechnological applications.

LEARNING RESULTS

Identify the mechanical parameters relevant in the behavior of a material or structure.

Select materials suitable for use in medical treatments.

Apply the physical and biochemical principles to the development of bio-inspired materials.

Establish the connection between the microstructure and the properties of biological materials.

Identify the possibilities and applications of nanotechnology in the part of the biotechnology related to health: Regenerative Medicine, Diagnosis and Drugs release.

Establish the basis of synthetic and biological material interaction.

Identify the physical and biological mechanisms involved in biodetection.

Relation of the main concepts of biodetection with clinical reality.

Relation of basic updated knowledge of nanotechnology with the health area.

LEARNING APPRAISAL SYSTEM

The evaluation will be done through:
1. Evaluation of the theoretical content by an objective evaluation test: 100%. An ordinary theory test will be carried out, consisting of test questions (with subtraction of score in case of error). The exam will include questions from the three parts of the subject, which will be weighed proportionally to the number of hours of each part. To pass the exam, it is necessary to obtain a 5 in the global exam.
The extraordinary call will be a theory test under the same conditions than the ordinary one.

Plagiarism behaviors, as well as the use of illegitimate means in the evaluation tests, will be sanctioned in accordance with those established in the University's Assessment Regulations and Coexistence Regulations.

Alternative evaluation system: the same percentages and contributions are maintained as in the ordinary evaluation. Students in 2nd or subsequent enrollments must contact the teacher to request to take advantage of this system and find out through the virtual classroom the dates to carry out the various deliveries and activities.

BIBLIOGRAPHY AND OTHER RESOURCES

Basic

edited by Jeffrey O. Hollinger. An introduction to biomaterials / Second Edition. 2012.

editors, Victor R. Preedy, Vinood B. Patel. Biosensors and environmental health / 2012.

Brian R. Eggins. Chemical sensors and biosensors [electronic resource] / Chichester ;Hoboken, N.J. :J. Wiley,c2002.

Jo Anne Shatkin. Nanotechnology :health and environmental risks / 2013.

Additional

José Pérez Rigueiro. Lecciones de materiales biológicos y biomateriales / Madrid :Universidad Politécnica de Madrid,[2006]