Universidad Francisco de Vitoria
UFV Madrid

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

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SUBJECT DESCRIPTION

The subject has been organized to provide the student with a strong knowledge in aspects of Engineering that are relevant in Biotechnology. Issues related to engineering materials applied to biological or biotechnological systems including synthetic materials inspired by natural ones (biomimetics) are emphasized in this subject. There is also a relatively extensive introduction to two fields of increasing interest such as nanotechnology and early disease detection (biosensors). In particular, the influence of both fields in the development of biotechnology is stressed.

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 requiered 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: Introduction: Material-biological system interfaces. Biological response and biocompatibility. Functionalization. Definition. Techniques. Applications.
Unit 2: Biosensors. Definition. Components of a biosensor. Classification. Development of a biosensor.
Unit 3: Mass and nanomechanical biosensors.
Unit 4: Optical biosensors.
Unit 5: Electrical and electrochemical 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

Master Class: The students will have 30 hours of master class to receive the subject contents.
Cooperative work: the students will make a critical revision of different papers related to the topics of the subject.

DISTRIBUTION OF WORK TIME

CLASSROOM-BASED ACTIVITY	INDEPENDENT STUDY/OUT-OF-CLASSROOM ACTIVITY
35 hours	40 hours
Lectures: master class given by the professors of the subject 30h Tutorial: Personalized attention of the students to review the theoretical contents explained in class, answer questions or discuss about specific topics. The aim is helping the students to achieve the objectives of the module. 1h Test 4h	Theoretical study: Study of theoretical contents using the information offered in the lectures 38h Preparation of tutorials 2h

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 acquire essential engineering knowledge for designing and scaling instruments needed to develop a biotechnological process.

To have acquired the ability for analytical, synthetic, reflective, critical, theoretical and practical thought.

To be able to plan time effectively.

To value sciences as a cultural fact.

To recognise the mutual influence existing between science, society and technological development in order to strive for a sustainable future.

Specific skills

To understand the foundations and applications of microarrays in biotechnology.

To acquire the technological and engineering knowledge needed in process design.

To study biological and biomimetic materials and their biotechnological applications.

To be able to approach a subject by means of rigorous, profound and comprehensive thought.

Capacity for written and oral communication of the knowledge acquired.

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 an objective evaluation test.
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. This exam will be the 100% of the final grade.
The extraordinary call will be a theory test under the same conditions than the ordinary one.

BIBLIOGRAPHY AND OTHER RESOURCES

Basic

Lecciones de Materiales Biológicos y Biomateriales. J. Pérez Rigueiro. www.ingebook.com

Structural Biological Materials (Edited by M. Elices), Pergamon Elsevier Science, Oxford, 2000

Nanobiotechnology II: Moare concepts and applications. Edited by CA Mirkin and CM Niemeyer , Wiley-VCH 2007.

Biotenología Mediambiental. R. amils. I Marín. J.L. Sanz. (Ed); editorial ehepmea 2005.

Additional

Structural Biomaterials, J. Vincent, Princenton Univ. Press, New Jersey, 1990

Mechanical Design in Organisms, S. A. Wainwright, W.D. Biggs, J.D. Currey, J.M. Gosline, Princenton Univ. Press, New Jersey, 1982

Nanobiotechnology: Conceps, applications and perspectivas, Edited by CM Niemeyer and CA Mirkin, Wiley-VCH, 2004

Nanobiotechnology II: More conceps and Applications, Edited by CM Niemeyer and CA Mirkin, Wiley-VCH, 2007