Introduction to Biomaterials

Academic Year: (2024 / 2025) **Review date: 26-04-2024**

Department assigned to the subject: Bioengineering Department

Coordinating teacher: VELASCO BAYON, DIEGO

Type: Compulsory ECTS Credits : 6.0

Year : 3 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Cell and Molecular Biology
Biochemistry

SKILLS AND LEARNING OUTCOMES

RA3: Be able to carry out conceptual designs for bioengineering applications according to their level of knowledge and understanding, working in a team. Design encompasses devices, processes, protocols, strategies, objects and specifications broader than strictly technical, including social awareness, health and safety, environmental and commercial considerations.
RA4: Be able to use appropriate methods to carry out studies and solve problems in the biomedical field, commensurate with their level of knowledge. Research involves conducting literature searches, designing and carrying out experimental practices, interpreting data, selecting the best approach and communicating knowledge, ideas and solutions within their field of study. May require consultation of databases, safety standards and procedures.
CB1: Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study.
CB2: Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
CB3: Students have the ability to gather and interpret relevant data (usually within their field of study) in order to make judgements which include reflection on relevant social, scientific or ethical issues.
CB4: Students should be able to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.
CG2: Ability to design, draft and develop scientific-technical projects in the field of biomedical engineering.
CG4: Ability to solve problems with initiative, decision-making, creativity, and to communicate and transmit knowledge, skills and abilities, understanding the ethical, social and professional responsibility of the biomedical engineer's activity. Capacity for leadership, innovation and entrepreneurial spirit.
CG7: Drafting, representing and interpreting scientific-technical documentation.
CG10: Knowledge of the structure, composition, processing, properties and behaviour in service of the different families of materials and their interrelationships. Being able to select materials according to their applications in biomedicine.
CG15: Ability to apply microfabrication, microfluidics, nanotechnology and 3D printing techniques in the field of biomaterials.
CG17: Ability to apply engineering, micro-engineering, nano and biotechnology techniques to solve complex biomedical problems in regenerative medicine.
ECRT15: Understand the properties of the different existing biomaterials and the organism's responses to biomaterials and implants. Critical ability to evaluate the possibilities and potential applications of existing or foreseeable biomaterials in the near future.
CT1: Ability to communicate knowledge orally and in writing to both specialised and non-specialised audiences.
CT2: Ability to establish good interpersonal communication and to work in multidisciplinary and international teams.
CT3: Ability to organise and plan their work, making the right decisions based on the information

available, gathering and interpreting relevant data in order to make judgements within their area of study.

OBJECTIVES

This course is designed to provide a comprehensive understanding of the multidisciplinary field of biomaterials, focusing on the biological responses to materials and the clinical context of their use. Through lectures, paper reviews, in class discussions and invited lectures, students will be introduced to the Biomaterials Science and the physiological interactions between body environment and biomaterials. Students will be required to acquire understanding and expertise from analysis of primary literature and will complete group presentations on the status of state-of-the-art biomaterial applications, including medical implants, artificial organs, and scaffolds for tissue engineering.

DESCRIPTION OF CONTENTS: PROGRAMME

This course is intended to provide a general understanding of the multidisciplinary field of principles and properties of biomedical biomaterials including the properties of biomaterials used in medicine, synthesis and properties of polymeric biomaterials, natural and synthetic biomaterials, biodegradable biomaterials, hydrogels, bioceramics and metals for biomedical applications and smart biomaterials.Also the interactions between biomaterials and biological systems (host reactions to biomaterials and its evaluation, cell-biomaterial interactions) and different applications of biomaterials, including tissue engineering, cardiovascular and orthopaedic applications and artificial organs, will be studied. Introduction to 3D printing, designing biomaterials for 3D bio/printing.

1. Introduction to Biomaterials. Basic concepts
2. Polymers and hydrogels for biomedical applications
3. Ceramics for biomedical applications
4. Biomaterial degradation
5. Designing biomaterials for 3D printing
6. Surface modification of biomaterials
7. Extracellular matrix-based biomaterials
8. Biomaterial implantation: acute inflammation and wound healing
9. Immune response to biomaterials
10. Infection, tumorigenesis and calcification of biomaterials
11. Blood-biomaterial interactions

LEARNING ACTIVITIES AND METHODOLOGY

The program will be divided into master classes (lectures) and discussion/problem classes (seminars). For specific subjects, there will be invited lectures given by prestigious professionals in the field. The topics covered by the invited speakers are part of the subject and will be evaluated in the continuous evaluation blocks and in the final exam as well. Students may be required to read assigned chapters/articles before the lectures and seminars. In the discussion classes, relevant scientific articles and problems will be presented and discussed by the students and the teaching team.

ASSESSMENT SYSTEM

% end-of-term-examination:	30
% of continuous assessment (assigments, laboratory, practicals…):	70

Grading will be based on continuous evaluation and a final exam covering the whole subject, including invited lectures and seminars. Help sessions and tutorial classes will be held prior to the final exam upon students´ request. Attendance to lectures and seminars is not compulsory. However, failure to attend any test or submit the exercises before the deadline will result in a mark of 0 in the corresponding continuous evaluation block (see below).

GRADING:
Total score: 10 points
Continuous evaluation: 7 points out of 10
Final exam: 3 points out of 10

CONTINUOUS EVALUATION: It accounts for up to 70% of the final score of the subject (7 points of the

% end-of-term-examination:	30
% of continuous assessment (assigments, laboratory, practicals…):	70

TOTAL SCORE), and includes two components:
1) Two tests: 5.8 points of THE TOTAL SCORE (2.9 points each). These tests will take place mostly during lectures and will be announced at least one week in advance. These tests will be not included in the final exam
2) Scientific paper presentation: 1.2 points of THE TOTAL SCORE.

FINAL EXAM: it will account for the 30 % of the final score (3 points of the TOTAL SCORE). The minimum score in the final exam to pass the subject is 4 over 10, notwithstanding the mark obtained in continuous evaluation

EXTRAORDINARY EXAM: there are two possibilities:
a) Examination of all the topics of the course (100% extraordinary exam mark)
b) Evaluation will follow the same criteria as the continuous evaluation (70% continuous evaluation, 30% final exam)

ACADEMIC CONDUCT: Unless specified, all exams will be closed-book, closed-notes, no PC or mobile phone, or anything else other than a writing implement and the exam itself. Plagiarism, cheating or other acts of academic dishonesty will not be tolerated. Any infractions whatever will result in a failing grade.

BASIC BIBLIOGRAPHY

- Chee Kai Chua, Wai Yee Yeong Bioprinting: Principles and Applications, World Scientific Publishing Company, 2015

- David Williams Essential Biomaterials Science, Cambridge University Press, 2014

- Jason A. Burdick and Robert L. Mauck Biomaterials for Tissue Engineering Applications: A Review of the Past and Future Trends, Springer Verlag, 2011

- Johnna S. Temenoff and Antonios G. Mikos Biomaterials: The Intersection of Biology and Materials Science, Prentice Hall, 2009

ADDITIONAL BIBLIOGRAPHY

- Abul K. Abbas, Andrew H. Lichtman and Shiv Pillai Cellular and Molecular Immunology, Saunders, 2011

- Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen and Jack E. Lemons Biomaterials Science: An Introduction to Materials in Medicine, Academic Press , 2012

- Clark R.A.F. and Henson P.M. The Molecular and Cellular Biology of Wound Repair, Plenum Press, 1996

- Kay C. Dee, David A. Puleo and Rena Bizios An Introduction to Tissue-Biomaterial Interactions, Wiley-Liss, 2002

- María Vallet-Regí Bio-Ceramics with Clinical Applications, Wiley, 2014