Tissue/organ regeneration and bioengineering

Academic Year: (2023 / 2024) **Review date: 19/12/2023 14:36:02**

Department assigned to the subject: Bioengineering Department

Coordinating teacher: GARCIA DIEZ, MARTA

Type: Electives ECTS Credits : 6.0

Year : 4 Semester :

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

The student must have coursed Introduction to Bioengineering, Cell and Molecular biology, Biochemistry, Biomechanics of continuum media I (solids), Biomechanics of continuum media II (fluids) Fundamentals of Tissue engineering and Regenerative
medicine, Transport phenomena in Biomedicine, and Introduction to Biomaterials.

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.
RA5: Acquire intermediate/advanced knowledge of engineering and biomedical sciences and demonstrate an understanding of the theoretical and practical aspects and methodology of work in their field of study.
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.
CB5: Students will have developed the learning skills necessary to undertake further study with a high degree of autonomy.
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.
CG6: Knowledge of current standards, regulations and legislation and ability to apply them to bioengineering projects. Bioethics applied to biomedical engineering.
CG7: Drafting, representing and interpreting scientific-technical documentation.
CG8: Ability to solve mathematical, physical, chemical and biochemical problems that may arise in biomedical engineering.
CG17: Ability to apply engineering, micro-engineering, nano and biotechnology techniques to solve complex biomedical problems in regenerative medicine.
CG18: Ability to apply knowledge of human anatomy and physiology to the resolution of problems in medicine from the point of view of bioengineering. Ability to identify medical problems that can be

treated by means of techniques encompassed in Biomedical Engineering.
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

Regenerative Medicine (RM) and Tissue Engineering are multidisciplinary fields that apply the principles of life science, engineering, and basic science to the development of viable substitutes which restore, maintain, or improve the function of human tissues.
This course is designed to provide an advanced knowledge of tissue and organ regeneration and a practical point of view to tissue engineering, understanding the biotechnological tools to generate each component.
Students will be required to learn and gain expertise from analysis of primary literature about the design of tissue functional units.
The student will acquire the ability to design biological tissues by using advanced techniques in bioengineering and biotechnology from the developmental point of view. The students will acquire the ability to understand the importance of stem cells and gene therapy in order to succeed in the generation of a tissue, even in pathological situations.

DESCRIPTION OF CONTENTS: PROGRAMME

PROGRAM:

1.Tissue¿s organization and development. Concepts of Embryogenesis and Morphogenesis.

2. Tissue/Organ Engineering Paradigm. Biotechnology.

3. Bioreactors for biotechnology.

4. Use of recombinant technologies in Tissue Engineering.

5. Gene therapy.

6. Gene delivery systems (viral and non-viral).

7. Next-generation Gene-therapy: Gene Editing.

8. Transgenic organisms as biofactories.

Organ reconstruction

9.Transplantation and rejection.
10. Stem cells.

11. Practical examples for organ reconstruction.

Regulations and Clinical use:

12 Advance therapy medicinal products.

13. Government regulations for engineered tissues.

LABORATORY EXPERIMENTS:
Cell Culture Laboratory for Biotechnology and Tissue Engineering.

a. Experimental design and methods that will be useful for tissue characterization and development

b. Understand biomaterial generation for organ bioengineering.

c. Stem cell harvest and isolation.

d. Tissue/organ bioengineering.

d. Tissues histological and molecular characterization using biotechnological tools.

e. Critical evaluation of scientific results.

LEARNING ACTIVITIES AND METHODOLOGY

The program will be divided into master classes, seminars and laboratory practical sesions.
Students are required to read or resolve assigned chapters, articles, problems, etc., before the corresponding classes.
To facilitate learning, students will receive the slide of each class and the bibliography.
The seminars and Journal Clubs will contain the discussion of relevant scientific articles and problems that will be presented by the students.
In the laboratory classes, students divided in 2-3 students small groups will perform a reduced experimental design with the help of the teaching team.
The student will be familiar with ethical and regulatory issues related to tissue engineering and regenerative medicine.
Students will be required to elaborate a report discussing the experiments performed, the obtained results, the relevance and applications in biomedicine and the experience and skills gained. These classes includes the problems and discussion sections.

ASSESSMENT SYSTEM

% end-of-term-examination/test:	60
% of continuous assessment (assigments, laboratory, practicals…):	40

TEACHING METHODOLOGY
Teaching methodology will be mainly based on lectures, seminars, journal clubs and practical sessions.
Students may be required to read assigned documentation before lectures and seminars. Lectures will be used by the teachers to stress and clarify some difficult or interesting points from the corresponding lesson, previously prepared by the student.
Grading will be based on continuous evaluation tests and a final exam covering the whole subject. Help sessions and tutorial classes will be held prior to the final exam upon student's request.
Attendance to lectures and seminars/ journal clubs is not compulsory. However, failure to attend any test will result in a mark of 0 in the corresponding continuous evaluation block (see below).
The practical sessions will consist on laboratory work (5 sessions) and a report will be presented at the end of the course.
The attendance to 80 % of practical sessions is mandatory otherwise the score will be 0 in this item.

GRADING:
Total score: 10 points
1) Students who pass the course through continuous evaluation will not have to take a final exam. In this case:
- 1st continuous evaluation test: 30% (minimum grade to pass the exam will be 4.5 points)
- 2nd continuous evaluation test: 30% (minimum grade to pass the exam will be 4.5 points)
- Journal club; 10%
- "Experimental Research in Bioengineering I-IV¿: paper + presentation= 20%
- "Experimental Research in Bioengineering V"): dossier=10%
Attendance at least 80% of the practical sessions is mandatory; otherwise, the score will be 0 in this section.
2) Students who do not pass one of the 2 continuous evaluation test (with less than 4.5 points), will have to take the final exam. In this case:
- Continuous evaluation: 40% of the final course score (5 points of the total score), and includes two components:
- 1st continuous evaluation test: 30% (minimum grade to pass the exam will be 4.5 points)

% end-of-term-examination/test:	60
% of continuous assessment (assigments, laboratory, practicals…):	40

- 2nd continuous evaluation test: 30% (minimum grade to pass the exam will be 4.5 points)
- Journal club; 10%
- "Experimental Research in Bioengineering I-IV¿: paper + presentation= 20%
- "Experimental Research in Bioengineering V"): dossier=10%

Attendance at least 80% of the practical sessions is mandatory; otherwise, the score will be 0 in this section.
-FINAL EXAM: The final exam will include the entire syllabus (and may include laboratory sessions) and will represent 60% of the final score. The minimum score in the final exam to pass the subject is 4.5 out of 10, without taking into account the grade obtained in the continuous assessment.
Students who pass the continuous evaluation want to present to raise their grade. In this case: 60% of the grade from the 2 continuous assessment tests will be replaced by 60% of the final exam grade.
3) EXTRAORDINARY EXAM:
The grade of the extraordinary exam will be:
a) 60% of the extraordinary exam and 40% of the continuous evaluation, for students who are examined in the same academic year.
b) 100% of the extraordinary exam, for students who are examined in years after the current academic year.
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 what so ever will result in a failing grade.

BASIC BIBLIOGRAPHY

- Atala A, Allickson J. Translational Regenerative Medicine. 1st edition, Elsevier, 2014

- Baptista PM, Atala A, Laurence J. Translating Regenerative Medicine to the Clinic, 1st Edition., Elsevier, 2015

- Guilak F, Butler, DL, Goldstein SA, and Mooney DJ Functional Tissue Engineering, Springer, 2003

- Lanza RP, Langer R, Vacanti J Principles of Tissue Engineering. Third edition, Academic Press, 2007

- Mescher AL JUNQUEIRA'S BASIC HISTOLOGY: TEXT AND ATLAS, Mc Graw Hill, 2013

- Palsson BO, Bhatia SN Tissue Engineering, Upper Saddle River: Pearson Prentice Hall, 2004

- Saltzman MW Tissue Engineering: Engineering Principles for the Design of Replacement Organs and Tissues, Oxford University Press, 2004

- Vunjak-Novakovic G, Freshney RI Culture of Cells for Tissue Engineering (Culture of specialized Cells), Springer, 2006