Fundamental of tissue engineering and regenerative medicine

Academic Year: (2024 / 2025) **Review date: 24-04-2024**

Department assigned to the subject: Bioengineering Department

Coordinating teacher: GUERRERO ASPIZUA, SARA

Type: Compulsory ECTS Credits : 6.0

Year : 3 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

The student must have coursed Cell and Molecular Biology and Biochemistry.

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.
CG7: Drafting, representing and interpreting scientific-technical documentation.
CG8: Ability to solve mathematical, physical, chemical and biochemical problems that may arise in biomedical engineering.
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.
ECRT19: Recognise and understand the structure of different tissues through the use of conventional and virtual optical microscopy. Knowledge of the different types of stem cells, their advantages and limitations and their applications in tissue engineering and regenerative medicine.
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

Tissue engineering (TE) is a multidisciplinary field which applies 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 a basic knowledge of Tissue and organ organization and an introduction to tissue engineering: Dynamic and structural interactions between mesenchyme and parenchyme, the role of the tissue microenvironment, stem cells, gene and cell-based therapies.
Students will be required to acquire understanding and expertise from analysis of primary literature and will participate in group discusions on the status of state-of-the-art designing tissue functional units.
Students will be required to use a conventional and virtual microscope to recognize and document normal and pathological structures. Students will be required to follow a SPOC (small private online course) that will intensify the knowledge acquired through the continuous evaluation.
The students will carry out audiovisual presentations as a result of their research in fields related to regenerative medicine.

DESCRIPTION OF CONTENTS: PROGRAMME

Obtain an overview of tissue engineering in clinical medicine and biomedical research
Understand the role of emerging technologies and engineering and life science disciplines in tissue engineering

1) Review of current status of tissue engineering and regenerative medicine
   Introduction to TE and overview of course objectives
2) Tissues morphological and functional units
   Organization of cell into higher ordered structures
   Dynamics of Cell-ECM Interactions
   Analysis of the physicochemical processes that affect limit and control cells and tissues function.
   - Epithelial Tissue, Connective Tissue, Muscular Tissue and Nervous Tissue
3) Systems and Organs: morphological and functional units
   Structural and dynamic interactions between mesenchyme and parenchyma
   The role of tissue microenvironment, extracellular matrix and communication by growth factors
4) Tegumentary System
5) Designing tissue functional units
   Stem cells and Genetic Engineering
6) Seminars on tissue recognition using virtual microscope.
7) "SPOC" about tissue engineering and regenerative medicine that wil firm up the continuous evaluation contents.
8) Audiovisual material preparation based on regenerative medicine.
LABORATORY EXPERIMENTS: (Every student will perform 15 hours of practical sessions in UC3M bioengineering laboratories)

a. Use of conventional microscopy for the understanding of tissue structure.
b. Understand microscopic organization of Tissues into Organs and systems.
c. Tissue observation and image capture. Tissue engineering.
d. Histology as a diagnostic tool.
e. Use of Immunohistochemical techniques.

LEARNING ACTIVITIES AND METHODOLOGY

The program will be divided into master classes (regular and invited lectures), discussion/problem classes (seminars) virtual microscope seminars, and the students will course a SPOC (small private online course), audiovisual material preparation based in Regenerative medicine and finally laboratory classes.
Students are required to read assigned chapters/articles, or solve problems before the corresponding classes. In the discussion and problems sections, relevant scientific articles and problems will be discussed by the students and the teaching team. In the laboratory sessions students, divided in small groups will perform different experiments with the help of a supervisor and Lab guide prepared by the

teaching team.
Students will be required to pass an exam at the end of laboratory sessions.

ASSESSMENT SYSTEM

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

TEACHING METHODOLOGY

Teaching methodology will be mainly based on lectures, seminars, an online course: SPOC (small private online course) and finally 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 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 (15 hours in 5 sessions) and a written test at the end of the sessions. The attendance to 80 % of practical sessions is mandatory otherwise the score will be 0 in this item.

GRADING:
Total score: 10 points
Continuos evaluation: 4 points out of 10
Final exam: 6 points out of 10

CONTINUOUS EVALUATION: It accounts for up to 40% of the final score of the subject (4 points of the TOTAL SCORE), and includes two components:
1) Continuos evaluation tests : Including at least 2 partials and assignments (VM atlas, video assesment, MOOC test...)
2) Laboratory: One written laboratory test will take place at the end of the laboratory sessions. .

Attendance to at least 80% of the practical sessions is mandatory; otherwise the score will be 0 in this item.

FINAL EXAM: The final exam will cover the whole subject (including the material learned in the laboratory sessions, seminars and SPOC) and will account for the 60 % of the final score. The minimum score in the final exam to pass the subject is 4.5 over 10, notwithstanding the mark obtained in continuous evaluation.

EXTRAORDINARY EXAM: The mark for students attending any extraordinary examination will be:
a) 100% exam
b) 60% exam and 40% continuous evaluation if it is available in the same course.

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 as well as any other disciplinary action imposed by the University.

BASIC BIBLIOGRAPHY

- Langer, Robert S, Lanza, R. P., and Vacanti, Joseph Principles of Tissue Engineering. 4th ed. , Elsevier, 2014

- Mescher, Anthony L. Junqueira's Basic Histology : Text and Atlas. 15th Ed., McGraw-Hill, 2018

- Micou, Melissa Kurtis, and Dawn M. Kilkenny A Laboratory Course in Tissue Engineering., CRC Press, 2013

ADDITIONAL BIBLIOGRAPHY

- Fawcett, Don W., and Ronald P. Jensh Bloom and Fawcett's Concise Histology. 2nd ed. , Arnorld, 2002

- Saltzman, W. Mark. Tissue Engineering Engineering Principles for the Design of Replacement Organs and Tissues., Oxford OP, 2004