Universidad de Navarra

Regenerative medicine (MIB)

Guía docente 2025-26

PRESENTACIÓN

Regenerative Medicine encompasses a number of novel technologies that promote the replacement of lost specialized tissue by undamaged specialized cells. This can be achieved by the so-called advanced therapies, i.e. cell-, gene-, or engineered tissue-based therapeutic approaches to restore organ and tissue function. Organs are extremely complex structures composed by many different tissues and the diversity of cells that function in a perfect synchronization to provide essential functions in our body. When tissues are damaged and need to be restored, a multidisciplinary approach and strong understanding of the complexity of the problem makes it possible to address these situations. A combination of specific stem cell-derived cultures, biomaterials and viral vector combinations can be used to create healthy substitutes or to reactivate the endogenous healing process of a damaged tissue.

In this 5-ECTS course students will be introduced to this field by learning essential concepts on advanced therapies, cellular and tissue response, design and engineering microenvironments, integrating micro and nanotechnologies, etc. The students will be encouraged to develop analytical and critical thinking over the available technologies and design their own approaches for the current medical challenges. It will be necessary to meet the standards, regulations and ethical guidelines in this field.

- **Titulación**: Master's Degree in Biomedical Engineering
- **Módulo/Materia**: Especialidad en Tecnologías, Sistemas y Dispositivos Biomédicos / Tecnologías, Sistemas y Dispositivos Biomédicos (Especialidad Análisis de Datos: Módulo Optativo/Materia Optatividad)
- **ECTS**: 5 ECTS
- **Curso, semestre**: Second
- **Carácter**: Optativo
- **Profesorado**:
  - Dr. Jacobo Paredes / Titular
  - Dr. Ander Izeta / Profesor invitado
  - Ane Miren Imaz / Personal de apoyo a la docencia
- **Idioma**: English
- **Aula, Horario**: TBD

RESULTADOS DE APRENDIZAJE (Competencias)

- CB6 - Students will possess and understand the knowledge that provides a basis or opportunity to be original in the development and/or application of ideas, often in a research context.
- CB7 - Students will know how to apply the knowledge acquired and will have the ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study.
- CB8 - Students will be able to incorporate knowledge and deal with the complexity of formulating opinions from information that, although being incomplete or limited, includes in-depth consideration of social and ethical responsibilities linked to the application of their knowledge and opinions.
- CB9 - Students will know how to communicate their conclusions, as well as the knowledge and reasons which support said conclusions, clearly and unambiguously to specialized and non-specialized audiences.

- CB10 - Students will possess sufficient learning abilities to continue studying, to a considerable extent, autonomously and under their own guidance.
- CG02 - Students will be able to carry out research, development and innovation in products, processes and/or methods in biomedical engineering.
- CG05 - Students will know how to project, calculate and design products, processes, facilities and control systems in the area of biomedical engineering.
- CE10 - Students will know how to integrate technologies from the field of engineering to solve medical needs

PROGRAMA

The syllabus of this course is organized in theory lessons and laboratory practices.

THEORY LESSONS

- Introduction to Regenerative Medicine Course: Presentation of activities, program, methodology, and assessment. Introductory concepts: Tissue regeneration vs. repair.
- Cellular Biology Foundations for Regenerative Medicine: Stem cells: types, characteristics, and sources; differentiation, transdifferentiation, and cellular plasticity; cell signaling in regenerative processes.
- Cellular Reprogramming and Genome Editing: Induced reprogramming (transfection technologies), iPSC generation; genetic editing tools: CRISPR/Cas9 and beyond, current challenges and limitations.
- Tissue Reprogramming and Tissue Engineering Strategies: Principles of tissue-level reprogramming; Manipulation of the cellular microenvironment; Integration with biomimetic materials.
- From Organoids to Whole-Organ Engineering: Development and culture of organoids; Strategies for organ engineering: methods, challenges, and clinical cases.
- Quality Standards in Advanced Therapies: Good Manufacturing Practice (GMP) for cell-based products; Scale-up processes and quality control; Certification, traceability, and product validation.
- Regulatory, Ethical, and Social Aspects: European and international regulatory frameworks; Ethics in research and clinical applications; Public acceptance and bioethical challenges.
- Emerging Topics and Complementary Technologies (subject to time availability): Organ-on-a-chip technologies and disease modeling; Design and use of bioreactors for cell and tissue culture; 3D bioprinting in regenerative medicine; Artificial intelligence in tissue engineering

PRACTICAL SESSIONS

- Review of basic cell culture techniques: Subculture of stem cells
- Approaches for engineering fat or bone from mesenchymal stem cells
- Cell reprogramming and engineering skeletal muscle constructs
- Fabrication of hierarchical polymeric scaffolds: electrospinning and FDM
- Characterization techniques: spectrophotometry, histology and fluoresecence immunostaining

BIOTECH COMPANY VISITS AND SEMINARS

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Throughout the course different visits and seminars with leading biotech companies will be schedule to provide the students with a first hand experience of cutting edge technologies. Collaborative companies belong to areas such as celluar therapy, gene therapy, regeneration technologies, wound healing medical prodcutcs or tissue engineering.

ACTIVIDADES FORMATIVAS

Learning process will be addressed taking into consideration the following points:

- Throughout the course, theoretical classes will be combined with practical classes guided by the professors and technical staff.
- Assignments and other tests, including scientific articles, videos and papers will be distributed during the sessions.
- Guest lecturers or visits will be scheduled to bring professional expertise to the topics covered during the regular classes.
- Students will carry out small hands-on projects based on laboratory practices. They will be asked to write a short report on the results and their analysis and to hand in a paper on one of the projects.
- Finally, they will be asked to make the presentation of the paper and the final exam.

As an orientation for the students, the dedication of this course could be distributed as:

- 25h theory classes and seminars
- 35h guided practical sessions
- 30h teamwork, reports and deliverables
- 25h personal work and study
- 10h assesment and mentoring

EVALUACIÓN

CONVOCATORIA ORDINARIA

The assesment of this course pursue students engagement the with the learning objectives. The evaluation of the course takes into account the following aspects:

- 20% Attendance, participation (promotion of critical thinking among the students).
- 20% Teamwork based on lab practice reports.
- 20% Personal work and laboratory performance.
- 40% Project (manuscript and presentation) based on one of the hands-on lab project

These percentages are subjected to modifications prior notitication to the students

REQUIREMENTS TO PASS THE COURSE: The assessment of certain aspects described above should have a minimum level. A maximum of two unjustified absence. Follow at all times the risk assessment guides to avoid or minimize accident risks.

CONVOCATORIA EXTRAORDINARIA

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In the event that one student fail to demonstrate the acquisition of any of the competences planed to this course, it will be necessary to asses again the related activities.

HORARIOS DE ATENCIÓN

The teaching and learning methodology was designed to stablish an open and fluid communication between the students and the lecturers, providing a great environment to discuss the different topics covered. In addition to this dialog, lecturers and teaching assistants will be available after each session. Also, students could contact the professors of the course through email to schedule a personal appointment.

BIBLIOGRAFÍA Y RECURSOS

Regenerative medicine is a field under continuous development and therefore the best source of information is the speciallized scientific journals. However there are some reference text books that bring together excellent compendium of key and relevant topics in this field. Therefore students are encourage to search, read and watch other interesnting materials available on the Web, specially research papers.

Documents and other materials: presentations, laboratory experimental protocols, videos, etc. will be available in the content section. Alternatively, students can review the recomended bibliography from previous corses such as:

- Lanza, RP, Langer, R, and Vacanti, J.P., Principles of Tissue Engineering, 4th edition (2008) ISBN 0124366309 Localízalo en la biblioteca (formato papel); Versión electrónica (2014)
- At the bench: A laboratory Navigator. 2005. Kathy Barker. CSHL Press ISBN 0879697083 (For the lab sessions) Localízalo en la biblioteca

There are other general textbooks that could be handy in key moments to review basic concepts: for example "Bruce Alberts. Molecular Biology of the Cell" Localízalo en la biblioteca