Innovations in Biotechnology applied to regenerative medicine

Objectives

The course aims to provide thorough knowledge of advanced biotechnologies in the field of regenerative medicine and tissue engineering through multidisciplinary training that combines updated theoretical concepts and practical skills within a highly international setting.

The graduate will:

- Master concepts of tissue degeneration and regeneration processes and applications in order to face contemporary and future challenges in this field;
- Integrate skills from different fields in order to develop original ideas in research and development;
- Maintain consistent updates in the field;
- Translate knowledge acquired in experimental and research activities into the clinic. The graduate will therefore be able to apply knowledge and problem solving skills to new and unexplored topics, encompassing broader and interdisciplinary settings;
- Acquire skills in communication with experts in the field.

Skills

Graduates will acquire:

- Concepts of the biology of stem cells: from basic knowledge to the characterization through -OMICS, up to the principles underlying their therapeutic use in the field of regenerative medicine; at the same time practical skills will be acquired regarding isolation procedures, cell expansion and use of specific instrumentation;
- Knowledge on the foundations of pathological processes related to tissue degeneration with reference to the cellular and molecular mechanisms involved;
- Knowledge on the mechanisms underlying tissue regeneration, with particular attention to emerging technologies in the field;
- Cross-disciplinary knowledge of innovative strategies in tissue engineering, starting from tissue biomechanics, up to the use of biomaterials, 3D printing and nanotechnologies;
- Knowledge on the ethical aspects of basic and preclinical research on stem cells and principles of clinical ethics;
- Skills related to the main biostatistics and bioinformatics methodologies that provide models for the analysis, description, interpretation, and dissemination of biological phenomena;
- Knowledge on regulatory aspects related to Advanced Therapy Medicinal Products (ATMP) including manufacturing processes, commercialization, costs, sustainability and approvals;
- Knowledge on basic and advanced instrumental analytical techniques and laboratory practice;
- Knowledge on patents, technology transfer, and economic aspects linked to biotechnological research in the field of regenerative medicine.

Course structure

The course is taught entirely in English. Lectures and laboratory activities will take place at the Centro di Ricerca E. Menni (CREM)-Fondazione Poliambulanza (Brescia), and the advanced materials physics laboratory activities will take place at the Faculty of Mathematical, Physical and Natural Sciences of Università Cattolica del Sacro Cuore (Brescia).

First year courses focus on topics that are es-

sential for understanding the basics of regenerative medicine- they are grouped into four main learning areas.

- **Area of biotechnology for the study and applications of stem cells**
  Understanding the implications of cellular biotechnology with a focus on the translational potential of stem cells and the role of the cell secretomes in therapeutic effects.
- **Advanced biotechnology area for regenerative medicine and tissue engineering**
  Specialist and multidisciplinary knowledge of modern biotechnological approaches aimed at the development of innovative therapies in the fields of regenerative medicine, tissue engineering and biomaterials. The area also aims to provide basic knowledge regarding the most recent analytical and quantitative tools for describing biological phenomena and providing models for processing experimental data.
- **Area of biotechnology for the development of experimental models and biotechnology applications in the clinical setting**
  Knowledge of different experimental models for investigating mechanisms underlying regeneration and for evaluating new therapeutic applications. The area aims to raise awareness of the methodological procedures in preclinical experimentation and clinical research for an optimal interdisciplinary transfer of skills and information.
- **Area of regulation, economics, technology transfer and soft skills**
  Foster managerial aspects that underlie the development of modern biotechnologies and their application in the clinical setting. The area also deals with aspects closely linked to research such as the development of technical-scientific language and critical thinking.

Few practical laboratory activities ("hands on") activities are present in the first year however they are progressively more frequent in the second year and allow the student to consolidate practical skills, and put acquired knowledge to use in the lab while developing critical judgment skills.

Seminars held by international experts on specific topics relating to the most recent applications of regenerative medicine are also planned: these activities, in addition to further strengthening knowledge and skills acquired in the training course, will constitute an opportunity for discussion with experts on open issues in the scientific community, thus contributing to the development of communication skills and inclusion in the international scientific context.

Students will be able to complete their training by carrying out internships in research laboratories or biotech companies affiliated with the University, both in Italy and abroad, aimed at developing projects consistent with the educational objectives of the course.

After graduation

Graduates are highly specialized professionals who are internationally competitive and able to operate in many areas including:

- research and service laboratories in public or private institutions (universities, research organisations);
- biotech and pharmaceutical industries, specifically in research and development, regulation, and quality control activities,
- national and international regulatory and certification bodies;
- companies that carry out and support technology transfer activities;
- institutions involved in activities complementary to biotechnology (publishing and scientific communication, service providers, grant writing and scientific support agencies).

In addition, after passing the State examination, the graduate can register with the Professional Order of Biologists (Senior List), and thus will be able to access career opportunities in the health sector. The graduate in Innovations in Biotechnology applied to Regenerative Medicine may also apply for a PhD and other post-graduate specialty schools with access reserved to 'non-medics' as per DI n. 716/2016, as well as to similar post-graduate courses at foreign universities.

Credits

The program is a 2-year course and made of a total of 120 credits. One credit (CFU) corresponds to 25 hours of total commitment per student. The breakdown of the total time commitment for each credit between assisted teaching and individual study is determined as follows:

- 1 credit lecture= 8 hours of lecture + 17 hours of individual study
- 1 credit laboratory=25 hours of assisted teaching
- 1 credit curricular internship= 25 hours of training activities (at the institution/industry where the internship is carried out)
- 1 credit final exam= 25 hours of individual study

The student acquires credits after passing the exam or successfully completing other forms of learning comprehension.

Frequency

Attendance is required for all activities (lectures and laboratory). In order to be admitted for exams students must have attended at least 65% of the lectures in the classroom and at least 80% of the laboratory activities. Attendance will be verified at the discretion of the Lecturer/Professor.

Study plans

The study plans may be subject to changes; the official one will be published in the specific Faculty Guide and in the SUA-CdS.

First year	CFU
Advanced stem cell Biology	8
Analytical tools in applied Biology	10
Mechanisms of degeneration and regeneration	9
The revolution of stem cell research	10
Biomaterials and tissue engineering	8
Refining project pitches and proposals	8
Translating stem cell research from bench to bed	10
Scientific English 1	2
Italian language (*)	2

Second year	CFU
Basic laboratory	2
From in vitro to in vivo preclinical models, towards clinical applications	8
Laboratory 1	5
Laboratory 2	10
Scientific English 2	2
Stages and internships abroad or in Italy	4
Experimental thesis	14

Optional courses

REGENERATIVE MEDICINE APPLICATIONS (**)	CFU
Advanced cell therapy in skin regeneration	1
Applications in Gynaecology and Obstetrics	1
Applications in Ophtalmology	1
Bioinformatics and biostatistics	1
Biotechnology approaches to treat cancer	1
Cell therapies in Hematology	1
Cell-based approaches for lung regeneration	1
Cellular mechanisms and advanced cell therapies in cardiac regeneration	1
Innovative therapies in Dentistry and Orthodontics	1
Tissue engineering in osteochondral regeneration	1

SEMINARS AND JOURNAL CLUB (**)	CFU
Advances in tissue engineering	2
ATMP: the regulatory journey to go from bench to bedside	2
Health biotech industry today: challenges and opportunities	2
Stem cell derivatives and mechanisms of action	2
Treatment effect evaluation in quasi-experimental settings	2

Note:
(*) for mother tongue Italian students, Advanced English (2 CFU)
(**) Students must obtain a total of 8 credits for optional courses (4 for the "Regenerative medicine applications" and 4 for the "Seminars and journal club")