UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Advanced Cellular Models in Pre-Clinical Research and Personalized Medicine

2324-1-F0802Q082

Aims

Address the problems of (re)-constructing multi-cellular systems able to reproduce different aspects of tissue heterogeneity and variability, and whose understanding requires a multidisciplinary approach in which biochemistry, cellular and molecular biology techniques are integrated by advanced methodologies of micro- fluidics and imaging. This approach makes it possible to address fundamental biological processes in integrated terms, providing the researcher with tools not only for generating and structuring knowledge, but also for developing in vitro replicas of portions of tissues and organs of single individuals in order to identify the most suitable personalized drug treatment for each individual patient.

1. Knowledge and understanding.
   At the end of the course the student will have to know the possibilities offered by various advanced cellular models both in the field of basic and pre-clinical research and in the application of these cellular systems in the diagnostic and therapeutic fields, with particular reference to precision medicine.
2. Ability to apply knowledge and understanding.
   At the end of the course, the student must be able to apply the knowledge acquired in point 1 to scientific, methodological and applicative problems other than those explicitly covered in class
3. Making judgments.
   The student must be able to re-elaborate the principles and methodologies learned, firstly to consult the literature, so to update his/her skills before they become obsolete, and secondly to identify the privileged areas of use.
4. Communication skills.
   At the end of the course the student will be able to express himself appropriately in Italian (for students of Italian mother tongue) and English (for all students) in the description of the topics addressed with proper language and safety of exposure.
5. Learning skills
   At the end of the course, the student will be able to analyse, apply, integrate and connect the acquired knowledge - and subsequently gained by consulting the literature - with what learned in related courses, in order to solve scientific problems in both basic and applied biochemistry.

Contents

Pre-clinical studies of multifactorial pathologies such as tumors and neurodegenerative diseases require increasingly complex cellular models capable of recapitulating the characteristics of the pathology under study more effectively than conventional two-dimensional cell cultures.
The methods of formation of the single models, the main analysis technologies will be described and compared, with particular reference to the techniques that allow to analyze properties related to the nature and position of the cells with advanced imaging techniques and single cell omics technologies and spatially resolved technologies. Finally, the possible role of some of these cellular models in personalized medicine will be discussed. Most of the topics will be treated through multidisciplinary analysis of specific case studies.

Detailed program

1. Spheroids: three-dimensional cell aggregates derived from a single cell type (homotypic) or two or more different cell types (heterotypic).
2. Organoids: structures derived from one or a few cells of a tissue, embryonic stem cells or induced pluripotent stem cells, which can self-organize in three-dimensional culture thanks to their self-renewal and differentiation capabilities.
3. Organ-on-chip: Systems containing engineered or natural miniature tissue grown within microfluidic chips. To better mimic human physiology, the chips are designed to control cellular microenvironments and maintain specific tissue functions.
4. Patient-derived xenografts (PDX): Tumor models in which tissue or cells from a patient's tumor are implanted into an immunodeficient or humanized mouse to reconstruct an environment that allows for natural tumor growth, tumor monitoring, and corresponding treatment assessments for the original patient.
5. Main analysis technologies, including quantitative ones: imaging, morphometric analysis, autofluorescence, RAMAN spectroscopy, specific fluorescent probes

Prerequisites

The course is based on concepts and methodologies exposed in the basic Biochemistry and Molecular Biology courses. In particular, the knowledge of the basic elements of the cellular biochemistry of complex eukaryotes (metabolism, signal transduction, cell cycle and cell death) is required. Some basic knowledge of statistics is appreciated.

Teaching form

Lectures, in-depth interactive analysis of selected scientific papers, Journal club.
Laboratory exercises related to the preparation and analysis (in particular through biochemical and imaging techniques) of advanced cellular models, in particular homo- and heterotypic spheroids in the presence and absence of matrices and their morphometric and biochemical analysis.

Textbook and teaching resource

Specialist articles, reviews and/or book chapters will be recommended in class.
The specific experimental protocols relating to laboratory experiments will be delivered

Semester

First semester

Assessment method

There are no mid-term exams;
The exam is oral and will verify the acquisition of the basic concepts of the development and use of advanced cellular models and their application, also through in-depth discussion of specific articles chosen in agreement with the students before the exam

Office hours

By phone or by appointment via email

Sustainable Development Goals

GOOD HEALTH AND WELL-BEING | QUALITY EDUCATION