UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Systems Biochemistry

2627-1-F0803Q069

Aims

The couse aims to approach the study of the cell as a complex system.

1. Knowledge and understanding.
   Upon completion of the course, students will be able to:
   • Understand the principles, applications, and limitations of the main advanced omics methodologies, with particular reference to metabolomics, fluxomics, single-cell and spatial transcriptomics, and multiplex proteomics.
   • Interpret complex omics data through a systemic and interdisciplinary approach, integrating information from different levels of biological organization.
2. Ability to apply knowledge and understanding.

- Critically evaluate the potential of omics technologies in the study of biological systems and in understanding the molecular mechanisms underlying physiological and pathological processes. Understand the role of biotransformations and biotechnologies in promoting the circular economy and the sustainability of production processes, with particular attention to the valorization of supply chains.
- Analyze the contribution of advanced cellular models and "omics" technologies to the identification of molecular targets and the development of personalized therapeutic strategies for multifactorial diseases.

3. Independent judgment.

- Acquire the ability to critically discuss recent scientific literature and apply an integrated approach to experimental design and interpretation of results.

4. Communication skills.

- By the end of the course, students will be able to express themselves appropriately in Italian (for native Italian speakers) and English (for all students) in describing the topics covered with command of language and confident delivery.

5. Learning skills

- By the end of the course, students will be able to analyze, apply, integrate, and connect the knowledge acquired—and subsequently developed through literature review—with what was learned in related courses, in order to solve scientific problems in both basic and applied biochemistry.

Contents

The course provides an advanced overview of contemporary omics technologies and their applications in biochemical and biomedical research. Topics include the principles and applications of metabolomics, fluxomics, single-cell and spatial transcriptomics, and multiplex proteomics, with particular emphasis on systems biology approaches for the integration and interpretation of complex biological datasets. The course also addresses the role of biotransformations and biotechnology in circular economy and sustainable production processes, as well as the use of advanced cellular models and omics technologies for the investigation of multifactorial diseases and the development of personalized therapeutic strategies. The syllabus may be partially adapted to reflect students' scientific interests and recent advances in the field.

Detailed program

The program will be agreed upon and may be partially modified according to the students' interests.

I. Advanced omics methodologies: metabolomics and fluxomics; single-cell and spatial transcriptomics; multiplex proteomic analyses: IBEX and MILAN

II. The systemic approach: Interpreting omics data in context using interdisciplinary approaches: general concepts and examples.

V. Biotransformations, circular economy, and green economy in the context of sustainable production and supply chain circularity

VI. Multifactorial diseases: advanced cellular models and omics technologies in the identification of molecular targets and the design of personalized therapies

Prerequisites

The course is based on concepts and methodologies exposed in the basic Biochemistry and Molecular Biology courses. In particular, knowledge of the basic elements of prokaryotic and eukaryotic cell biochemistry (metabolism, signal transduction and cell cycle) and enzymology is required. Some basic statistical knowledge is appreciated

Teaching form

21 2-hour lessons consisting of:

- one part (6-8 lessons) in delivery mode (delivery teaching, DE) focused on the presentation-illustration of contents, concepts, scientific principles

- the remaining part - maximum 15 lessons - in interactive mode (interactive teaching, DI), which includes:

    - Interactive discussion of scientific articles by the students;
    - presentation of scientific articles in a manner similar to the presentation of data at a scientific congress (oral report = journal Club or Poster);

        - 1 CFU (7 hours of lessons) carried out in interactive mode in co-presence with the teacher of Analisi Qualitativa e Quantitativa di Sistemi Biologici (Prof. Pasquale Palumbo) and with Prof. Damiani to deal with a case study together. This educational approach will allow the presentation and examination of biological pathways, functions and systems from complementary points of view, seen with the eye of the biologist and the computational modeller.

- All activities are conveyed by means of face-to-face lectures

Language: Italian, can be changed to English upon request of foreign students

Textbook and teaching resource

Basic concepts of System Biology are presentyed in :
Lilia Alberghina: Per Comprendere la Complessità Biologica – Licosia Editore
Original research, review articles and book chapters will be suggested in class
Video recordings of each lesson, slides and papers discussed in the classroom will be provided

Semester

Second semester

Assessment method

There are no exams in itinere; The exam is oral and will verify the acquisition of the basic concepts of systems biochemistry and their application, also through in-depth discussion of specific articles chosen in agreement with the students before the exam. The ability to apply the concepts presented in the course to biochemical problems not explicitely covered in class will contribute to the final score. Grading will strictly depend on the correct use of biochemical terminology, the ability to explain concepts and methodologies with scientific rigor, and a clear, logical presentation

Office hours

By telephone or e-mail appointment

Sustainable Development Goals

GOOD HEALTH AND WELL-BEING | QUALITY EDUCATION | RESPONSIBLE CONSUMPTION AND PRODUCTION