UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Biochemistry for Biotechnologies

2627-3-E0201Q059

Aims

The course aims to provide students with biochemical aspects useful for the understanding of advanced biotechnological methodologies in different fields of application of biotechnology. The topics will be dealt with at an intermediate level, with emphasis on one side on approaches to the expansion of molecular and system knowledge and on the other end the application of consolidated methodologies that are closer to more markedly industrial problems with emphasis on the engineering of proteins and on drug discovery.

Knowledge and understanding.
At the end of the course the student must know and understand:
the principles underlying intracellular protein trafficking, some advanced concepts of enzymology, of the engineering of proteins and enzymes and the basic principles of the application of enzymes in industry; the basic principles of signal transduction and cell cycle in eukaryotes; the basic principles of protein-protein interaction and related study methods; the basic principles of systems biology (post-genomic techniques, reductionist approach vs systemic approach)

Ability to apply knowledge and understanding.
At the end of the course the student must be able to apply the acquired knowledge to the scientific, methodological and applicative problems studied in class and in contiguous areas not directly treated in the lessons.

Making judgments
The student must be able to identify the privileged areas of use of the methodologies addressed. The critical and judgment skills are implemented at different levels that include: exercises and computer demonstrations carried out in the classroom; presentation and discussion of one or more case studies that start from the analysis of the biochemical properties of proteins, pass through their structure-guided and/or evolution-guided engineering up to the implementation of pharmacologically active molecules or derivatives thereof usable in the clinic or enzymes usable in the industrial field.

Communication skills.
At the end of the course the student will be able to express himself appropriately in the description of the topics

addressed with proper language.

Learning skills
At the end of the course the student will be able to read and understand at a basic level, literature pure and applied biochemistry, also in view of the choice of the literature to be studied for the thesis preparation.

Contents

Maturation and post-translational modifications of proteins.
Signal transduction.
Molecular enzymology.
Experimental and computational approaches to the determination of protein three-dimensional structure; Protein Engineering.
Post-genomic technologies.
Systems Biology.

Detailed program

CHAPTER 1
Post-translational maturation and modification of proteins: structural characterization, main pathways in vivo and their application valence (for example, effects of glycosylation on the antigenicity and stability of the recombinant proteins)

CHAPTER 2
Signal transduction: definition, examples and potential applications

CHAPTER 4

Principles of protein three-dimensional structure determination and overview of the main experimental techniques. Exploration of the Protein Data Bank (PDB). Use of dedicated software tools for the visualization and structural analysis of proteins and other biomolecules.
Introduction to protein sequence alignment methods. Generation and analysis of multiple sequence alignments aimed at identifying conserved residues, functional motifs, and evolutionary relationships.
Experimental structure versus computational model: conceptual and practical differences. Basic principles of the main computational approaches for protein three-dimensional structure prediction, with particular emphasis on homology modelling and artificial intelligence-based methods. Generation of three-dimensional protein models using homology modelling techniques and AlphaFold 3.
Assessment and validation of structural models. Analysis of the main metrics used to estimate model quality, including the pLDDT score and Ramachandran plots.

CHAPTER 4
Enzymes: reaction mechanisms, specificity, regulation, parameters of relevance in biocatalysis. Engineering, immobilization and applications of recombinant proteins for industrial use.

CHAPTER 5
Introductory aspects to "omics" technologies, their role in the molecular dissection of pathways and in drug discovery. Topics will be introduced through examples, focusing on the limits and possibilities of the various methodologies. In particular, it will be highlighted how the context of application dramatically varies the purpose and methods of analyzing the "omics" data.

CHAPTER 6
Elements of systems biology: generalities and potential uses (in particular in the drug discovery process and in the development of resposable production chains using enginereed enzymes or microrganisms.

CHAPTER 7

Biochemistry and molecular science in the world of work from basic science to research and development in Biotechnology and the Health world.

Prerequisites

Background: concepts and methodologies of biochemistry, basics of molecular biology, biomolecular and biochemical methods.
Specific prerequisites: Biochemistry.
General prerequisites: Students can take the exams of the third year after having passed all the exams of the first year of the course.

Teaching form

59 total hours divided into twenty-nine 2-hour lessons and one 1-hour lesson consisting of:
• 24 lessons in delivery mode (delivery teaching, DE) focused on the presentation-illustration of contents, concepts, scientific principles;
• the remaining part (5 lessons) in interactive mode (interactive teaching, DI), which includes the presentation and use of bioinformatics tools aimed at studying the three-dimensional structure of proteins also in a protein engineering context;
• up to a maximum of 5 lessons can be held remotely in asynchronous mode.

Teaching language: italian.

Textbook and teaching resource

Learning material (slides of the lessons, scientific articles) is available at the e-learning platform of the course. Book chapters will be suggested in class.
Video recording of the lessons will be made available

Semester

First semester

Assessment method

Written + Oral
The written exam takes place in a computer lab. It consists of:
Part A = 30 multiple choice questions (total max score = 150, threshold score A = 75);
Part B = 2 definitions, 2 problems, 3 open answers, total max score = 180, threshold score B = 90).
The oral exam will be open to:
students who reached or exceeded both thresholds in the written exam
or
the students who, despite having reached or exceeded only one of the two thresholds, reached a total score greater than or equal to 180

The oral exam score will algebraically modify the written exam score.

The exam will verify the acquisition of the basic concepts and methodologies exposed, evaluating the student's ability to apply them to different problems, not necessarily addressed in class.

The score of the open questions in the written exam and in the oral exam will also be dependent of the proper use of the (blochemical) language and on the ability to illustrate concepts, methodologies and examples with scientific rigor and clear and logical articulation of the answer.

Office hours

Contact: on demand, upon request by e-mail to lecturer.

Sustainable Development Goals

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