



UNIVERSITÀ DI PAVIA

Anno Accademico 2020/2021

ORGANIC CHEMISTRY AND BIOCHEMISTRY

Enrollment year	2020/2021
Academic year	2020/2021
Regulations	DM270
Department	DEPARTMENT OF ELECTRICAL, COMPUTER AND BIOMEDICAL ENGINEERING
Course	BIOENGINEERING
Curriculum	Cellule, tessuti e dispositivi
Year of study	1°
Period	1st semester (28/09/2020 - 22/01/2021)
ECTS	9
Language	Italian

The activity is split

500191 - **BIOCHEMISTRY**

500178 - **ORGANIC CHEMISTRY**



BIOCHEMISTRY

Enrollment year	2020/2021
Academic year	2020/2021
Regulations	DM270
Academic discipline	BIO/10 (BIOCHEMISTRY)
Department	DEPARTMENT OF ELECTRICAL, COMPUTER AND BIOMEDICAL ENGINEERING
Course	BIOENGINEERING
Curriculum	Cellule, tessuti e dispositivi
Year of study	1°
Period	1st semester (28/09/2020 - 22/01/2021)
ECTS	6
Lesson hours	52 lesson hours
Language	Italian
Activity type	WRITTEN TEST
Teacher	BLOISE NORA - 2 ECTS DIVIETI PAOLA - 2 ECTS VISAI LIVIA - 2 ECTS
Prerequisites	The fundamental prerequisites to be able to follow the Biochemistry course and fully understand its meaning are the passing of the General and Inorganic Chemistry and Organic Chemistry exams.
Learning outcomes	<p>Educational objectives: The main objective of the course is to study the basic and more advanced aspects of biochemistry. Particular emphasis will be given to the aspects most closely related to biochemistry applied to bioengineering contexts.</p> <p>Contents: The course will provide students with the structural characteristics of the most relevant macromolecules, including proteins, carbohydrates, lipids and nucleic acids, to understand the structure-function relationships of biomacromolecules. It will describe</p>

the key principles of the structure, kinetics and regulation of enzymes. It illustrates the basis for understanding the molecular mechanisms of cellular macromolecules. The molecular mechanisms of biological recognition will be illustrated. Furthermore, the main signaling and physical stimulation mechanisms involving cell adhesion and proliferation will be illustrated. Finally, the laboratory activity will complete the student's preparation.

Course contents

The course is divided into 3 parts, each by 2CFU carried out by 3 different teachers.

Furthermore, an experimental laboratory activity based on the extraction of proteins from cell cultures, assay of proteins and their separation by SDS-PAGE electrophoresis is also planned.

Prof. LIVIA VISAI

- CHEMICAL CHARACTERISTICS, FUNCTIONS, STRUCTURE AND METABOLIC ROLE OF THE MAIN BIOMOLECULES (sugars, lipids, amino acids, proteins, nucleic acids, and their derivatives);
- THE MECHANISMS OF PRODUCTION OF METABOLIC ENERGY AND THE ENERGY AND STRUCTURAL HOMEOSTASIS OF THE LIVING (General aspects, anabolism and catabolism, coupled reactions, high-energy compounds. Principles of bioenergetics. Structure and function of ATP, the mechanisms of production of ATP The main coenzymes involved in the metabolic pathways Anaerobiosis and aerobiosis The role of oxygen in metabolism ROS (production of reactive oxygen species and defense systems of the organism) Glutathione.
- METABOLIC INTERRELATIONS WITH PARTICULAR REFERENCE TO THE BIO-MEDICAL FIELD (Metabolic inter-relationships between the various organs. Fasting-nutrition cycle. Hormonal regulation. Mechanism of action of protein and steroid hormones. The meaning of the second messengers. Biochemical aspects of human pathologies: diabetes, hypercholesterolemia, cancer (notes); The extracellular matrix).

Dr NORA BLOISE

- Signal transduction:
 - Phases of the signal transduction process
 - The fundamental characteristics of signal transduction systems
 - The main signal transduction systems
 - The G protein coupled receptor and transduction (effectors and second messengers)
 - The enzyme receptors
 - The controlled ion channels
 - The intracellular receptors
- Cells - physical factors interaction:
 - The adhesion receptors and their main characteristics
 - Cell interaction - biophysical factors: signal transduction mechanism.
 - Mechanosensors: integrins and signal transduction
 - Physical and mechanical stimuli and their applications in regenerative medicine and tissue engineering
- Main biochemical techniques for the study of signal transduction

Prof. PAOLA DIVIETI (university of Boston, USA)

- Principle of bone biology (cellular components, matrix, development)
- Skeletal pathologies (Some examples like osteoporosis and osteopetrosis with emphasis more on the underlying cellular and molecular mechanisms and brief summary on what can be done therapeutically)
- Calcium and Phosphate Homeostasis (basic principle, hormonal regulations and some diseases)
- New players in skeletal biology SIK and HDAC (see Wein et al Nature communication) and PthrP (Bans current research)
- Mechanical forces and cellular responses (we can focus on bone and MSC and how the matrix stiffness affects cellular behavior (1hr) and then move on how mechanical forces regulates the skeleton in general (1hr) =
- Cross talk bone and HSC (current research and literature review) = (Prohibitions's current research)
- Bone and fat (current research and literature review) = (Divieti's current research) (Hot topic)
- New approaches and strategies: in vitro (3D) and in vivo tools (cre-lox, lineage tracing, CRISPR / Cas9, E-Flut) and new genomic approaches (RNA-seq, single cell RNA-seq)

Teaching methods

The lectures consist of power point presentations in both Italian and English. In addition, videos illustrating the fundamental concepts of biochemistry are also provided. Finally, the experience obtained with short laboratory exercises allows the student to begin to understand the experimental settings in the biological field

Reccomended or required readings

-Le basi della biochimica. Con Contenuto digitale (fornito elettronicamente) (Italiano)
di Denise R. Ferrier, Zanichelli;
-I principi di biochimica di Lehninger. Con e-book
David L. Nelson, Michael M. Cox, zanichelli;
-Fondamenti di biochimica. Con e-book
Donald Voet, Judith G. Voet, Charlotte W. Pratt, Zanichelli;
-Harper's. Biochimica illustrata. Ediz. illustrata
Robert K. Murray, David A. Bender, Kathleen M. Botham, EMSI

Assessment methods

Written exam consisting of questions relating to both the lectures and the laboratory experience. There are no ongoing tests. The Biochemistry module consists of 6 CFUs and is part of the integrated course of Organic Chemistry and Biochemistry (9 CFU).

Further information

Internship places are available to carry out an experimental thesis of at least 1 year for students who have successfully passed the biochemistry exam

Sustainable development goals - Agenda 2030

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ORGANIC CHEMISTRY	
Enrollment year	2020/2021
Academic year	2020/2021
Regulations	DM270
Academic discipline	CHIM/06 (ORGANIC CHEMISTRY)
Department	DEPARTMENT OF ELECTRICAL, COMPUTER AND BIOMEDICAL ENGINEERING
Course	BIOENGINEERING
Curriculum	Cellule, tessuti e dispositivi
Year of study	1°
Period	1st semester (28/09/2020 - 22/01/2021)
ECTS	3
Lesson hours	23 lesson hours
Language	Italian
Activity type	ORAL TEST
Teacher	PASINI DARIO (titolare) - 3 ECTS
Prerequisites	Basic notions of General Chemistry are required.
Learning outcomes	The objective of this part of the course is to introduce the student to the principles of Organic Chemistry. The teaching module, temporally the first the student will encounter in the integrated course of Organic Chemistry and Biochemistry, has the purpose to give the students the basic knowledge for the understanding of the structure and reactivity of organic molecules, with which they will frequently deal with in the prosecution of their studies, both in the biological field and as biomaterials.
Course contents	The fundamental concepts of Organic Chemistry will be illustrated (structure and bonding, acidity and basicity, resonance, stereoisomery and chirality). The structure of the main classes of organic compounds (saturated and unsaturated hydrocarbons, aromatic compounds,

alcohols and ethers, aldehydes and ketones, amines and carboxylic acids) will be presented, and their reactivity will be described considering the characteristic functional groups of each class. The main classes of biomolecules will be examined in terms of their structure: aminoacids and proteins, carbohydrates, nucleic acids.

The program, enucleated in detail, is as follows:

- Structure and bonding. Electronic structures of atoms. Lewis structures. Electronegativity and chemical bonds. Ionic, covalent and noncovalent bonds. Formal charge. Resonance. Functional groups. Bronsted-Lowry acids and bases. Lewis acids and bases.
- Stereoisomery and chirality. Definitions. Stereocenters. The R,S system. Molecules with two or more stereocenters. Enantiomers and diastereoisomers. Optical activity. Polarized light. Racemic mixtures. Separation of enantiomers.
- Types of organic reactions. Mechanisms, equilibrium, kinetics and free energy profiles. Radicalic and polar reactions.
- Structure of alkanes. Constitutional isomerism and nomenclature. Conformation of alkanes and cycloalkanes. Unsaturated hydrocarbons. Structure and configuration of alkenes. Reactions of alkenes: electrophilic addition. Alkynes.
- Alkyl halides. Nucleophilic substitution and elimination: mechanisms.
- Aldehydes and ketones. Nucleophilic addition reactions. Acetals and emiacetals.
- Benzene and aromaticity. Nomenclature. Energy of resonance of benzene. Aromatic electrophilic substitution.
- Alcohols, phenols, ethers and thiols. Acidity and basicity. Reactions of alcohols and phenols.
- Amines and carboxylic acids. Structure and properties. Reactions with acids and bases. Esterification of carboxylic acids. Aminoacids. Amide bond in polypeptides and proteins.
- Carbohydrates. Monosaccharides. Structure and stereoisomerism. Mutarotations. Disaccharides and polysaccharides.
- Structure of nucleosides and nucleotides.

Teaching methods

Lectures

Reccomended or required readings

Slides and other lecture material will be provided by the professor. The students may integrate the lecture material with one of the following recommended books:

William H Brown - Thomas Poon. Introduzione alla Chimica Organica. EDISES.

McMurry. Chimica organica: un approccio biologico. Zanichelli

Assessment methods

Oral exam

Further information

Oral exam

Sustainable development goals - Agenda 2030

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