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del Sacro Cuore

Biochemistry

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Course aims and intended learning outcomes

The course is aimed to provide a general comprehension of the main biochemical classes, namely proteins and amino acids, lipids and carbohydrates (module 1) as well as the transformation processes these compounds undergo in vivo (metabolism – module 2). Particular attention will be given to the biochemical aspects related to the agro-food chain.

At the end of the course the student is expected to achieve a KNOWLEDGE AND COMPREHENSION of

- the chemical structure of the main classes of macromolecules (carbohydrates, proteins, lipids), including their spatial conformation
- the chemical processes underlying biological systems, in terms of energy transfer reactions (catabolism and anabolism)
- the catalysis provided by enzymes and its regulation processes
- the transport and signalling processes across cell membrane
- the complex metabolic transformation occurring on carbohydrates, lipids and proteins (assimilation, biosynthesis, catabolic degradation).
- concerning the skills TO APPLY KNOWLEDGE AND COMPREHENSION, the student will be able to critically discuss and apply the concepts concerning:
 - the metabolic regulation, and the interplay between different metabolic pathways
 - the shunts between different metabolisms
 - the reprogramming of metabolism under different conditions and its impact on a biological system
 - the relationship between metabolic processes and physiological response to different conditions.

Course content

	Credits
Module “BIOCHEMISTRY”	
Biomolecules	
Cell structure and the metabolism concept. Carbohydrates: main aspects, classification, structure and properties. Main monosaccharide and polysaccharides. Plant cell wall.	0.5
Amino acids: main aspects, classification, and properties. Proteins and protein structure.	0.5
Lipids: main aspects, classification, properties. Cell membrane and its functionality.	0.5
Nucleotides and DNA structure. DNA replication and transcription. RNA structure and functions. mRNA maturation and transduction. Ribosomal synthesis of peptides.	0.5
Bioenergetics	
Potential of membranes and transport: diffusion, partition, and active transport. Water.	0.5
Enzymatic catalysis: molecular mechanism and regulation. Enzyme kinetics.	0.5
Module “APPLIED BIOCHEMISTRY”	
Metabolism of carbohydrates and oxidative phosphorylation	
Bioenergetics. Glycolysis, aerobic and anaerobic fate of pyruvate. Gluconeogenesis. The pentose phosphate pathway. The Krebs cycle, mitochondrial transport of electrons, ATP synthesis. Photosynthesis, CO ₂ fixation, Calvin cycle.	1.5
Metabolism of proteins and amino acids	
The nitrogen cycle in soil, N assimilation. Metabolism of amino acids, the urea cycle.	1
Metabolism of lipids	



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Catabolism of fatty acids. The ketone bodies. The modulation of lipids metabolism. Cholesterol. Biosynthesis of fatty acids.	0.5
<i>EXERCISES</i> . Classroom and laboratory exercises	2

Reading list

Denniston, Topping, Quirk Dorr & Caret – General, organic and biochemistry, ninth edition. Mc graw Hill ed.

Teaching method

The teaching method is mainly based on classroom lectures, during which the active participation of students is strongly encouraged. Even though the slides used will be made available in advance via the Blackboard online platform, this information must not be considered as exhaustive and should be better considered a base that graphically supports lectures. Therefore, the student is advised to attend lectures and to integrate the information provided by slides with a reference text (e.g. as provided in the reading list above-reported).

Besides lectures, classroom exercises (where the student practices the drawing of chemical structures for carbohydrates, amino acids and peptides) will be provided together with laboratory exercises (where the student will apply in practical exercises the concepts introduced in lectures.).

Assessment method and criteria

The method applied to assess the degree of competence acquired includes: a) a written exam (intermediate, mid-term assessment) with open questions on the first module of the course, taking 1 hour; b) a final exam done orally, with 3-6 questions.

The intermediate assessment is facultative and, in case the test is positive (hence with a score of 18/31 as minimum), the corresponding topics will not be investigated further during the oral examination. However, in case of negative scores, it is still possible to do the oral exam on the whole course contents. The students not carrying out or not passing the intermediate written exam can do the oral exam; in that case, they will be examined on the whole course content (i.e., both module 1 and module 2).

The oral exam consists of 3 questions (5-6 in case the written test was unsuccessful). The final score is a weighted average between the (eventual) written and the oral assessments, with a relative weight of 40% and 60% respectively.

During the assessments, the skills regarding (i) the proper drawing of molecular structures for carbohydrates, lipids, amino acids and proteins; (ii) the knowledge of the biological role(s) of biochemical molecules; (iii) the knowledge on the biochemical pathways for biosynthesis and degradation, as well as (iv) the regulation of metabolic processes will be investigated. The student is asked to argument and defend his conclusions regarding the impact of biochemical processes into biological systems.

Notes and prerequisites

The student is asked to possess previous skills from general chemistry such as atoms structure, lewis structures, resonance and molecular orbitals. Furthermore, the previous concepts of organic chemistry (with main focus on structure, nomenclature and reactivity for carbonyl and carboxylic compounds) are essential. The knowledge about the different classes of carboxy-derived compounds and their reactivity is of particular importance.



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The teacher is available in the 2 hours following the lectures, at the Department for Sustainable food process. It is advisable to schedule in advance with the teacher (by email), the eventual appointment.