

BIOCHEMISTRY (OPR123)

1. language

Italian.

2. course contents

Coordinator: Prof. NOCCA GIUSEPPINA

Year Course: 2022/2023 (First year)

Semester: Second

CFU/UFC: 6

Modules and lecturers:

- BIOCHIMICA 2 (OPR17A) - 6 cfu - ssd BIO/10

Prof. Giuseppina Nocca, Prof. Andrea Silvestrini

3. bibliography

NELSON, D.L., COX, M. M. Principi di biochimica di Lehninger. Zanichelli, Settima edizione, 2022.

VOET, D., VOETJ.G., PRATT, C.W. Fondamenti di Biochimica. Zanichelli, Quarta edizione, 2017.

SILIPRANDI, N., TETTAMANTI, G. BIOCHIMICA MEDICA STRUTTURALE METABOLICA E FUNZIONALE. PICCIN, QUINTA EDIZIONE, 2018.

It is necessary that the student has a biochemistry text, chosen from those recommended or other text after the teacher's approval.

4. learning objectives

The course aims to provide the student with the necessary skills to know and understand the molecular basis of life and biochemical processes which underlie the functioning of the human organism.

Knowledge and understanding - (Dublin 1) At the end of the course the student must demonstrate knowledge and understanding of the biochemical basis of biological processes, the relationships between structure and function in the main classes of biological macromolecules (acids nucleic acids, carbohydrates, lipids and proteins), the main metabolic pathways of carbohydrates, lipids and amino acids and the mechanisms of metabolic integration and regulation, with particular attention to hormonal regulation.

Applied knowledge and understanding - (Dublin 2) At the end of the course the student must demonstrate that he is able to apply the knowledge acquired to interpreting and explaining biological phenomena in a biochemical key. Finally, the student must demonstrate that they are able to use the biochemical knowledge acquired for the understanding of other disciplines (Physiology, General Pathology and Pharmacology) and for practical application in analysis and research laboratories.

Independent judgment - (Dublin 3) At the end of the course the student must know independently discuss and critically analyze the molecular mechanisms underlying the metabolism of biomolecules. Autonomy of judgment will be stimulated during the provision of frontal lessons, with the request to students to provide their own interpretation of biochemical problems. Autonomy of judgment will also be favored from reading selected scientific articles. At the time of the exam, the student will be also assessed for the level of autonomy of judgment achieved.

Communication skills - (Dublin 4) At the end of the course the student must be able to expose and explain their biochemical knowledge even to non-expert interlocutors with logical rigor, property of language, and correct scientific terminology. Furthermore, the student must be able to recognize and write the structural formulas of main metabolites and biomolecules.

Ability to learn - (Dublin 5) At the end of the course the student must be able to evaluate their knowledge and skills and, consequently, of implement and/or update them by independently drawing on texts, scientific articles and online platforms

5. PREREQUISITES

The student must have the knowledge of Physics, Chemistry and Propaedeutics

Biochemistry and having taken the related exams. On the other hand, basic knowledge of biology is extremely useful.

6. TEACHING METHODS

The course will take place with oral lectures that will make use of multimedia systems. The lessons are based on interactive methods, integrating activities based on active learning with standard teachings, such as "problem-based learning", "self-learning", and "case studies". The teachers will be available for the entire duration of the course, by appointment via e-mail, to answer questions and support students during their training, even with individual meetings.

The teaching methods used in this course are designed to allow the student to pursue the educational objectives, by virtue of the following characteristics:

Knowledge and understanding - frontal teaching will systematically deal with all the topics listed in the program detailed below, focusing on the most relevant and essential aspects, in order to provide students with the complete picture of the integrated topics and the correct study method to strengthen theoretical knowledge.

Applied knowledge and understanding - the use of practical examples and case studies allows students to learn the applicative potential of the topics covered.

Independent judgment - the active learning methods implemented in this course are designed to allow the student the ability to formulate concepts and ideas independently.

Communication skills - active learning methods and constant interaction with the teacher during lectures will be conducted in such a way as to allow the student the progressive acquisition of communication skills aimed at exposing biochemistry topics with the correct scientific terminology.

Ability to learn - the use of supplementary teaching material, including in the form of articles from international scientific literature, will allow the student to undertake subsequent studies with a high degree of autonomy

7. other informations

The teacher is available for information on the course and for clarification on the lessons with appointment by e-mail or, if for a quick request, at the end of lessons.

8. methods for verifying learning and for evaluation

There will be a final oral exam on the topics of the course. The student is asked questions about the program. The student's preparation will be assessed on the ability to describe the biochemical processes in a clear and scientifically rigorous way and to know how to connect the various topics, demonstrating that he has understood the biochemical logic. Each of the two teachers, on the basis of the criteria set out, expresses an evaluation out of thirty and the final grade is the average of the individual grades. The student obtains honors if his average mark is 30/30 and at least one of the two teachers has proposed honors.

This type of assessment may undergo changes as a result of specific logistical needs induced by the pandemic

The objective of the exam is to verify:

- the level of knowledge of the topics covered by the program and the understanding of the role of the cellular and molecular processes studied as well as the knowledge of the topics indicated in the program of the various modules (Knowledge and understanding);*
- the ability to connect theoretical concepts to concrete biological problems aimed at the preparation of cosmetic products (applied knowledge and understanding);*
- the ability to make transversal connections on the topics covered. (Autonomy of judgment);*
- adequate command and ownership of language and correct technical/scientific terminology (communication skills);*
- the ability to investigate issues of biological and chemical interest (Ability to learn)*

9. program

Glucides: Review of the chemistry and properties of monosaccharides and derivatives, of disaccharides, of homo and hetero-polysaccharides of biological interest, of proteoglycans. Biological role of glucose.

Lipids: Definition, Properties and Classification. Fatty acids: saturated, unsaturated, polyunsaturated. Reserve lipids: Triacylglycerols. Structural membrane lipids: glycerophospholipids, phosphosphingolipids and glycosphingolipids. Sterols: cholesterol and derivatives. Eicosanoids. Lipoproteins. Proteins: Amino acids, structure and composition of proteins. Review of the primary, secondary, tertiary and quaternary structure of proteins. Multi-domain proteins and mosaic proteins. Super secondary structures. Molecular chaperones and their role. Structure-function relationship in protein families: fibrous proteins, globular proteins, immunoglobulins. Hemoglobin and oxygen transport. Outline of biological membranes and transport: supramolecular architecture of membranes: the lipid bilayer and its models, integral and peripheral membrane proteins. Transmembrane transport systems: active and passive transport, transport of ions and solutes. Active transmembrane transport pumps; the transporters; ion channels, porins.

Vitamins and coenzymes: Fat-soluble vitamins: Vitamin A, D, E, K. Water-soluble vitamins and

their coenzymes: Vitamin B1, Vitamin B2, Vitamin B3, Vitamin B5, Vitamin B6, Vitamin B8, Vitamin B9, Vitamin B12, Vitamin C.

Enzymes: Review of thermodynamics. Enzymes: biological catalysts. Enzymatic kinetics: Michaelis-Menten equation, Briggs-Haldane equation. Enzyme inhibition. PH and temperature effect. Enzymatic catalysis. Regulation of enzymatic activity.

Biochemistry of the oral cavity with particular reference to the macromolecules present in saliva and to the compounds that form the teeth

Control of metabolic flow: Reactions to equilibrium. Non-equilibrium reactions. Flow generating reactions. Concept of metabolic flow and regulatory mechanisms. Bioenergetics: Transfer reactions of the phosphoric group. The role of the ATP. Substrate level phosphorylation. Mitochondrial oxidative phosphorylation.

Bioenergetics and oxidative metabolism: Biological reductions. Nernst equation. Free energy and redox potentials. Electron transport: Thermodynamics of electron transport. The sequence of electron transport. Bioenergetics and kinetics of transmembrane transport. Carbohydrate metabolism: Biochemical aspects of carbohydrate digestion, Catabolism of hexoses: Glucose, Fructose. Galactose. Glycolysis and its short and long term regulation. Moonlighting proteins. The anaerobic fate of pyruvate: Cori cycle and glucose-alanine cycle. The aerobic fate of pyruvate: mitochondrial shuttles, pyruvate dehydrogenase and the tricarboxylic acid cycle and its regulation. The phosphate pentose pathway and its regulation. Production and role of NADPH. Glycolysis interrelationships and the pentose phosphate pathway. Gluconeogenesis and its regulation. Gluconeogenic precursors. Glycogenosynthesis, glycogenolysis and their regulation. Hormonal control of carbohydrate metabolism. Glucose metabolism in cancer cells. Lipid metabolism: Biochemical aspects of lipid digestion. Mobilization of reserve triacylglycerols. Activation and transport of fatty acids in the mitochondria. The beta-oxidation of mitochondrial and peroxisomal fatty acids and their regulation. Oxidation of saturated, unsaturated, odd and even chain and branched fatty acids. The metabolism of ketone bodies: ketogenesis, ketolysis. Biosynthesis of fatty acids and its regulation. Desaturation of fatty acids. Biosynthesis of triacylglycerols. Biosynthesis of glycerphospholipids. Biosynthesis of sphingolipids and their degradation. Biosynthesis of cholesterol and its regulation in the short and long term. Triacylglycerol cycle. Metabolism of the various classes of lipoproteins. Hormonal control of lipid metabolism. Amino acid metabolism and urea cycle: Biochemical aspects of protein digestion. Proteolysis and metabolic fate of amino acids. Transaminations. Deamination. Ammonia and ammonia reactions: glutamic dehydrogenase, glutamine synthetase, glutaminase. Urea cycle and its short and long term regulation. Catabolism of the carbonaceous skeleton of amino acids: gluco- and keto-genic and mixed amino acids. Glycine catabolism. Catabolism of aromatic and branched-chain amino acids. Congenital errors of amino acid metabolism: phenylketonuria and leucinosis. Essential, semi-essential and non-essential amino acids. Endogenous synthesis of amino acids. Biosynthesis of polyamines. Metabolism of purine and pyrimidine nucleotides: biosynthesis of purine nucleotides and its regulation. Catabolism of purine nucleotides: formation of uric acid and gout. Biosynthesis of pyrimidine nucleotides and its regulation. Catabolism of pyrimidine nucleotides. Rescue routes for purines and pyrimidines. Outline of inborn errors of purine and pyrimidine metabolism. Synthesis of deoxyribotides and its regulation. Hormones: Peptide, amino, steroid hormones. Hormone-like substances. Main peptide hormones: synthesis, structure and their effects. Steroid hormones: synthesis, structure and their effects. Hypothalamic, pituitary, thyroid, pancreatic, adrenal, sexual hormones. Molecular mechanisms of signal transduction. Introduction to hormonal regulation of metabolism.