Master Degree in Human Nutrition Sciences
Course: **BIOCHEMISTRY AND MOLECULAR BIOLOGY**
Credits: **12**

Module: **Biochemistry and nutrient metabolism**
SSD course: **BIO/10**
Credits: **7**
Professor's name: **Prof. Barbara Tavazzi (2 CFU)** e-mail:barbara.tavazzi@unicamillus.org
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Prof. Giacomo Lazzarino (5 CFU) e-mail: giacomo.lazzarino@unicamillus.org
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Module: **Clinical biochemistry and clinical molecular biology**
SSD course: **BIO/12**
Credits: **5**
Professor's name: **Prof. Costanza Montagna (2CFU)** e-mail: costanza.montagna@unicamillus.org
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PREREQUISITES

In order to learn contents of the integrated in Biochemistry and Molecular Biology, it is necessary to have mastery of the fundamental knowledge of inorganic and organic chemistry, such as: chemical bonds, acid-base equilibria in solution, pH, oxidation-reduction reactions and electrochemical potentials, hybridization of the carbon atom, aromatic compounds, properties of the major functional groups. In addition, it is necessary to have some basic knowledge about the basic concepts of General Biochemistry, particularly regarding the main metabolic pathways. It is also necessary to have mastery of the fundamental concepts acquired in the teaching of General Biochemistry, Biology Cellular, and Genetics

LEARNING OBJECTIVES

The educational objectives of the module of integrated in Biochemistry and Molecular Biology are aimed at acquiring knowledge about the biochemistry of food and nutrition, with emphasis on the function and regulation of biological macromolecules and general mechanisms of metabolic regulation. Acquire knowledge of the major metabolic pathways and cycles with emphasis on glucose, lipids and amino acids metabolisms. Understand the significance of metabolic alterations under conditions far from physiological (prolonged fasting, physical exertion). Also, have good knowledge about particular elements necessary for proper daily nutritional intake, such as micro- and macro-elements, the fat- and water-soluble vitamins. Last but not least, acquire important information on free radicals and antioxidants, the balance of which is fundamentally linked to the correct nutritional regimen. Further educational objectives are aimed at acquiring knowledge of the main methodologies used in clinical biochemistry; understanding the significance of alterations in biochemical-clinical relevant profiles; acquiring basic knowledge about the fundamental processes of molecular biology and their regulation, which are essential for understanding the pathogenetic mechanisms of diseases and molecular mechanisms relevant to

therapeutic applications.

LEARNING OUTCOMES

At the end of the teaching of the integrated course, the student should know/be able to know the structure and function of major biological macromolecules; know the different metabolic cycles occurring in eukaryotic cells; know the role of different "fuels" in energy production mainly related to the nutritional aspect; understand the molecular basis of cellular biological processes underlying eukaryotic cells; properly interpret the importance of alterations in biochemical processes as the cause of various nutrition-related disease conditions.

Knowledge and understanding

At the end of the teaching of the integrated course, the student should be able to communicate clearly and unequivocally the scientific and applied contents covered in the two modules, using appropriate technical language, including with independent judgment to make broad assessments related to the topics covered. He/she should demonstrate mastery of the Biochemistry topics underlying nutritional biochemistry; know the steps from biological sample collection to the reports; know the analytical groupings and profiles of biochemical-clinical relevance; know and understand the molecular biology of the cell and the fields of application of molecular biotechnology

Ability to apply knowledge and understanding

The student should be able to use the knowledge acquired during the integrated course, for the autonomous in-depth study of aspects related to the specific field to which he or she will devote himself or herself in the context of professional activity. This should also be done with autonomy of judgment that will enable them to make broad assessments related to the topics covered, regarding the biochemistry of nutrition and its interrelationships with other fundamental disciplines such as clinical biochemistry and physiology. In addition, the student will need to: Know the steps from biological specimen collection to the final reporting; Know the analytical groupings; Know The biochemical-clinical relevance profiles; Know and understand the molecular biology of the cell; Know and understand the fields of application of molecular biotechnology

COURSE SYLLABUS

BIOCHEMISTRY AND NUTRIENT METABOLISM

Food and Nutrition

Nutritional standards and dietary guidelines. LARNs, safe ranges and adequacy of food intake. Nutrient categories, macronutrients and micronutrients. From nutrients to foods: definition of food and the classes of foods.

Recalls of general biochemistry

Enzyme kinetics and major metabolic processes. Hormones and their general functioning.

Carbohydrates

Chemical, biochemical and nutritional definition of carbohydrates. Digestion, absorption and transport of major dietary-introduced carbohydrates and their involvement in energy metabolism. Glycemic Index and Glycemic Load and their biochemical significances. Catabolism and anabolism of glucose and glycogen. Hormonal control of carbohydrate metabolism. Role of available carbohydrates in the diet. Dietary fiber. Solubility and viscosity of dietary fiber. Beneficial and adverse effects of fiber. Metabolism of fructose. Metabolism of galactose. Recommended intake levels. Diabetes and diet in the diabetic patient.

Lipids

Classification and chemical composition. Dietary fats. Main lipids introduced in the diet and their energy value. Fatty acids of nutritional interest: saturated and unsaturated, essential fatty acids, trans fatty acids and polyunsaturated fatty acids. Lipid requirements. Digestion, absorption and transport of dietary-introduced lipids. Mobilization of triacylglycerol reserves. Fatty acid metabolism. Dietary and endogenous cholesterol: cholesterol balance in the body. Transport of cholesterol and other lipids by plasma lipoproteins. Non-pharmacological control of blood cholesterol levels. Atherosclerosis, definition and correlation with cholesterol levels. Dyslipidemias. Diet in cardiovascular disease.

Proteins

Nutritional significance and energy value. Amino acids: functional, chemical, nutritional and metabolic classification. Digestion, absorption and transport of dietary introduced proteins. Metabolic fates of amino acids: glucogenic, ketogenic and mixed amino acids. Protein turnover. Nutritional value of protein and regulation of nitrogen balance. Protein requirements. Congenital errors of amino acid metabolism. Celiac disease.

Water as food

Importance of water in body homeostasis. Water balance and its hormonal regulation. Classification of the main types of water in commerce.

Integration of metabolism

Energy expenditure of the body. Basal metabolic rate. Distribution of energy reserves. Metabolic adaptations in the fasting-nutrition cycle. Hormonal involvement in the regulation of metabolic processes. Malnutrition: Kwashiorkor and Marasmus as models of biochemical injury. Approach from a biochemical perspective to malnutrition, dietary approach.

Micro e macroelements

Importance of the presence of these compounds in daily dietary intake. Nutritional and metabolic significance. Recommended RDA values for each of the individual compounds.

Fat- and water-soluble vitamins

Nutritional significance and their specific functions in metabolism. Biochemical characteristics with regard to their cellular and body use. Dietary requirements, their metabolization and suggested nutritional values.

Free radicals

Formation and physiological genesis. Free radicals, exogenous and endogenous causes. The reactions of free radicals. Oxygen metabolism. Oxidative and nitrosative stress. Cellular damage induced by oxygen free radicals. Damage to biological membranes, nitrogen bases and proteins. Defenses against oxidative stress.

Antioxidant defenses

Antioxidants: defense systems against radicals. Classification of antioxidants. Mechanisms of action of antioxidants: preventive, scavenger, repair and de novo. Enzymatic endogenous antioxidants: superoxide dismutase, catalase, glutathione peroxidase. Nonenzymatic antioxidants: glutathione, bilirubin, uric acid, ascorbic acid, alpha-tocopherol, carotenoids, lycopene, polyphenols, lipoic acid, ubiquinone, trace elements.

Oxidative stress related diseases

The importance of pathologies in which oxygen radicals are involved. Hypoperfusion, ischemia, and reperfusion. Photosensitivity, alcoholism, trauma, acute and chronic neurodegeneration.

CLINICAL BIOCHEMISTRY AND CLINICAL MOLECULAR BIOLOGY

From biological sample collection to reporting

Pre-pre-analytical phase, pre-analytical phase, analytical phase, post-analytical phase, interpretation of results.

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Analytical groupings
Blood, urine, feces, CSF, hair, and saliva.
Profiles of biochemical-clinical significance
Glucose profile, protein profile, lipid profile, profile. vitamin profile..
Cell structure
Eukaryotic and prokaryotic cell differences.
Structure and replication of DNA
Genome and organization of genetic material in eukaryotic cells; mechanisms of DNA repair.
RNA structure
Transcription, control of gene expression: promoters and enhancers. Structure and function of various types of RNA; mRNA maturation.
Protein synthesis:
Translation initiation, elongation, and termination.
Recombinant DNA biotechnology.
PCR. Hybridization. Sequencing.

COURSE STRUCTURE
The integrated course is structured in 145 video lectures 1of 5-minutes (delivered didactics) and 12 hours of face-to-face teaching (interactive didactics) to address students' questions. The video lectures include theoretical lectures on the program topics.

COURSE GRADE DETERMINATION
Final exams consist of a multiple-choice test, for each teaching. A single exam grade for the integrated course will be verbalized. For each correct answer 1 point will be assigned. For every wrong or missing answer 0 points will be assigned. The final score of the written test will be given by the sum of the scores of each correct answer and will be calculated in thirtieths.
The final grade for integrated teaching will be expressed in thirtieths. The exam will be considered passed if the student totals a final score of 18/30 or higher.

Overall, the examination will be evaluated according to the following criteria:

Not sufficient: Poor or deficient knowledge and understanding of topics; limited ability to analyze and synthesize; frequent generalization of required contents; inability to use technical language.

18-20: Barely sufficient knowledge and understanding of topics, with evident imperfections; barely sufficient ability to analyze, synthesize and making judgment; poor ability to use technical language.

21-23: Sufficient knowledge and understanding of topics; sufficient ability to analyze and synthesize with ability to argue the required contents, with logic and coherence; sufficient ability to use technical language.

24-26: Fair knowledge and understanding of topics; fair ability to analyze and synthesize with ability to rigorously argue the required contents; fair ability to use technical language.

27-29: Good knowledge and understanding of the required contents; good ability to analyze and synthesize with ability to rigorously argue the required contents; good ability to use technical language.

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30-30L: Excellent level of knowledge and understanding of the required contents with excellent analytical and synthesis skills with the ability to rigorously, innovatively and originally argue the required content; excellent ability to use technical language.

OPTIONAL ACTIVITIES

In addition to the didactic activity provided, students will be able to take advantage of the integrative teaching hours. In addition, students can take advantage of reception hours with Professors of Biochemistry and Nutrient Metabolism (Prof. Tavazzi and Prof. Lazzarino) and with the Professor of Clinical Biochemistry and Clinical Molecular Biology (Prof. Montagna). Students are received by appointment by writing via email.

SUGGESTED TEXTBOOKS:

Biochemistry and nutrient metabolism:

1. PPT slides
2. Ugo Leuzzi, Ersilia Bellocco, Davide Barreca; BIOCHIMICA DELLA NUTRIZIONE; Ediz. Zanichelli, 2013
3. Ivo Cozzani, Enrico Dainese; BIOCHIMICA DEGLI ALIMENTI E DELLA NUTRIZIONE, Ediz. Piccin-Nuova Libraria, 2006

Clinical biochemistry and clinical molecular biology:

1. PPT slides
2. Biochimica clinica essenziale, dal laboratorio ai quadri di patologia clinica. Elisabetta Albi Tommaso Beccari Samuela Cataldi. Zanichelli 2019.
3. L'essenziale di biologia molecolare della cellula. Bruce Alberts Karen Hopkin Alexander Johnson David Morgan Martin Raff Keith Roberts Peter Walter. Quinta edizione. Zanichelli 2020.

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