

Biomedical Laboratory Techniques

Course: BIOCHEMISTRY, FIOLOGY E MICROBIOLOGY

SSD INSEGNAMENTO: BIO/09, BIO/10, BIO/12, MED/07

CFU: 10

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MODULE: Biochemistry

SSD: BIO/10

Number CFU: 4

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MODULE: Biochemistry applied

SSD: BIO/12

Number CFU: 1

Teacher name: Costanza Montagna e-mail: costanza.montagna@unicamillus.org

MODULE: Fisiology

SSD: BIO/09

Number CFU 2

Teacher name: Maria Concetta Pellicciari

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MODULE: Microbiology

SSD: MED/07

Number CFU: 2

Teacher name: Daniele Armenia e-mail: daniele.armenia@unicamillus.org

MODULE : Scienze Tecniche di Medicina di laboratorio

SSD: MED/46

Number CFU: 1

Teacher name: Paolo Casalino e-mail: paolo.casalino@unicamillus.org

ATTENDANCE MODE: MANDATORY WITH AT LEAST 75% OF PRESENCE DURING THE INTEGRATED COURSE

PREREQUISITES

Although there is no prerequisite, basic concepts of the exact sciences (physics, chemistry and mathematics) and a knowledge of the basics of cell biology are necessary.

LEARNING OBJECTIVES

The aim of the integrated teaching of BIOCHEMISTRY, PHYSIOLOGY AND MICROBIOLOGY is to provide students with the fundamental knowledge relating to the structure of the macromolecules necessary for the functioning and regulation of living organisms and their transformation processes. Put the student in a position to understand the basics of cellular metabolism and the variations induced by exercise. The module also intends to provide the student with the fundamental knowledge relating to the basic concepts of chemistry, the structure of macromolecules underlying the metabolic processes necessary for the functioning and regulation of living organisms: carbohydrates, lipids, nucleic acids. To enable the student to understand the basics of cellular metabolism. The cellular mechanisms and integrated functions of the main organs and systems aimed at maintaining body homeostasis in the context of changes in the environment will also be analyzed. Knowledge of the structure of the various microorganisms, of the microbial pathogenicity, of the interactions between microorganism and host, of the causes and mechanisms of onset of the main diseases with microbial etiology are essential objectives. The course aims to provide the student with some essential methods used in biochemical practice and the theoretical principles on which these methodologies and their field of application are based.

LEARNING OUTCOMES

The expected learning outcomes are consistent with the general provisions of the Bologna Process and the specific provisions of Directive 2005/36 / EC. They are found within the European Qualifications Framework (Dublin descriptors) as follows:

Knowledge and understanding

At the end of this teaching the student:

- o Knows the structure and function of the most important biological macromolecules and is able to frame their role in the main metabolic processes that take place in the cell
- o Knows biochemical terminology correctly;
- o Knows the main metabolic pathways and their integrations
- o Describe the general aspects of the immune system
- o Knows the immunochemical assays and their principle
- o Knows the electrophoretic techniques for the separation of proteins;
- o Knows and explains genetic mutations
- o Knows the sequencing methods and their evolution.
- o Has acquired knowledge of the anatomical and functional organization of the apparatuses and systems that make up the human organism.
- o Has acquired the ability to interpret the anatomical and physiological mechanisms and phenomena.
- o Knows the bacterial and virological classification criteria.
- o Knows the basics of bacterial and viral genetics: transformation, transduction, bacterial conjugation, viral genetic variability.
- o Knows the pathogenic action of bacteria and viruses: transmission routes and stages of the infectious process.
- o Knows and describes the characteristics of immune sera and vaccines.
- o Knows the general principles for the diagnosis of diseases caused by pathogenic microorganisms.

- o Knows the main direct indirect diagnostic techniques: microscopy, culture assays, serological assays, molecular assays.
- o Knows and explains the organization of a clinical biochemistry laboratory.
- o Knows and explains the main instruments used for clinical biochemistry investigations: CBC, coagulation and clinical chemistry.
- o Knows and explains the analytical processes of a laboratory: pre-analytical phase, analytical phase and post-analytical phase.

Applying knowledge and understanding

At the end of the course, the student will be able to:

- o Use the knowledge acquired for the autonomous study of aspects relating to the specific field to which the student will dedicate himself in the professional activity;
- o Use the tools, methodologies, language and conventions of biochemistry and physiology to test and communicate ideas and explanations.
- o Use the tools, methodologies, language and conventions of microbiology to test and communicate ideas and explanations.
- o Apply the technologies learned during the course to real application contexts

Communication skills

At the end of the course, the student must know:

- Use specific scientific terminology appropriately
- Orally present the topics in an organized and coherent way.
- Use of adequate scientific language that is in keeping with the topic of the discussion.

Making judgements

At the end of the course, the student must:

- carry out general evaluations relating to the topics covered
- develop the ability to interpret biological complexity through these methodologies
- carry out general evaluations relating to the topics covered in clinical biochemistry

COURSE SYLLABUS

BIOCHEMISTRY

Elements of chemistry: Atoms and molecules, Chemical reactions, Ionic balance in solution, Water.

Elements of organic chemistry: Carbohydrates, Lipids, Nucleic acids, proteins, Food digestion. Amino acids: general structure and classification. Proteins: structure and function. Structural levels. Protein folding. Fibrous proteins: structure of alpha-keratin, collagen and silk fibroin. Globular proteins: structure and function of myoglobin and hemoglobin; the heme group; saturation curve; regulation of the affinity of hemoglobin for oxygen. Enzymes: general characteristics; activation energy and reaction rate; general concepts on enzymatic kinetics. Regulatory mechanisms: competitive and non-competitive inhibitors; allosteric enzymes and enzymes regulated by covalent modifications. Catalytic strategies. Catalysis of serine-proteases. The blood coagulation

cascade as an example to clarify determinants of specificity, the role of cofactors and the formation of macromolecular complexes.

INTRODUCTION TO METABOLISM: general organization. Catabolism and anabolism. Bioenergetics. Energetically relevant molecules. Use of energy within the cell. Examples of regulation of metabolic processes.

Glucose as a fuel for energy production. Hormonal control of glucose metabolism. Glycolysis - phases and regulation. The pentose phosphate pathway and its biochemical importance. Degradation of glycogen - glycogen phosphorylase and its hormonal control. Gluconeogenesis and other biosynthetic pathways of carbohydrates.

Lactic fermentation and alcoholic fermentation. Anaerobic metabolism. Pyruvate oxidation mechanism - the pyruvate dehydrogenase complex.

The citric acid cycle - Functions, energy balance and cycle regulation. Oxidative Phosphorylation - The mitochondrion as the cell's powerhouse. The machinery for transporting electrons: structure and function of complexes I, II, III and IV. The electrochemical potential in the transport of electrons. Use of oxygen. ATP synthase: structure and mechanism of action. Stoichiometry of electron transport, proton transport, oxygen consumption and ATP production.

Brief introduction to mitochondrial dysfunction: mitochondria as generators of reactive oxygen species (ROS). ROS, oxidative stress, antioxidants and nutrition.

Activation of lipolysis and transport of free fatty acids. Activation and transport of free fatty acids in mitochondria. The catabolism of lipids - β -oxidation. Ketogenesis.

Synthesis of fatty acids - Regulation of the metabolism of fatty acids.

Cholesterol metabolism.

Transamination and transdeamination of amino acids. The urea cycle.

Bioenergetics and regulation of energy metabolism - energy metabolism disorders.

APPLIED BIOCHEMISTRY

Solutions

Concentration, molarity, molality, molar ratio, dilution, stoichiometry.

Immunochemistry.

General aspects of the immune system, production of antibodies, immunochemical assays, Elisa, immunohistochemistry.

Electrophoretic techniques

General principles, supports used in electrophoresis, polyacrylamide gel electrophoresis (PAGE), SDS-PAGE, Western blot.

Molecular biology techniques

General aspects of the genetic, mutations and clinical significance, PCR, sequencing, principle of genomic and NGS sequencing.

PHYSIOLOGY

INTRODUCTION TO PHYSIOLOGY AND HOMEOSTASIS: Description of physiological mechanism. Structure-Function relationships of the body. Levels of organization in the body. Concept of Homeostasis. Homeostatic Control Systems.

CELL PHYSIOLOGY AND PLASMA MEMBRANE: Membrane transport of ions and molecules. Membrane potential and action potentials. Synapses and neuronal integration. Intercellular communication and signal transduction. Neurotransmitters.

MUSCLE PHYSIOLOGY: Motor unit, neuromuscular junctions. Excitation and contraction of skeletal muscle tissue. Skeletal muscle contraction and mechanics. Physiology of skeletal, smooth and cardiac muscle.

PHYSIOLOGY OF THE NERVOUS SYSTEM: Functional organization of central nervous system and peripheral nervous system. The peripheral nervous system: afferent and efferent divisions. Role of glia cells. Autonomic nervous system. Integrative functions of nervous system.

CARDIAC PHYSIOLOGY: Anatomy and electrical activity of the heart. Mechanical events of the cardiac cycle. Cardiac output and its control. General principles of hemodynamics. Blood vessels and blood pressure. Blood and hemostasis.

PHYSIOLOGY OF ENDOCRINE SYSTEM AND REPRODUCTIVE SYSTEM: General principles of endocrinology. Principles of general functioning of hormones. Central and peripheral endocrine glands and their hormones. Hypothalamic-Pituitary Axis. Control of calcium and phosphate metabolism. Physiology of male and female reproductive system.

PHYSIOLOGY OF RESPIRATORY SYSTEM: Respiratory anatomy and mechanic. Gas exchange and transport of oxygen and carbon dioxide. Control of respiration.

PHYSIOLOGY OF URINARY SYSTEM: Elements of renal function: kidney and nephron. Glomerular filtration. Tubular reabsorption and tubular secretion. Urinary tract. Ureter, bladder and urethra. Urine excretion and plasma clearance.

PHYSIOLOGY OF DIGESTIVE SYSTEM: Digestive tract and accessory digestive organs. General aspects of digestion. Secretory function of digestive system. Motility of digestive tract. Nutrient digestion and absorption

MICROBIOLOGY

Basic principles of microbiology Morphology and structure of the bacterial cell Bacterial spore structure and sporulation process Gram stain and stain for acid resistance Metabolism, growth and bacterial replication Sterilization, disinfection, asepsis Structure, replication and pathogenic mechanisms of fungi Morphology of viral particles Cell tropism and host spectrum Viral enzymes Virus classification Stages of viral replication Basic concepts of the immune response The host's natural immune response Acquired humoral immune response Cell-mediated acquired immune response Immune responses against infectious agents Mechanisms of action of Interferon Vaccines and passive immunoprophylaxis Bacterial pathogenesis mechanisms Demonstration of the causal nature between pathogen and disease: Koch's postulates Normal microbial flora of our organism Host-microorganism interactions: Commensalism-Mutualism - Parasitism Factors that influence the "host-microorganism" balance Method of transmission of the infection Stages of the infectious process Bacterial virulence factors Mechanisms of viral pathogenesis and interaction with the host: Transmission mode Stages of the infectious process Localized and disseminated infection Persistence and latency status Viral oncogenesis Cytopathic effect induced by viruses Alteration of expression of genes and / or cellular proteins **LABORATORY MEDICINE** Organization of a laboratory Knowledge of the main laboratory instruments Types of test tubes (with and without anticoagulant) used in analytical investigations CBC and basic concepts of blood tests The various stages of an analytical process

COURSE STRUCTURE

BIOCHEMISTRY the module is structured in 40 hours of frontal teaching, divided into lessons of 2 or 3 hours according to the academic calendar. The frontal teaching includes theoretical lessons and supplementary seminars on the topics covered.

APPLIED BIOCHEMISTRY the module is structured in 10 hours of frontal teaching, divided into lessons of 2 or 4 hours according to the academic calendar. **PHYSIOLOGY** the module is structured in 20 hours of frontal teaching divided into lessons of 2, 3 or 4 courses based on the academic calendar. Lectures will include theoretical lessons and supplementary seminars on the topics covered. In addition, the student will be involved in critical reading, understanding and discussion of scientific articles related to the topics covered in the teaching module.

MICROBIOLOGY the module is structured in 20 hours of frontal teaching, divided into lessons of 2 or 4 hours according to the academic calendar. The frontal teaching includes theoretical lessons and supplementary seminars on the topics covered.

LABORATORY MEDICINE the module is structured in 10 hours of frontal teaching, divided into lessons of 2 or 3 hours according to the academic calendar. The frontal teaching includes theoretical lessons and the possible projection of videos on the topics covered.

COURSE GRADE DETERMINATION

BIOCHEMISTRY Verification of students' preparation will take place with a written exam. The written test will consist of 16 questions. Two points will be awarded for each answer. The final score of the written test will be given by the sum of the partial scores assigned to each question correctly answered. The test will be passed with a mark equal to or greater than 18. The aim of the written test is to evaluate the student's ability to apply knowledge and to make sure that the skills are adequate to support and solve biochemical problems. The following will be evaluated: autonomy of judgment (making judgments), communication skills (communication skills) and learning skills (learning skills) as indicated in the Dublin descriptors. In the evaluation, knowledge and comprehension skills have a weight equal to 40%, applied knowledge and comprehension skills of 40% and judgment autonomy of 20%.

APPLIED BIOCHEMISTRY The preparation of the students will be verified by an oral exam. During the oral exam, the examining commission will evaluate the student's ability to apply the knowledge acquired. The following will also be assessed: autonomy of judgment, communication skills and learning ability. In the evaluation, knowledge and comprehension skills have a weight equal to 40%, applied knowledge and comprehension skills of 40% and judgment autonomy of 20%.

PHYSIOLOGY The verification of the student preparation will be done in written form followed by an oral exam. All the contents of the course are subject to evaluation. The written test will consist of 30 multiple choice questions, for each correct answer a point will be assigned. The final score of the written test will be given by the sum of the partial scores assigned to each question answered correctly. To access the oral exam, the student must have totaled at least a minimum of 18 points. During the oral exam, the examining commission will assess the student's learning skills as well as the ability to apply the knowledge and ensure that the skills are adequate to support and solve problems of a physiological nature (50% of the score). It will also be assessed: autonomy

of judgment (25% of the score) and communication skills (25% of the score) as indicated in the Dublin descriptors.

MICROBIOLOGY The preparation of the students will be verified with a written exam followed by an oral test. The written test will consist of 30 questions with multiple choice answers, for each correct answer a point will be awarded. The final score of the written test will be given by the sum of the partial scores assigned to each question correctly answered. To access the oral exam, the student must have completed at least a minimum of 15 points. During the oral exam, the examining commission will evaluate the student's ability to apply knowledge and ensure that the skills are adequate to support and solve laboratory diagnosis problems of a microbiological nature. The following will also be assessed: making judgments, communication skills and learning skills as indicated in the Dublin descriptors. In the evaluation, knowledge and comprehension skills have a weight equal to 40%, applied knowledge and comprehension skills of 40% and judgment autonomy of 20%.

LABORATORY MEDICINE The preparation of the students will be verified with a written exam followed by an oral test. The written test will consist of 30 questions with multiple choice answers, for each correct answer a point will be awarded. The final score of the written test will be given by the sum of the partial scores assigned to each question correctly answered. To access the oral exam, the student must have completed at least a minimum of 18 points. During the oral exam, the examining commission will evaluate the student's ability to apply knowledge and ensure that the skills are adequate to support and solve laboratory problems related to clinical biochemistry. The following will also be assessed: making judgments, communication skills and learning skills as indicated in the Dublin descriptors. In the evaluation, knowledge and comprehension skills have a weight equal to 40%, applied knowledge and comprehension skills of 40% and judgment autonomy of 20%.

In the final assessment, the weighted average of the teaching modules will be made

OPTIONAL ACTIVITIES

BIOCHEMISTRY In addition to the frontal teaching activity, the teacher will be available to students for further information or clarifications on topics of particular interest by the student.

PHYSIOLOGY In addition to the didactic activity, the student will be given the opportunity to attend seminars and monographic courses, and will have opportunity to conduct theoretical/practical exercises. The topics of the activities are not subject to examination.

LABORATORY MEDICINE In addition to the teaching activity, the student will be given the opportunity to participate in any ECM courses pertaining to the topics covered. The topics of the activities are not subject to examination. The acquisition of the assigned hours takes place only with a mandatory frequency of 100% and eligibility is required.

READING MATERIALS

BIOCHIMICA

"Chimica e Biochimica". Massimo Stefani, Niccolò Taddei; Zanichelli editore

"Appunti di biochimica. Per le lauree triennali". MV Catani, V Gasperi, A DiVenere, I Savini, P Guerrieri, L Avigliano; Piccin editore

BIOCHIMICA APPLICATA

"Biochimica Applicata", Monica Stoppini, Vittorio Bellotti; Editore. EdiSES.

"Biochemistry", Terry A. Brown; Scion Publishing.

FISIOLOGIA

"Fondamenti di Fisiologia Umana". Sherwood. Editore: Piccin.

"Berne & Levy Fisiologia". Koepfen and Stanton. Editore: Casa Editrice Ambrosiana.

"Fisiologia Medica". Guyton and Hall. Editore: Edra.

MICROBIOLOGIA

"Le basi della Microbiologia". Richard Harvey, Pamela C. Champe, Richard D. Fisher; Zanichelli editore.

MEDICINA DI LABORATORIO

Sarà fornito allo studente materiale didattico, come dispense e presentazioni

RESPONSIBLE AVAILABILITY

Students are received by appointment

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