UNICAMILLUS

Degree Course in Biomedical Laboratory Techniques

INTEGRATED COURSE: BIOCHEMISTRY, PHYSIOLOGY AND MICROBIOLOGY
SSD: BIO/09, BIO/10, BIO/12, MED/07
CFU : 10
COORDINATOR: Almerinda Di Venere
e-mail: almerinda.divenere@unicamillus.org

MODULE: Biochemistry
SSD: BIO/10
Numbes CFU: 4
Teacher : Eleonora Nicolai e-mail: eleonora.nicolai@unicamillus.org
Giacomo Lazzarino e-mail: giacomo.lazzarino@unicamillus.org

MODULE: Applied Biochemistry
Number di CFU: 1
Teacher: Costanza Montagna e-mail: costanza.montagna@unicamillus.org

MODULE: Fisiology
SSD: BIO/09
Number CFU 2
Teacher: Sabina Ficili email: sabina.ficili@unicamillus.org

MODULE: Microbiology
SSD: MED/07
Number CFU: 2
Teacher: Daniele Armenia e-mail: daniele.armenia@unicamillus.org

MODULE : Technical sciences of laboratory medicine
SSD I: MED/46
Number CFU: 1
Teacher: Paolo Casalino e-mail:paolo.casalino@unicamillus.org

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 macro-molecules 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 vari-ations 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

The integrated teaching exam consists of an oral and write exam, during which the commission will assess the student's ability to apply the knowledge learned and will ensure that the skills are adequate to solve the problems that arise in the specific disciplinary field and taking I also take into account the objectives of the teaching. The exam can be passed with a grade of 18/30. The student's learning ability, judgment ability and communication skills will be assessed. In the evaluation,

knowledge and understanding have a weight of 50%, knowledge and understanding of 20% and autonomy of judgment of 30%

The student can take the exam in a single session in the recovery session (September / January), while the exam can be taken in two separate sessions in the ordinary sessions (February / July)

The assessments can be carried out both in progress and at the end of the integrated course. The methodology will be communicated at the beginning of the lessons together with the bibliography and / or teaching materials necessary for the preparation for the final evaluation.

• Oral exam: It will focus on questions concerning the study programs. It will evaluate the student's ability to have acquired the knowledge related to the contents of the courses and their integrations, and will ascertain the appropriate use of terminology.

• Written test: It will focus on the programmed topics of the courses that make up the integrated course.

The exam will be assessed according to the following criteria:

Not suitable: Poor or lacking knowledge and understanding of the topics; limited capacity for analysis and synthesis, frequent generalizations of the requested contents; inability to use technical language.

18-20: Just enough knowledge and understanding of the topics, with obvious imperfections; just sufficient capacity for analysis, synthesis and autonomy of judgment; poor ability to use technical language.

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

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

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

30-30L: Excellent level of knowledge and understanding of the required content with an excellent ability to analyze and synthesize with the ability to argue the required content in a rigorous, innovative and original way; excellent ability to use technical language.

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”. Koeppen 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
Dr.ssa Eleonora Nicolai
Email: **eleonora.nicolai@unicamillus.org**