

## Degree in Biomedical Laboratory Techniques

Teaching : **BIOCHEMISTRY, PHYSIOLOGY AND MICROBIOLOGY**

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

CFU : **10**

Coordinator's Name : **Almerinda Di Venere**

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### **MODULE: Biochemistry**

SSD: **BIO/10**

CFU: **4**

Professor's name: Almerinda Di Venere e-mail: [almerinda.divenere@unicamillus.org](mailto:almerinda.divenere@unicamillus.org)

Eleonora Nicolai e-mail: [eleonora.nicolai@unicamillus.org](mailto:eleonora.nicolai@unicamillus.org)

### **MODULE: Applied Biochemistry**

SSD: **BIO/12**

CFU: **1**

Professor's name: Costanza Montagna e-mail: [costanza.montagna@unicamillus.org](mailto:costanza.montagna@unicamillus.org)

### **MODULE: Physiology**

SSD: **BIO/09**

CFU **2**

Professor's name: Gabriele Pallone email : [gabriele.pallone@unicamillus.org](mailto:gabriele.pallone@unicamillus.org)

### **MODULE: Microbiology**

SSD: **MED/07**

CFU: **2**

Professor's name: Daniele Armenia e-mail: [daniele.armenia@unicamillus.org](mailto:daniele.armenia@unicamillus.org)

### **MODULE: Technical Sciences of Laboratory Medicine**

SSD: **MED/46**

CFU: **1**

Professor's name: Paolo Casalino e-mail: [paolo.casalino@unicamillus.org](mailto: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 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 Amino acids: general structure and classification. Proteins: structure and function. Structural levels. Protein folding. Fibrous proteins: alpha-keratin, collagen and silk fibroin structure. 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. Regulation mechanisms: competitive and non-competitive inhibitors; allosteric enzymes and enzymes regulated by covalent modifications. Catalytic strategies. Catalysis of serine proteases. The cascade of blood coagulation as an example to clarify specific determinants (concept of exosite), the role of cofactors and the formation of macromolecular complexes. Bioenergetics and Metabolism Bioenergetics principles. The transfer of phosphate groups. Structure and function of the ATP. The electron carriers (NADH, NADPH and FADH<sub>2</sub>). Coenzyme A. General concepts on carbohydrates. Use of glucose. Glycolysis: phases and regulation. Gluconeogenesis. Allosteric and hormonal regulation. General concepts on the pentose phosphate pathway. Glycogen. Degradation and synthesis, and coordinated regulation. Fate of the pyruvate in aerobic and anaerobic conditions. Synthesis of Acetyl-CoA: pyruvate dehydrogenase. Lactic (Cori cycle) and alcoholic fermentation. Citric acid cycle: Functions, energy balance and regulation. Oxidative phosphorylation: Electron transporters. Electron flow and ATP synthesis. CHEMICAL ELEMENTS: Atoms and molecules, Chemical reactions, Ionic balance in solution, Water, Elements of organic chemistry. BIOCHEMISTRY: Carbohydrates, Lipids, Nucleic Acids, Proteins, Food Digestion

## INTRODUCTION TO METABOLISM: General,, Catabolism, Anabolism.

### 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** Cell membrane physiology: -Transport of ions and molecules through the cell membrane - Membrane potential and Action Potential Muscle Physiology: -Excitation and contraction of skeletal muscle tissue. -Neuromuscular transmission and excitation-contraction coupling. - Motor unit Physiology of the nervous system: -The sensory system: decoding and processing of sensory information. -The motor system: general characteristics of the motor system: involuntary, voluntary and automatic movements; spinal reflexes; trunk-brain control of movement: posture and balance. Cortical control of voluntary movements. The cerebellum: general characteristics, functions of the cerebellum. The basal ganglia: functional role. -The autonomic nervous system. -Integrative functions of the nervous system. Cardiovascular physiology: -Myocardial physiology: functional anatomy of the myocardium, myocardial action potentials, contraction of the heart muscle. Cardiac cycle -Nervous control of cardiac activity. - General principles of hemodynamics. -Regulation of circulation, blood pressure and blood flow. - Cardiac output: principles of regulation of cardiac output. -Cardiac tones. The Respiratory System: -Pulmonary ventilation: respiratory mechanics, lung volumes and capacities. Respiratory tract - Gaseous exchanges: diffusion of oxygen and carbon dioxide through the respiratory membrane. - Transport of oxygen and carbon dioxide into the blood and body fluids. -Regulation of breathing: general principles. -Adjusting the acid-base balance: general principles. Body fluids and kidney function: - Functional anatomy of the kidney, function of the nephron. Glomerular filtration: general principles. - Processing of glomerular filtrate: tubular reabsorption and secretion, - Checking the osmolarity and the sodium concentration of the extracellular liquid: general principles. -Renal regulation of blood volume: general principles The endocrine system: -General principles of endocrinology: nature of a hormone; general picture of the endocrine glands and their hormones. Principles of general functioning of hormones.

**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.

**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 exemption will be in writing with 30 multiple choice questions. 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% **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 teaching activity, the student may be given the opportunity to participate in seminars and monographic courses. The topics of the activities are exam subjects. The acquisition of the assigned hours takes place only with a mandatory frequency of 100% and eligibility is required. **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

Appunti di biochimica. Per le lauree triennali

[M.V.Catani](#), [V.Gasperri](#), [A.Di Venere](#), [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

- "Berne & Levy Physiology", Sixth Updated Edition

- "Sherwood" ninth edition

- "Guyton-Hall"

### MICROBIOLOGIA

Le basi della Microbiologia

Autori: Richard A. Harvey, Pamela C. Champe Bruce D. Fisher

MEDICINA DI LABORATORIO Sarà fornito allo studente materiale didattico, come dispense e presentazioni

### RESPONSIBLE AVAILABILITY

Students are received by appointment

**Dr.ssa Almerinda Di Venere**

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