INTEGRATED COURSE: BIOLOGICAL AND BIOCHEMICAL FOUNDATIONS OF LIVING SYSTEM
SSD: BIO/13, MED/36, BIO/10, BIO/12, MED/03, MED/07
CFU: 9
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MODULE:Applied Biology
SSD: BIO 13
CFU: 2
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MODULE: Radiobiology
SSD: MED/36
CFU: 1
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MODULE: Biochemistry
SSD: BIO/10
CFU: 2
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MODULE: Clinical biochemistry and molecular biology
SSD: BIO/12
CFU 2
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MODULE: Genetica/ Genetics
SSD: MED/03
CFU: 1
Professor: **Maria Rosaria D'Apice** e-mail: maria.rosaria.dapice@unicamillus.org

MODULE: Microbiologia/ Microbiology
SSD: MED/07
CFU: 1
Professor: **Daniele Armenia** e-mail: daniele.armenia@unicamillus.org

PREREQUISITES

Although there are no prerequisites, basic knowledge of cell biology and chemistry is required.

LEARNING OBJECTIVES

The teaching of Biological and Biochemical Bases of Life, through the integration of biological and medical disciplines, is aimed at making the student acquire knowledge relating to the physiological, morphological, structural, and genetic characteristics of living organisms, and the causes of occurrence of events pathological even of microbial origin. The student will also be introduced to the logic and tools underlying the execution of diagnostic tests of clinical biochemistry and molecular biology and radiology. At the end of integrated teaching, the student, thanks to the basic knowledge acquired, will be able to understand physiological and pathological mechanisms and to interpret and evaluate the results of diagnostic and radiological tests in clinical practice.

Bio13. The main objective of the Applied Biology teaching is to acquire knowledge relating to the physiological and morphological characteristics of cells, as functional units of living organisms. The key to any biological problem can, in fact, be sought at the cellular level. Another important goal is the use of the experimental method as a means of understanding the biological mechanisms that regulate life and a tool for the study of pathological processes.

Med36 Radiobiology teaching aims to introduce the student to the radiological discipline and to provide him with the basic knowledge of radiation physics and radiobiology.

Bio10 The teaching of Biochemistry will allow you to acquire knowledge of the main biological macromolecules, of the functioning mechanism of enzymes, a general knowledge of the main metabolic pathways and, in more detail, of the main pathway of glucose catabolism.

Bio12 The teaching of Clinical Biochemistry and Clinical Molecular Biology aims to provide students with the theoretical-practical knowledge of the basic principles of Biochemistry and Molecular Biology underlying the execution and evaluation of laboratory diagnostic tests.

Med03 The purpose of the Medical Genetics teaching is to provide students with the main knowledge on the inheritance of monogenic, chromosomal, and multifactorial diseases. At the end of the course the student will be able to distinguish the main classes of genetic diseases and to recognize their transmission methods.

Med07 Knowledge of the structure of the various microorganisms, of the microbial pathogenicity, of the causes and mechanisms of onset of the main diseases with microbial ethology are essential objectives of teaching Microbiology.

LEARNING OUTCOMES

The learning outcomes expected from the integrated teaching Biological and Biochemical foundations of living organisms are consistent with the provisions from the Bologna Process and are found within the Dublin descriptors as follows:

knowledge and understanding

- *Describe bacteria and viruses. Know the structure and function of biological molecules. Know the differences between eukaryotic and prokaryotic cells. Know what the approaches and tools are to study the cell. Describe cellular compartments and intracellular organelles. Know the cell physiology, the movement of molecules, passive transport, active transport, endocytosis (phagocytosis and pinocytosis) and exocytosis. Know the nucleic acids. DNA and RNA. Transcription and translation. Regulation of gene expression. Describe the biosynthesis of proteins. Describe the cell cycle. Describe sexual reproduction and its evolutionary meaning. Describe tissues, stem cells and cancer. Know the genes that are critical for cancer development: proto-oncogenes and tumours suppressor genes.*
- *Have basic knowledge of radiation physics and radiobiology. Develop a knowledge of the basic elements of the different radiological techniques.*
- *Students will have to demonstrate that they have understood through the lessons and exercises which are the structures of the most important biological macromolecules. They will also have to demonstrate, through the final test, that they know how to frame the role of these molecules in the context of the main metabolic processes that take place in the cell.*
- *Know and understand the principles underlying the interpretation of laboratory data: the sources of pre-analytical and analytical variability; the principles of quality control; the diagnostic reference values; the dosage methods and the diagnostic role of the main enzymatic markers (including in their use as organ markers); homeostasis of water and electrolytes; the principles of methods for dosing electrolytes from clinical samples; the principles of blood gas assessment methods; the impact of acid-base balance in the development of pathologies, the main techniques of diagnostic molecular biology*
- *Demonstrate the knowledge of the correct genetic terminology, the knowledge of the main hereditary transmission models of monogenic, chromosomal and multifactorial diseases, the knowledge of the main biological mechanisms that cause hereditary diseases, the understanding of how to build family pedigrees and calculate the recurrence of the disease. understanding of the main types of genetic tests and their correct use.*
- *Describe the architecture of the bacterial, fungal, and protozoan cell and the structure of the viral particles. Know the metabolism and bacterial growth: the production of bacterial spores. Know the stages of viral replication cycles. Know the basics of bacterial and viral genetics: transformation, transduction, bacterial conjugation, viral genetic variability. Know the pathogenic action of bacteria and viruses: transmission routes and stages of the infectious process. Know the process of toxin production and explain the mechanisms of action of exotoxins and endotoxins. Know the basics of innate and cell-mediated immunity. Know and describe the characteristics of immune sera and vaccines. Know the general principles for the diagnosis of diseases caused by pathogenic microorganisms.*

Applying knowledge and understanding

At the end of the integrated teaching, the student will be able to:
use the knowledge acquired for the understanding of the biological phenomena that regulate life and for the understanding and study of pathological processes. Use the knowledge acquired to approach the subsequent courses dedicated to the various radiological techniques. Students will be repeatedly tested through open questions on quantitative (numerical) and qualitative biochemistry

problems (for example inherent pathologies related to dysfunctions / deficiencies of which the molecular origin is known) on the topics covered in class, to constantly evaluate them the ability to study. They will be able to understand the applications of biochemical and molecular techniques for diagnostic purposes and to correctly interpret the tests performed to diagnose pathological conditions
They will have acquired the ability the ability to analyze family pedigrees and the ability to calculate the risk of recurrence of the disease

communication skills

At the end of the course, the student must be able to communicate the scientific and application contents acquired in each area of the integrated course in a clear and unambiguous way, using an appropriate scientific and technical language.

making judgements

At the end of the course the student will have to
carry out assessments relating to the topics covered that allow the correct interpretation of scientific notions and the correct use of radiological and diagnostic techniques. During the lessons, students will also be asked questions whose answers require, starting from the acquired knowledge, a logical reasoning (type cause-effect and / or vice versa). In this way, students will be induced to think independently, each evaluating their deductive skills during the subsequent collegial discussion of the answers given.
Finally, at the end of the course the student must be able to deepen and keep their knowledge and skills updated by consulting scientific literature, databases and specialized websites, capturing the fundamental and relevant aspects for their professional context.

COURSE SYLLABUS

APPLIED BIOLOGY

- *Origin of life. Eukaryotic cell and prokaryotic cell. Bacteria and archaeobacteria. Virus.*
- *Structure and function of biological molecules. Carbohydrates, lipids, proteins, nucleic acids. Water and pH.*
- *How to study the cell (optical and electronic microscopes; biochemical methods).*
- *Cellular compartments and organelles (the plasma membrane, the nucleus, the cytoskeleton, the endoplasmic reticulum, the ribosomes, the Golgi complex, the mitochondria, the chloroplasts, the peroxisomes, the lysosomes and the vacuoles).*
- *Movement of molecules. Passive transport, active transport, endocytosis (phagocytosis and pinocytosis), exocytosis.*
- *Nucleic acids. DNA and RNA. Transcription and translation. Regulation of gene expression.*
- *Cell cycle. Types of cell division in prokaryotes and eukaryotes (mitosis and meiosis).*
- *Protein biosynthesis.*
- *Sexual reproduction and its evolutionary meaning.*
- *Tissues, stem cells and cancer. Genes that are critical for cancer development: proto-oncogenes and tumours suppressor genes.*

RADIOLOGY

- *Definition and physical principles of Radiation and distinction between types of radiation (Non-Ionizing Radiation and Ionizing Radiation).*
- *Main sources of natural and artificial radiation. Radioactivity and radioactive decay*
- *Effects of radiation on DNA and mechanisms of repair of radio-induced damage; effects of radiation exposure to tissues, organs and the whole organism*
- *Use of radiation in diagnostic imaging and radiotherapy*

BIOCHEMISTRY

- *Structure / function of biological molecules: Structure of proteins: amino acids; peptide bond; primary structure; tertiary and quaternary secondary. Protein functions. Myoglobin and haemoglobin. Enzymes: characteristics and functioning; enzymatic inhibition mechanisms.*
- *Glucose catabolism: the anaerobic catabolic pathway, glycolysis and fermentations.*
- *The aerobic catabolic pathway: the Krebs cycle and oxidative phosphorylation. The regulation: hormones and vitamins*
- *Fatty acid catabolism: Beta oxidation. Ketogenesis*

CLINICAL BIOCHEMISTRY AND MOLECULAR CLINICAL BIOLOGY

- *Definition, limits and aims of Clinical Biochemistry and Clinical Molecular Biology as disciplines of Laboratory Medicine.*
- *General organization of the Clinical Diagnostic Laboratory: from the request for analysis to the report.*
- *Reference ranges, critical values*
- *Sources of variability in the pre-analytical and analytical phase, intra and inter-individual biological variability, concepts of diagnostic sensitivity and specificity and their applications. Internal and external quality control*
- *Balance of body fluids and electrolytes. Acid-base balance. Conditions associated with abnormal electrolyte composition or acid-base balance*
- *Plasma proteins and enzymes as biomarkers of tissue and organ damage. Evaluation of plasma / serum enzymes and metabolites for diagnostic purposes.*
- *Introduction to Clinical Molecular Biology and Molecular Biomarkers*
- *Methods of preparation and analysis of proteins and nucleic acids in clinical diagnostics (E.g. immuno-detections and immunoassays of proteins, protein and nucleic acid electrophoresis, PCR, gene sequencing, arrays, LC-MS, etc)*
- *Molecular diagnostic tests (genetic and oncological diseases)*

GENETICS

- *Basic concepts and terminology: gene, locus, allele, genotype, phenotype, haplotype, homozygous, heterozygous, haploid, diploid, dominance, recessivity, codominance.*

- *Mutations and polymorphisms.*
- *Mendel's laws. Dominant and recessive traits. The genetics of the main blood groups (AB0, Rh). Fetal maternal incompatibility*
- *Transmission patterns of Mendelian (or monogenic) traits: autosomal recessive and dominant inheritance, inheritance linked to recessive and dominant sex.*
- *Risk calculations related to the above models and analysis of family trees*
- *Concepts of penetrance, expressiveness, epistasis, anticipation, consanguinity, genetic heterogeneity*
- *Chromosomes: structure and characteristics. Anomalies of number and structure of chromosomes*
- *Multifactorial inheritance: genetic markers and polymorphisms. Inter-individual genetic variation. Association studies*
- *Genetic tests and their applications.*

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. Morphology of viral particles. Cell tropism and host spectrum. Viral enzymes. Virus classification. Stages of viral replication*
- *Mechanisms of bacterial pathogenesis: Demonstration of the causal nature between pathogen and disease: Koch 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: Method of transmission. 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*

COURSE STRUCTURE

*The module of **Biological and Biochemical Foundations of Living System** is organized in lectures for a total of 90 hours and theoretical-practical exercises. The teachers use Power Point presentations to deal with the teaching topics.*

COURSE GRADE DETERMINATION

The exam is unique for the entire integrated course, it is not possible to take exam tests for the individual modules
The exam consists of a compulsory written test and an oral integration test
The written test consists multiple choice questions that will cover all the teachings. Students who have obtained a score of at least 18/30 are admitted to the oral exam.

The final exam grade will be calculated as the average of the written grade and the individual oral tests taken according to the following crtieria:
***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 sufficient 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 contents with an excellent ability to analyze and synthesize with the ability to argue the required contents in a rigorous, innovative and original way; excellent ability to use technical language*

OPTIONAL ACTIVITIES

Students will have the opportunity to carry out theoretical / practical exercises and participate in seminars. The teachers will provide constant support during and after the lessons. In addition to the teaching activity, the student will be given the opportunity to take advantage of tutoring on request.

READING MATERIALS

APPLIED BIOLOGY:

1. Bruce Alberts, Karen Hopkin, Alexander D. Johnson, David Morgan, Martin Raff, Keith Roberts, Peter Walter. “Essential Cell Biology (Fifth Edition)”. Casa editrice: W. W. Norton & Company. 2019.

2. Peter H. Raven, George Johnson, Kenneth A. Mason, Jonathan B. Losos, Tod Duncan. “Biology”. Casa editrice: McGraw-Hill Education, 2019.

RADIOLOGY:

1. Radiobiology for the radiologist / Eric J. Hall, Amato J. Giaccia.—7th ed.
2. Bontrager’s Handbook of Radiographic Positioning and Techniques 9th Edition by Lampignano John; Kendrick, Leslie E.

BIOCHEMISTRY:

1. ”Biochemistry”, D. R. Ferrier Wolters Kluwer;
2. “Lehningher principles of biochemistry”, D. L. Nelson, M.M. Cox (2017) W.H. Freeman & Co.

CLINICAL BIOCHEMISTRY AND MOLECULAR CLINICAL BIOLOGY

1. Michael Laposata. “Laboratory Medicine: the diagnosis of disease in the clinical laboratory” (3rd edition). LANGE editor
2. Michael J. Murphy & Rajeev Srivastava & Kevin Deans “Clinical Biochemistry”, Sixth Edition , Elsevier

3. Michael M. Cox, Jennifer Doudna, Michael O'Donnell. “Molecular Biology: Principles and Practice”; W H Freeman & Co; 2

Additional educational material will also be provided, in the form of scientific articles and appropriate telematic sources, to complete, deepen and update the contents covered in class.

GENETICS :

“Medical Genetics”, autori: Lynn Jorde John Carey Michael Bamshad. Edizioni Elsevier

MICROBIOLOGY :

The basics of Microbiology. Authors: Richard A. Harvey, Pamela C. Champe Bruce D. Fisher