Integrated Course: BIOLOGICAL AND BIOCHEMICAL FOUNDATIONS OF LIVING SYSTEM
SSD: BIO/13, MED/36, BIO/10, BIO/12, MED/03, MED/07
CFU: 9
Coordinator: PROF. DIEGO SBARDELLA
E-mail: DIEGO.SBARDELLA@UNICAMILLUS.ORG

MODULE: Applied Biology
SSD: BIO 13
CFU: 2
Professor name: Roberta Nardacci e-mail: roberta.nardacci@unicamillus.org

MODULE: Radiology
SSD: MED/36
CFU: 1
Professor name: Simone Altobelli e-mail: simone.altobelli@unicamillus.org

MODULE: Biochemistry
SSD: BIO/10
CFU: 2
Professor name: Giampiero Mei e-mail: giampiero.mei@unicamillus.org

MODULE: Clinical biochemistry and molecular biology
SSD: BIO/12
CFU 2
Professor name: Diego Sbardella email: diego.sbardella@unicamillus.org

MODULE: Genetics
SSD: MED/03
CFU: 1
Professor name: Cinzia Ciccacci e-mail: cinzia.ciccacci@unicamillus.org

MODULE: Microbiology
SSD: MED/07
CFU: 1
Professor name: 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 main objective of the course 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.
The course aims to introduce the student to the radiological discipline and to provide him with the basic knowledge of radiation physics and radiobiology. Knowledge of the main biological macromolecules. Knowledge of the functioning mechanism of enzymes.
General knowledge of the main metabolic pathways and, in more detail, of the main pathway of glucose catabolism. The purpose of the Medical Genetics course 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. 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.

LEARNING OUTCOMES
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. The teaching of Applied Biochemistry aims to provide students with a complete theoretical knowledge of the principles, rules and structures of molecular chemistry and biochemistry. The student must also, at the end of the course, acquire the ability to identify the main structural components of inorganic and organic compounds. He must also understand the importance of these structures, focusing on their pathophysiological interaction with the human body and their possible alterations. A careful understanding of the aforementioned chemical and biochemical processes will allow the student to have the basis for understanding the rationale for use and the principles of operation of instruments used in the field of medical radiology and radiotherapy. 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

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, in order to constantly evaluate them the ability to study. 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 know:
express yourself using specific scientific terminology. Use the appropriate scientific and technical terminology also in relation to the different radiological techniques. The ability to describe the main models of inheritance and the risk of recurrence, using correct genetic terminology

Making judgements

At the end of the course, the student must know:
carry out evaluations, when related to the topics covered. carry out basic assessments that allow the correct use of radiological techniques. During the lessons, students will also be asked questions whose answers require, starting from the knowledge acquired, a reasoning of logic (type cause-effect and / or vice versa). In this way students will be induced to think autonomously, each evaluating their own deductive skills in the subsequent collegial discussion of the answers given

COURSE SYLLABUS

- *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.*

- *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*

- *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*

- *introductory notes - periodic table of the elements and inorganic nomenclature.*
- *constitution of the atom - elementary particles: proton, neutron, electron. isotopes. auf-bau. the chemical bond.*
- *states of aggregation of matter - gas: equation of state of ideal gases. liquids: vapor pressure of a liquid.*
- *solutions - concentration of solutions. dilutions. osmotic pressure.*
- *chemical equilibrium - gas phase equilibria. expression of the equilibrium constant.*
- *electrolyte solutions - strong and weak electrolytes; degree of dissociation. acids and bases. ph; calculation of ph. saline hydrolysis. buffer solutions.*
- *heterogeneous systems - definition of saturated solution. heterogeneous equilibria. solubility constant.*
- *hybridization of the carbon atom - sp3, sp2, sp hybridizations and their geometry.*
- *hydrocarbons - saturated and unsaturated hydrocarbons. nomenclature and reactions.*
- *aromatic compounds - benzene and derivatives. nomenclature and reactions.*

- *alcohols and phenols - nomenclature. alcohols with more than one hydroxyl group. comparing alcohols and phenols.*
- *ethers - nomenclature.*
- *aldehydes and ketones - nomenclature. the carbonyl group. formation of semiacetals and acetals. carboxylic acids and their derivatives - nomenclature of acids.*
- *the derivatives of carboxylic acids: esters, anhydrides, amides.*
- *amines - classification of amines and nomenclature. basicity of amines.*
- *carbohydrates - definitions and classification. monosaccharides. fischer projections. cyclic structures of monosaccharides. disaccharides and polysaccharides.*
- *lipids - structure of fatty acids, glycerol, glycerol derivatives. steroids.*
- *amino acids - structure and function. peptide bond.*
- *proteins - structure and function. primary, secondary, tertiary and quaternary structures. allosteria and cooperativity. enzymes and their properties. michaelis-menten. enzymatic inhibition.*
- *vitamins.*

- *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.*

- *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

APPLIED BIOLOGY:

The test consists of a compulsory written test and an optional oral test. The written and oral tests are aimed at evaluating both the theoretical knowledge and the student's ability to solve problems. The written test consists of 15 multiple choice questions. Each correct answer gets a score of 2/30, while there is no penalty for the wrong answers. Only students who have obtained a written test of at least 16/30 are admitted to the oral exam.

RADIOLOGY:

written exam with 30 multiple-choice questions. 18 will be the minimum mark to pass the written test

BIOCHEMISTRY:

Written test in the form of multiple-choice tests. Possible integration with oral interview.

CLINICAL BIOCHEMISTRY AND MOLECULAR BIOLOGY:

The exam consists of a multiple-choice quiz. One answer will be correct. The student will have to answer 30 quizzes and a minimum of 18 correct answers is necessary to pass the test. Wrong answer to a quiz does not incur a penalty.

GENETICS:

The written exam consists of 20 questions with multiple answers. Each correct answer is worth 1.5 points. The score of the written exam is given by the sum of the scores of the correct answers. The minimum mark for passing the exam is 18/30.

MICROBIOLOGY:

oral examination.

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:

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.

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 BIOLOGY:

1. Peter Atkins , Loretta Jones, Leroy Laverman Chemical Principles: The Quest for Insight
2. Chemistry by M.S. Silderberg, McGraw-Hill International Edition.
3. Katherine J Denniston, Joseph J Topping and Robert L Caret. General, Organic & Biochemistry. 7th Ed. 2010. McGraw-Hill Higher Education.
4.

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

DEGREE IN RADIOLOGY, DIAGNOSTIC IMAGING AND RADIOTHERAPY TECHNIQUES