## BSc in Nursing

**INTEGRATED TEACHING:** BIOLOGY, APPLIED PHYSICS, BIOCHEMISTRY
**NUMBER OF CFU:** 4
**SSD:** BIOS-06/A ; BIOS-07/A ; MEDS-01/A ; BIOS-10/A
**RESPONSIBLE PROFESSOR: LAURA PACINI**
**E-MAIL:** laura.pacini@unicamillus.org

MODULE: BIOPHYSICS
NUMBER OF CFU: 1
SSD: BIOS-06/A
PROFESSOR: SAVIANA ANTONELLA BARBATI
e-mail: saviana.barbati@unicamillus.org
Office hours (by appointment) : Thursday from 3 pm to 4 pm
https://www.unicamillus.org/personnel/barbati-saviana-antonella-2/

MODULE: BIOCHEMISTRY
NUMBER OF CFU: 1
SSD: BIOS-07/A
PROFESSOR: SILVIA BUONVINO
e-mail: silvia.buonvino@unicamillus.org
Office hours (by appointment) : Thursday from 3 pm to 4 pm

MODULE: MEDICAL GENETICS
NUMBER OF CFU: 1
SSD: MEDS-01/A
PROFESSOR: Antonio Novelli
e-mail: antonio.novelli@unicamillus.org
Office hours (by appointment) : Thursday from 3 pm to 4 pm

MODULE: APPLIED BIOLOGY
NUMBER OF CFU: 1
SSD: BIOS-10/A
PROFESSOR: LAURA PACINI
e-mail: laura.pacini@unicamillus.org
Office hours (by appointment) : Thursday from 3 pm to 4 pm
https://www.unicamillus.org/personnel/laura-pacini-2/

## PREREQUISITES

Basic knowledge and skills in Mathematics, Physics and Statistics (High School level), appropriate knowledge of the basic concepts in inorganic chemistry including: chemical bonds, properties of solutions, acids, bases, buffers. The student, matriculated with educational debt, must fulfill the educational obligation (OFA) before taking the Biology, Applied Physics and Biochemistry exams. All the prerequisites listed above are essential for understanding the Biology module.

## LEARNING OBJECTIVES

The objectives of this Integrated Teaching are aimed at providing students with the knowledge required for their future work. In particular, the BioPhysics module aims to provide tools for understanding the principles underlying medical physics and the functioning of medical equipment. By the end of the course, the student will have acquired the fundamental concepts for applying the Scientific Method to the study of physiological and biomedical phenomena, including the selection and measurement of parameters and the assessment of errors. Students will acquire basic knowledge regarding the structure and function of biological macromolecules (carbohydrates, lipids, amino acids and proteins). They will also gain the understanding of essential metabolic pathways and cycles with a special focus on glucose, lipid and amino acid metabolism. Moreover, they will become familiar with the morphological and physiological characteristics of the cell, as functional unit of living organisms. Another significant objective will be to apply the experimental method to comprehend the biological mechanisms regulating life and and the pathological processes stemming from alterations in these mechanisms. Students will come to realize that the solution to each biological problem can be sought at the cellular level. Upon completing the course, they will also be proficient in distinguishing the primary categories of genetic diseases, including monogenic, chromosomal, and multifactorial diseases, as well as recognizing their modes of transmission.

## LEARNING OUTCOMES

The specific learning outcomes of the program are coherent with the general provisions of the Bologna Process and the specific provisions of EC Directive 2005/36/EC. They lie within the European Qualifications Framework (Dublin Descriptors) as follows:

### Knowledge and Understanding

- Understand the experimental method and learn the use and conversion of measure units.
- Possess accurate and comprehensive knowledge of specific terminology in Physics, Biochemistry, Biology and Genetics.
- Develop a solid knowledge of the fundamental principles and laws of Physics concerning electricity, vibrations and waves, radiation, heat, and fluids.
- Apply the fundamental laws of Physics to understand biological and physiological phenomena in living organisms.
- Identify and recognize the physical principles governing the function of specific human organs.
- Possess basic knowledge of the structure and function of major biological macromolecules.
- Know the basics of enzymatic catalysis.
- Know the biosynthetic pathways of some molecules of biochemical interest.

- Know the role of different "fuels" in energy production.
- Know experimental approaches and tools for cell studies.
- Describe bacteria and viruses and their main differences.
- Know the differences between prokaryotic and eukaryotic cells.
- Know the structure and function of biological membranes.
- Describe cellular compartments and intracellular organelles.
- Describe structure and function of nucleic acids (DNA and RNA). Transcription and translation processes.
- Understand the main mechanisms regulating gene expression.
- Know the cell cycle and its regulation in eukaryotic cells.
- Know the correct genetic terminology.
- Know the main models of hereditary transmission of monogenic, chromosomal, and multifactorial diseases.
- Know the main biological mechanisms causing hereditary diseases.
- Understand how to build family pedigrees and calculate disease recurrence.
- Understand the main types of genetic tests and their correct use.

**Applying knowledge and understanding**

- Apply the principles of Physics to selected problems and a wide range of situations.
- Use the tools, methodologies, language, and conventions of Physics to conduct experiments and effectively communicate ideas."
- Employ the acquired knowledge for an in-depth exploration of aspects relevant to future professional activity.
- Interpret the significance of alterations in biochemical processes as causative factors in various disease states.
- Acquire the ability to analyse family history to construct pedigrees.
- Acquire the ability to calculate disease recurrence risk.

**Communication skills**

- Explaining arguments orally in an organized and coherent manner.
- Employ scientific language suitable for the topic of discussion.
- Clearly and unambiguously communicate scientific and applied content, using appropriate technical language.
- Describe the main patterns of inheritance and risk of recurrence using correct genetic terminology.

**Making judgements**

- Recognize the importance of an in-depth knowledge of topics consistent with a proper medical education.
- Identify the pivotal role of a proper theoretical knowledge in clinical practice.
- Carry out assessments of the covered topics.
- Ability to synthesize and correlate aspects related to different clinical issues.

- Critically use genetic tests for molecular diagnosis of monogenic and chromosomal diseases or for evaluating genetic susceptibility to complex diseases.
- Make appropriate and relevant assessments of the analyzed clinical issues.

**Learning skills**

The student will have acquired skills and methods of learning suitable for deepening and improving their competencies in the field of Biology, applied physic, biochemistry and genetical medics also through consulting scientific literature.

**MODULE SYLLABUS**

**BIOPHYSISCS**

Membrane physiology and biophysics: ion channels, receptors, transporters, protein-lipid interactions, surface phenomena, model membranes, Gradients, diffusion, osmotic pressure, chemical potentials, and electrical potentials, ionic currents. Exchange across membranes of gases and solutes (passive diffusion, facilitated diffusion, regulated diffusion, primary and secondary active transport), homeostasis, regulation of cellular functions.

Cellular Excitability: Polarization of the cell membrane (ionic distribution on both sides of the membrane and its genesis). Characteristics and genesis of potentials (membrane potential, graded potentials, miniature potentials, action potentials). Smooth, cardiac and skeletal muscle physiology, excitation-contraction coupling, cellular motility.
Cellular Communication Mechanisms: Chemical messengers, ligand-gated and voltage-gated ion channels (sodium, potassium, calcium, chloride).
Biophysical analysis of cellular function (bioenergetics, volume regulation, thermodynamics, mathematical models)

**BIOCHEMISTRY**

Short summary of basic concepts of inorganic and organic chemistry - Chemical bonds, osmotic pressure, pH, buffers. The constituents of biological macromolecules: carbohydrates, lipids, purines, pyrimidines, nucleosides, nucleotides, amino acids. Proteins structure and function. Hemoproteins and gas transport (O2, CO2). Coenzymes and vitamins. Enzymes. Introduction to metabolism. Catabolism and anabolism. Glucose catabolism: glycolysis and the Kreb's cycle. Catabolism of fatty acids. The mitochondrion as the power plant of the cell: oxidative phosphorylation. Hormonal control of glucose metabolism. Insulin and glucagon: glycogenolysis, glycogen synthesis, gluconeogenesis and lipolysis. Fasting, diabetes and ketogenesis. Biosynthesis of fatty acids and phospholipids. Cholesterol metabolism. Amino acid metabolism and urea cycle in brief.

**MEDICAL GENETICS**

Introduction to Medical Genetics and Key Terms: gene, locus, allele, genotype, phenotype, haplotype, homozygous, heterozygous, haploid, diploid, dominance, recessivity, mutation, polymorphism.

Principles of Genetic Transmission: Segregation in Human Pedigrees.

Monogenic Inheritance Models: Autosomal inheritance, Autosomal recessive inheritance, X-linked inheritance, Y-linked; Mitochondrial DNA and pattern of inheritance.
Genetic Risk calculation and pedigrees.
Chromosomes: Structure and Analysis, Pathologies.
X-chromosome inactivation.
Multifactorial models: polymorphisms, susceptibility genes, gene-environment interaction, association studies.
Pharmacogenomics and Personalised Medicine.
Genetic tests and Counselling.

**APPLIED BIOLOGY**

Characteristics of living organisms, levels of organization and classification principles.
Macromolecules structure, shape and function: carbohydrates, lipids, proteins and nucleic acids.
The cell as the basic unit of life. Prokaryotic and eukaryotic cells.
Cellular compartments and intracellular organelles: plasma membrane, cytoplasm, ribosomes, smooth and rough endoplasmic reticulum, Golgi apparatus, lysosomes, peroxisomes, cytoskeleton.
Relationship between energy conversion processes and cellular structures, mitochondria and chloroplasts (notes).
Nucleus. Nuclear envelope, nucleolus, chromatin and chromosomes.
Molecular bases of hereditary information. DNA structure and function.
Gene expression: RNA structure and function, transcription and maturation of transcripts.
Genetic code and translation. Main post-translational modifications and post-synthetic fate of proteins.
Cell cycle, Mitosis and Meiosis.

## COURSE STRUCTURE

The 4 modules are structured into 14 hours of frontal teaching each, divided into lessons of 2 or 3 hours, based on the academic calendar. Frontal teaching includes theoretical lessons on the topics of the program, and instructors use teaching aids such as presentations organized in PowerPoint files with diagrams, illustrations, and explanatory images. In the Applied Biophysics module, a review of the mathematical concepts and skills that are essential prerequisites for a fruitful completion of the Integrated teaching will be carried out before the frontal lectures begins.

The Applied Biology module will use videos and animations to describe the main cellular processes discussed in class. In the Genetics module, both theoretical lessons with PowerPoint presentations and interactive lessons during which exercises will be addressed in class, individually and in groups, are planned. Attendance is mandatory, at least 75 percent of the total scheduled hours for all modules in the integrated teaching is required.

## COURSE GRADE DETERMINATION

Student performance will be evaluated through a written exam on topics related to Biology, Biophysics, Biochemistry and Medical Genetics.

The exam will be organized into 60 multiple-choice questions (15 questions/module), each offering 4 or 5 possible answers of which only one is correct. Correct answers are awarded a score of 1, while incorrect answers receive a score of 0 (without any penalty for wrong answers). If the written test results in a sufficient grade, students can choose to improve the grade obtained by an optional oral test. To pass the exam, students must achieve a final mark of at least 18 out of 30.

The final score will be determined as follows: 30% for knowledge and understanding, 30% for application of knowledge and understanding, 30% for autonomous judgment, and 10% for communication skills.

The evaluation criteria considered will be: acquired knowledge, independent judgment, communication skills and learning skills. The exams will be assessed according to the following criteria:

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|---|---|
| **< 18 insufficient** | The candidate possesses an inadequate knowledge of the topic, makes significant errors in applying theoretical concepts, and shows weak presentation skills. |
| **18 - 20** | The candidate possesses a barely adequate and only superficial knowledge of topic, limited presentation skills, and only an inconsistent ability to apply theoretical concepts. |
| **21 – 23** | The candidate possesses an adequate, but not in-depth, knowledge of the topic, a partial ability to apply theoretical concepts, and acceptable presentation skills. |
| **24 – 26** | The candidate possesses a fair knowledge of the topic, a reasonable ability to apply theoretical concepts correctly and present ideas clearly. |
| **27 - 29** | The candidate possesses an in-depth knowledge of the topic, a sound ability to apply theoretical concepts, good analytical skills, clear argumentative clarity and an ability to synthesize |
| **30 - 30L** | The candidate possesses an in-depth knowledge of the topic, an outstanding ability to apply theoretical concepts, a high level of argumentative clarity, as well as excellent analytical skills, and a well-developed ability to synthesize and establish interdisciplinary connections. |

**OPTIONAL ACTIVITIES**

Students have the opportunity to engage in seminars, research internships, department internships, and monographic courses. These activities are not subject to examination and require 100% mandatory attendance for the allocated hours to be acquired.

**READING MATERIALS**

The suggested textbooks should be considered recommendations or points of reference. The students can choose the textbook(s) they prefer or find most suitable for their learning needs. Additional teaching material will be provided by the instructor.

**Reading materials for BIOPHYSISCS**

- Stanfield, Principle of Human Physiology, 5th Ed.

**Reading materials for BIOCHEMESTRY**

- Ashok Kumar, J. (2011). Textbook of biochemestry. I K International Publishing House

**Reading materials for MEDICAL GENETICS**

- Jorde, L.B., Carey, M.D., John, C. (2019). Medical Genetics. Elsevier Science Health Science.

**Reading materials for APPLIED BIOLOGY**

- Raven, P.H., Johnson, G.B., Mason, K.A., Losos, J.B., Singer, S.R. (2017). Biology. Mc Graw Hill. XI ed.



UniCamillus – Saint Camillus International University of Health Sciences – Via di Sant'Alessandro 8 - 00131 Roma
www.unicamillus.org info@unicamillus.org PEC: unicamillus@pec.it Tel. +39 06 40 06 40 Codice Fiscale 97962900581 P.Iva. 15031161001