

## Degree in Nursing

### Teaching: BIOLOGY, APPLIED PHYSICS, BIOCHEMISTRY

SSD Course: BIO/09, BIO/10, MED/03, BIO/13

CFU: 4

Coordinator's name: Prof. Cinzia Ciccacci

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Module : BIOPHYSICS

SSD: BIO/09

CFU : 1

Professor's name : Iole Indovina,

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Module: BIOCHEMISTRY

SSD Course: BIO/10

Credits: 1

Professor's name: Prof. Giacomo Lazzarino

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Module: MEDICAL GENETICS;

SSD Course: MED/03

Credits: 1

Professor's Name: Cinzia Ciccacci

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Module: APPLIED BIOLOGY

SSD Course: BIO/13

Credits: 1

Professor's Name: Roberta Nardacci

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### PREREQUISITES

Knowledge and competence in Basic Mathematics, Physics and Statistics at High School level, appropriate knowledge of the basic concepts of chemistry, including: chemical bonds, properties of solutions, acids, bases, buffers.

There are no prerequisites, but it would be desirable if the student already knows basic biology elements, such as the gene structure, DNA replication, concepts of meiosis and mitosis.

### LEARNING OBJECTIVES

Aim of the teaching is to provide students with knowledge on the fundamentals of applied physics necessary to the performance of their future activity. In particular, the comprehension of physical principles at the base of medical physics and of functioning of medical instrumentation will be addressed.

At the end of the course, the students will know the fundamental concepts of application of the Scientific Method to the study of biomedical phenomena (choice and measure of parameters, evaluation of errors), they will be able to describe physical phenomena of complex systems using

suitable mathematical tools, they will know the scientific basis of medical procedures and principles of functioning of the equipment commonly used for diagnostics and therapeutics.

Students will learn knowledge on the structure, function and regulation of biological macromolecules (carbohydrates, lipids, amino acids and proteins). To acquire basic knowledge on the main metabolic pathways and cycles with particular regard to carbohydrate, lipid and amino acid metabolism.

Students will learn with knowledge on the main notions on 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 the modes of transmission of hereditary diseases.

Students will learn knowledge related to the physiological and morphological characteristics of cells, as functional units of living organisms.

**Another important goal is to utilize the experimental method to understand the biological mechanisms that regulate life and as a tool for the study of pathological processes.**

### **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 transformation of measure units.
- Know and understand the proper terminology of physics.
- Know and understand the main physical principles and laws concerning electricity, vibration and waves, radiation heat and fluids.
- Apply these concepts to biological and physiological phenomena in living organisms.
- Identify and recognize the physical principles which govern the function of the specific human organs.
- Knowledge of the basic information on the structure and function of the main biological macromolecules
- Knowledge of the basic principles of enzymatic catalysis
- Knowledge of the different metabolic pathways of eukaryotic cells
- Knowledge of the role of different "fuels" in energy production
- Knowledge of the biosynthetic pathways of some molecules of biochemical interest
- Knowledge of correct genetic terminology
- Knowledge of the main inheritance models of monogenic, chromosomal and multifactorial diseases
- Knowledge of the main biological mechanisms that cause hereditary diseases
- Understanding of how to reconstruct family pedigrees and to calculate disease recurrence
- Understanding of the major kinds of genetic testing and their proper use
- Bacteria and viruses.
- The structure and function of biological molecules.
- The differences between eukaryotic cell and prokaryotic cell.
- The approaches and tools to study the cell.

- The cellular compartments and intracellular organelles.
- The physiology of the cell, the movement of molecules, passive transport, active transport, endocytosis (phagocytosis and pinocytosis) and exocytosis.
- The nucleic acids. DNA and RNA. Transcription and translation. Regulation of gene expression.
- The cell cycle.
- The protein biosynthesis.

### **Applying Knowledge and Understanding**

- Apply the principles of physics to selected problems and to a variable range of situations.
- Use the tools, methodologies, language and conventions of physics to test and communicate ideas and explanations.
- Adequately interpret the importance of biochemical processes alterations, as a cause of various pathological conditions.
- Use the acquired knowledge for an in-depth study of aspects related to his future professional activity.
- Capacity to analyse family history and reconstruct pedigrees
- Ability to calculate disease recurrence risk
- Use the acquired knowledge to understand the biological phenomena that regulate life and pathological processes.

### **Communication Skills**

- Present the topics verbally in an organized and consistent manner.
- Utilize a proper scientific language coherent with the topic of discussion.
- Communicate scientific contents in a clear and unambiguous way, using appropriate technical language.
- Use of correct genetic terminology
- Ability to describe the main models of inheritance and the recurrence risk

### **Making Judgements**

- Recognize the importance of an in-depth knowledge of the topics consistent with a proper medical education.
- Identify the fundamental role of a proper theoretical knowledge of the topic in the clinical practice.
- Carry out assessments of the topics covered.
- Ability to synthesize and correlate the various topics
- Critical ability on the use of genetic tests for the molecular diagnosis of monogenic and chromosomal diseases or for the evaluation of genetic susceptibility to complex diseases
- Make assessments, when related to the covered topics.

## **COURSE SYLLABUS**

- Chapter **1**: Introduction, Measurement, Estimating
  - 1.4: Measurement and Uncertainty; Significant Figures
  - 1.5: Units, Standards, and SI Units
  - 1.6: Converting Units
  - 1.8: Dimensions and Dimensional Analysis
- Chapter **14**: Heat
  - 14.1 Heat as Energy Transfer
  - 14.2 Internal Energy
  - 14.3: Specific Heat
  - 14.4: Calorimetry
  - 14.5: Latent Heat
  - 14.6: Heat Transfer: Conduction
  - 14.7: Heat Transfer: Convection
  - 14.8: Heat Transfer: Radiation
- Chapter **15**: The Laws of Thermodynamics
  - 15.1: The First Law of Thermodynamics
  - 15.2: Thermodynamic Processes and the First Law
- **Fluids**
- Chapter **10**: Fluids
  - 10.1: Phases of Matter
  - 10.2: Density and Specific Gravity
  - 10.3: Pressure in Fluids
  - 10.4: Atmospheric Pressure Gauge Pressure
  - 10.5: Pascal's Principle
  - 10.6: Measurement of Pressure; Gauges and the Barometer
  - 10.7: Buoyancy and Archimedes' Principle
- **Vibrations and Waves**
- Chapter **11**: Vibrations and Waves
  - 11.7: Wave Motion
  - 11.8: Types of Waves: Transverse and Longitudinal
  - 11.9: Energy Transported by Waves
  - 11.10: Intensity Related to Amplitude and Frequency
- Chapter **12**: Sound

- 12-1 Characteristics of Sound
- 12-2 Intensity of Sound: Decibels
- 12-7 Doppler Effect
- Electricity and Magnetism
  
- Chapter **16**: Electric Charge and Electric Field
  
- 16.1: Static Electricity; Electric Charge and its Conservation
- 16.2: Electric Charge in the Atom
- 16.3: Insulators and Conductors
- 16.4: Induced Charge; the Electroscope
- 16.5: Coulomb's Law
- 16.6: Solving Problems Involving Coulomb's Law and Vectors
- 16.7: The Electric Field
- 16.8: Field Lines
- 16.9: Electric Fields and Conductors
  
- Chapter **17**: Electric Potential
  
- 17.1: Electric Potential Energy and Potential Differences
- 17.2: Relation Between Electric Potential and Electric Field
- 17.3: Equipotential Lines
- 17.4: The Electron Volt, a Unit of Energy
- 17.5: Electric Potential Due to Point Charges
- 17.7: Capacitance
- 17.8: Dielectrics
- 17.9: Storage of Electric Energy
  
- Chapter **18**: Electric Currents
  
- 18.1: The Electric Battery
- 18.2: The Electric Current
- 18.3: Ohm's Law: Resistance and Resistors
- 18.4: Resistivity
- 18.5: Electric Power
  
- Chapter **19**: DC Circuits
  
- 19.1: EMF and Terminal Voltage
- 19.2: Resistors in Series and in Parallel
- 19.3: Kirchhoff's Rules
- 19.4: EMFs in Series and in Parallel; Charging a Battery
- 19.5: Circuits Containing Capacitors in Series and in Parallel
- 19.6: RC Circuits-Resistor and Capacitor in Series
- 25-11: X-Rays and X-Ray Diffraction
- 25-12: X-Ray Imaging and Computed Tomography (CT Scan)

- 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 ( $O_2$ ,  $CO_2$ ). Coenzymes and vitamins. Enzymes. Introduction to metabolism. Catabolism and anabolism. Glucose catabolism: glycolysis and the Krebs'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.
- Basic Genetics: Definitions of Key Terms: gene, locus, allele, genotype, phenotype, haplotype, homozygous, heterozygous, haploid, diploid, dominance, recessivity, codominance, mutation, polymorphism.
- Principles of Genetic Transmission: Mendel's Genetic Hypothesis, The Monohybrid and Dihybrid Crosses, Segregation in Human Pedigrees, Blood groups Genetics
- Monogenic Inheritance Models: Autosomal inheritance, Autosomal recessive inheritance, X-linked inheritance
- Genetic Risk calculation and pedigrees
- Chromosomes: Structure and Analysis, Chromosomes Pathologies
- Genomic Imprinting
- X-chromosome inactivation
- Mitochondrial inheritance: mitochondrial DNA, pattern of inheritance
- Multifactorial inheritance: polymorphisms, susceptibility genes, gene-environment interaction, association studies
- Pharmacogenomics and Personalised Medicine
- Genetic tests and Counselling
- Life origin. Cell theory. Eukaryotic cell and prokaryotic cell. Bacteria and archaea. Viruses.
- Structure and functions of biological molecules. Carbohydrates, lipids, proteins, nucleic acids. Water and pH.
- How to study cells (light and electron microscopes and the tools of biochemistry)
- Cellular compartments and intracellular organelles (plasma membrane, nucleus, cytoskeleton, endoplasmic reticulum, ribosomes, Golgi complex, mitochondria, chloroplasts, peroxisomes, lysosomes, vacuoles).
- Molecules movement and cells. Passive transport, active transport, endocytosis (phagocytosis & pinocytosis), exocytosis.
- The nucleic acids. DNA and RNA. Transcription and translation. Regulation of gene expression.
- Cell cycle. Types of cell division in prokaryotes and in eukaryotes (mitosis and meiosis).
- Protein biosynthesis.

## **COURSE STRUCTURE**

- The module of Biophysics consists of 14 hours of frontal teaching, divided into 2-hour lessons based on the academic calendar. Attendance is mandatory for at least 75% of the hours, added to all the courses of the integrated course. Before the course, there will be preliminary lessons necessary to the recovery of the mathematical concepts and skills that are necessary prerequisites for a successful development of the Integrated Course.

- The module of Biochemistry is structured in 14 hours of frontal teaching, divided into 1 or 2 hour lessons basing on the academic calendar. Lectures will include theoretical lessons on the topics of the program.
- The module of Medical Genetics is structured in 1 CFU with 14 hours of frontal lessons. Lectures will include theoretical lessons with power-point presentations and exercises (both in groups and alone). The attendance at lectures is mandatory.
- The module of Applied Biology is structured in 14 hours of frontal teaching, divided into 2-hour lessons.

Mandatory attendance.

### **COURSE GRADE DETERMINATION**

The exam of the teaching of Biology, Applied Physics and Biochemistry is comprised of an examination of the modules of BIOPHYSICS, BIOCHEMISTRY, MEDICAL GENETICS and APPLIED BIOLOGY, whose marks are an integral part of the Teaching.

The student can take the exams in a single session or in different sessions of the academic year according to the modalities listed below.

The knowledge and ability to understand, the ability to apply knowledge and understanding, the autonomy of judgment and the communication skills of the student will weigh in the final score as follows 30%, 30%, 30% and 10%, respectively.

**BIOPHYSICS EXAM:** The Physics exam consists of a mandatory written test and an optional oral tests. The written and oral tests are aimed at evaluating both the theoretical knowledge and the student's ability to solve problems. The result of the written test is valid for one academic year. The written test consists of 15 multiple choice questions. Each correct answer gets a score of 2/30, while there is no penalty for wrong answers. Only students who have obtained at least 8/30 in the written test are admitted to the oral test.

Grade less than 8 in the written test: the written test need to be repeated in a following session.

Grade range 8-16 in the written test: the student have to mandatorily perform the oral test.

Grade range 18-30L in the written test: the student can optionally perform the oral test.

The exam grade is established according to the following criteria:

Exam failed: important deficiencies and / or inaccuracies in knowledge and understanding of the topics.

18-20: Just sufficient knowledge and understanding of the subjects.

21-23: Modest knowledge and understanding of topics.

24-26: Good knowledge and understanding of the topics.

27-29: Complete knowledge and understanding of the subjects.

30-30L: Excellent level of knowledge and understanding of the topics.

**BIOCHEMISTRY EXAM:** The Biochemistry exam will consist of a written test with 31 multiple choice questions on all the topics of the program. One point will be awarded for each correct answer and 0 points for each wrong answer or not provided. The final score of the exam will be given by the sum of the scores of each correct answer.

**MEDICAL GENETICS EXAM:** The written test will consist of 20 questions with multiple choice answers, for each correct answer a 1.5 point will be assigned. The final score of the written test will be given by the sum of the partial scores assigned to correct answers. Oral exam is optional. To access the oral exam student must have obtained at least a minimum of 15 points at the written exam (15/30). The minimum score to pass the exam is 18/30.

Student learning will be assessed through a written exam held at the end of the course, in which the student answers to multiple choice questions on topics presented during lectures.

**APPLIED BIOLOGY EXAM:** 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 wrong answers. Only students who have obtained at least a score of 16/30, are admitted to the oral test.

The student can take the exam of Applied Biology in a single exam session or in different sessions of the current academic year.

### **OPTIONAL ACTIVITIES**

In addition to the teaching activity, the student will be given the opportunity to participate in seminars, research internships, department internships and monographic courses. The topics of the activities are not subject to examination. Acquisition of the hours allocated occurs only with a mandatory frequency of 100%.

### **READING MATERIALS**

- Douglas C. Giancoli "PHYSICS: Principles with Applications" Seventh edition or subsequent, Pearson Education. Inc
- Ashok Kumar J. "Textbook of Biochemistry for Nurses" II edition – 2012. I K International Publishing House
- "Medical Genetics" by Lynn Jorde John Carey Michael Bamshad. Edited by Elsevier
- Bruce Alberts, Karen Hopkin, Alexander D. Johnson, David Morgan, Martin Raff, Keith Roberts, Peter Walter. "Essential Cell Biology (Fifth Edition)". W. W. Norton & Company. Published July 1st 2019

The indicated textbook is just a reference. Students are allowed to adopt the book/books of their choice. Additional material will be provided by the instructor.