DEGREE IN MIDWIFERY

Integrated Teaching: BIOLOGY, APPLIED PHYSICS, BIOCHEMISTRY
SSD: FIS/07, BIO/10, MED/03, BIO/13
Credits: 4
Responsible Professor: Cinzia Ciccacci
E-mail: cinzia.ciccacci@unicamillus.org

Module: Applied Physics
SSD: FIS/07
Numbers of credits: 1
Professor: Mariagiovanna Guerrisi
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Module: BIOCHEMISTRY
SSD: BIO/10
Number of credits: 1
Professor: Silvio Naviglio
Email: silvio.naviglio@unicamillus.org

Module: Medical Genetics
SSD: MED/03
Number of credits: 1
Professor: Cinzia Ciccacci
Email: cinzia.ciccacci@unicamillus.org

Module: Applied Biology
SSD: Bio/13
Number of credits: 1
Professor: Laura Pacini
Email: laura.pacini@unicamillus.org

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.
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, biochemistry, medical genetics and biology necessary to the performance of their future activity.
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.
- 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.

- Use the acquired knowledge for an in-depth study of aspects related to his future professional activity.

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

APPLIED PHYSICS

PHYSICAL QUANTITIES: Operational concept of physical quantity. Fundamental and derivative quantities. Scalar and vector quantities. Systems of measurement units. Measurement of physical quantities. Systematic errors and accidental errors. Sensitivity, precision of a measuring instrument.
MOVEMENT: Velocity and acceleration as scalar quantities. Velocity and acceleration as vectors.
THE FORCES: The concept of strength and the principle of inertia. The concept of mass is the second principle of dynamics. The weight force is the acceleration of gravity. The third principle of dynamics. Static balance of a material point. Balancing of a system of forces. Friction. Rigid bodies and center of gravity. Moment of a force with respect to a point. Balance of a rigid body. Definition and equilibrium condition of a lever. Various types of leverage. Levers in the human body.
WORK AND ENERGY: Work of a force. Work and kinetic energy. The concept of energy. Conservative forces (outline). Potential energy.
LIQUIDS: Definition and unit of measurement of pressure. Density and specific weight. Forces acting on a volume of fluid at rest. Stevino Law. Pressure gauges. Pascal's law.
THERMOMETRY and GAS: The concept of temperature. The centigrade temperature scale. Expansion thermometers. Clinical thermometer. Absolute temperature scale. The equation of state of perfect gases.
HEAT AND INTERNAL ENERGY: The concept of quantity of heat. Heat measurement unit. Thermal capacity of a body and specific heat of a substance. Expression of the amount of heat exchanged by a body. The internal energy of a system. The first principle of thermodynamics. Thermodynamic transformations. State changes. Metabolic power. Energy value of food. Temperature control
SOUND: wave phenomena. Elastic and electromagnetic waves. Nature of sound. Wavelength. Sound intensity. Technical applications and biological effects of ultrasound. Ultrasound in medical diagnostics.
THE ELECTRICAL PHENOMENA: The electric charge. Conductors and insulators. Electric field and intensity of the electric field. Coulomb law. Unit of measurement of electric charges. Dielectric constant. Electrical potential and potential difference. Electric capacitors. Electric current and current intensity. The direct current. Energy considerations on electrical circuits. Ohm's law. Electrical resistance and resistivity. Resistance in series and in parallel.

Internal resistance of a generator. The thermal energy connected with the Joule effect. Power absorbed by a device. Electrical Safety
IONIZING RADIATION: Introduction to radiation. Radiation, radioactive decay, law of radioactive decay. Biological half-life. The most common decays and associated radiation. Interaction of radiation with matter and hints of dosimetry

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 (O_2, CO_2). 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

- 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: polimorphisms, susceptibility genes, gene-environment interaction, association studies
- Pharmacogenomics and Personalised Medicine
- Genetic tests and Counselling

APPLIED BIOLOGY

- 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.

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COURSE STRUCTURE

The integrated course consists of 4 modules, each one structured in 14 hours of lesson. The attendance at lectures is mandatory (at least 75% of attendance, calculated on the entire integrated course)

- The module of Biophysics consists of 14 hours of frontal teaching. 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 hours 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 module of Applied Biology is structured in 14 hours of frontal teaching, divided into 2-hour lessons.

COURSE GRADE DETERMINATION

The exam of the integrated course of "Biology, Applied Physics and Biochemistry" consists of an examination of the modules of BIOPHYSICS, BIOCHEMISTRY, MEDICAL GENETICS and APPLIED BIOLOGY, whose marks are an integral part of the Teaching.

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 evaluation is carried out through a written test and an oral test to be taken in the same appeal. The written test is compulsory for everyone and only students who have obtained a mark ≥ 15 in the written test are admitted to the oral test. The written exam consists of 20 multiple choice questions aimed at assessing the theoretical knowledge of the program carried out and two open question aimed at evaluating the ability to summarize and explain clarity. Students who have passed the written test with a vote ≥18 may decide not to take the oral test and accept as a final grade the one obtained in the written test.
Eventual ongoing tests will be communicated by the Professor at the beginning of the course.

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.

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.

OPTIONAL ACTIVITIES

There are no optional activites

READING MATERIALS

Gian Marco Contessa- Giuseppe Augusto Marzo; Fisica applicata alle scienze mediche- Casa Editrice Ambrosiano

Ezio Ragozzino, Elementi di Fisica per studenti di Scienze Biomediche –EdiSES - 2 ediz.

Paul Davidovits: Fisica per le professioni sanitarie- UTET.

Ashok Kumar J. "Textbook of Biochemistry for Nurses" II edition – 2012.I K International Publishing House

"Genetica in Medicina", by Nussbaum, McInnes, Willard. Edises; "Genetica Medica Essenziale" by Dallapiccola, Novelli. Cic editore

"Essential Cell Biology (Fifth Edition)". Casa editrice: W. W. Norton & Company. 2019.The indicated textbook is just a reference. Students can adopt the book/books of their choice. Additional material will be provided by the instructor.