BASI MOLECOLARI DELLA VITA (INV112)

1. language

Italian

2. course contents

Coordinator: Prof. ALESSANDRO LUPI
Year Course: 1st
Semester: 1st
UFC: 5
Modules and lecturers:
- BIOCHIMICA (INV05A) - 2 CFU - SSD BIO/10 - Prof. Alessandro Lupi
- BIOLOGIA (INV06A) - 1 CFU - SSD BIO/13 - Prof. Carmela Giampa'
- FISICA APPLICATA (INV08A) - 1 CFU - SSD FIS/07 - Prof. Massimiliano Papi
- GENETICA APPLICATA (INV07A) - 1 CFU - SSD MED/03 - Prof. Eugenio Sangiorgi

3. BIBLIOGRAPHY

Biochemistry module
T. Bellini. Chimica medica e propedeutica biochimica con applicazioni cliniche Zanichelli 2017
G. Ricciotti, Fondamenti di Biochimica, Ed. Bovolenta, 1997.
Biology module
Eldra P. Solomon, Linda R. Berg., Diana W. Martin) Fondamenti di Biologia, Edises
Hillis D. et al Elementi di Biologia e Genetica, Zanichelli.
Applied physics module
D. Scannicchio, Fisica Biomedica, EdiSES, 2013
Applied genetics module
Hillis D. et al Elementi di Biologia e Genetica, Zanichelli.
It is necessary for the student to have a text, either one of the recommended ones or another text after teacher's approval.

4. LEARNING OBJECTIVES

The course aims to provide students with the necessary skills to know and understand the molecular basis of life and the biochemical processes underlying the functioning of the human organism.
Knowledge and understanding - (Dublin 1) On completion of the course, the student must demonstrate knowledge and understanding of the basics of chemistry (chemical elements and reactions), of biology, of physics and genetics.
Applied knowledge and understanding - (Dublin 2) At the end of the course the student must demonstrate to be able to apply the acquired knowledge of biology and chemistry to interpret and

explain biological phenomena; he must demonstrate that he is able to use what he has learned for the understanding of other disciplines and for practical application in analytical and research laboratories, being aware that this knowledge is fundamental for understanding the application of specific techniques in the field of biomedical diagnostics and research.

Autonomy of judgement - (Dublin 3) At the end of the course the student should be able to independently discuss and critically analyse the cellular and molecular mechanisms underlying life processes. Autonomy of judgement will be stimulated during lectures through discussion of relevant issues. At the time of the examination, the student will also be assessed for the level of autonomy of judgement achieved.

Communication skills - (Dublin 4) At the end of the course the student must be able to expose and explain their knowledge - even to non-expert interlocutors - with logical rigor, proper language and scientific terminology. The student must also be able to recognize and write the structural formulas of the main biomolecules.

Ability to learn - (Dublin 5) At the end of the course the student must be able to evaluate their knowledge and skills and, consequently, to implement and/or update them by independently drawing on texts, scientific articles and online platforms.

5. prerequisites

It is necessary for the student to have a basic knowledge of Mathematics, Physics, Chemistry and Biology.

6. TEACHING METHODS

The teaching of the course consists of lectures with the aid of Power Point presentations (Dublin 1). During the lessons, students are involved in active participation through exercises and discussions (Dublin 2). Students thus begin to acquire autonomy in interpreting the importance of the mechanisms underlying biology and the chemistry of life (Dublin 3); they also acquire discipline-specific terminology and the ability to communicate to others (Dublin 4).

Finally, students are invited to test the subject matter by studying the recommended texts and to express their doubts and curiosity in the following lesson. The disciplines will be taught in order to create the basis and interest for subsequent studies (Dublin 5).

7. OTHER INFORMATION

The teachers are available for information on the course and for clarification on the lessons by appointment via e-mail or, if for short questions, at the end of the lessons.

8. METHODS FOR VERIFYING LEARNING AND FOR EVALUATION

A written examination with multiple-choice questions, possibly supplemented by an oral examination, on the course topics is planned. The student's preparation will be assessed on the basis of the ability to describe biological and chemical processes in a clear and scientifically rigorous manner and to be able to connect the various topics, demonstrating an understanding of

biochemical logic. The student achieves a mark of 30/30 by answering exactly all the questions asked and possibly the praise if the judgement of the Committee is unanimous.

9. program

BIOCHEMISTRY

Atomic structure and periodic table. Electronic configuration. Quantum numbers and orbitals. Isotopes. Radioactive decays. Chemical bonds. Electronegativity. Structure of molecules. Molecules and chemical reactions. Water. Acid-base reactions. Oxidation number. Redox reactions. Thermodynamics: quantities and laws. Law of ideal gases. Aqueous solutions of electrolytes. Definition of mole. Definitions of the concentration of a solution. Colligative properties of solutions. Osmotic pressure and its biological effects. Physiological solutions. Definition of osmolarity. Acids, bases and salts. Acid-base theories. Strong and weak acids. Dissociation constant, pKa. Ionic product of water and pH. Buffer solutions. Properties of the carbon atom. Sp^2 and sp^3 hybridization. Nomenclature, chemical-physical characteristics and reactivity of the main types of carbon compounds: hydrocarbons, alcohols, aldehydes and ketones, esters, carboxylic acids, nitrogen compounds, aromatic compounds. Compounds of biological interest: amino acids, proteins, carbohydrates, lipids and phospholipids, nucleotides and nucleic acids. Enzymes: operation mode and inhibition. Pathologies due to enzyme deficiencies. Main metabolic processes: glycolysis, Krebs cycle, beta-oxidation of fatty acids. Respiratory chain. Oxidative phosphorylation.

BIOLOGY

Discovery of the cells, basic properties and the two fundamentally different classes of cells. The structure and functions of biological molecules (carbohydrates, lipids, protein and nucleic acid). Differences between prokaryotic, eukaryotic cells and viruses. Cellular membrane (function and chemical composition, the movement of substances across cell membrane, diffusion and facilitated diffusion, active transport, exocytosis, endocytosis). Cellular organelles: nucleus, endoplasmic reticulum, lysosomes, golgi complex, mitochondrion and aerobic respiration). The cytoskeleton. The extracellular matrix and cell interactions. Cell division: cell cycle and its regulation. Mitosis and meiosis. Cell signaling pathways. Duplication and transcription of DNA. Translation of mRNA in prokaryotic and eukaryotic cells. Controlling gene expression.

APPLIED PHYSICS

Physical quantities and their units of measurement. Kinematics of the material point. Speed. Acceleration. Gravity acceleration. Circular motion. Dynamics and Newton's laws. Strength, weight, mass. Friction. Fundamental equations of the statics of rigid bodies. Levers. Elastic properties of materials. Elastic deformations, traction, compression, shear and torsion stresses. Momentum and conservation principle. Work, energy and its conservation. Mechanical power. Fluidostatics. Density and pressure. Stevino's law. Pascal's law. Archimedes' principle. Torricelli's experience and blood pressure gauges. Blood pressure measurement. Sphygmomanometer. Fluid dynamics. Bernoulli equation. Torricelli's theorem. Venturi effect. Hydrodynamics of blood circulation. Surface tension. Capillarity. Diffusion. Fick's law. Membranes. Gases and solutions. Osmotic pressure.

Osmosis processes in the biological field. Thermometric scales. Laws of perfect gases. Thermal capacity and specific heats. Phase changes, latent heat, heat propagation. Principles of thermodynamics. Electrostatics. Electrical properties of matter. Coulomb's law. Electric field and electric potential. Electric current and measuring instruments. Electrical resistance. Ohm's law. Operating principle of the electrocardiogram. Magnetic fields produced by electric currents. Electromagnetic radiation. Non-ionizing radiation. Ionizing radiation and interaction with biological matter.

APPLIED GENETICS

Role of genetics in medicine. Mendel’s laws, mendelian transmission; the genetic code; mutations; structure and function of the genes. Exceptions to Mendelian laws. Multifactorial characters. Structure and function of the chromosomes; numerical chromosomal anomalies, structural chromosomal anomalies. Tumor genetics. Invasive and not invasive prenatal diagnosis, clinical indication to pre and post-natal genetic testing.