AI and data mining [1210502]

Offerta didattica a.a. 2026/2027

Docenti: VALERIO GUARRASI

Periodo: Primo Ciclo Semestrale

Obiettivi formativi

The primary goal of the AI and Data Mining course is to equip students with comprehensive knowledge and practical skills for applying artificial intelligence techniques and data mining processes. The course is designed to enable students to extract meaningful patterns, insights, and knowledge from large datasets using various AI methodologies.

Specifically, students will:
• Gain a thorough understanding of the theoretical foundations of data mining and AI techniques, including supervised and unsupervised learning, clustering, classification, regression, and association rule mining.
• Develop the ability to apply machine learning algorithms to analyze and interpret complex datasets, identifying patterns and trends that facilitate decision-making.
• Acquire proficiency in using advanced data mining tools and software, which enables the effective implementation of AI techniques in real-world scenarios.
• Learn to design and execute experimental procedures for data mining projects, including data preprocessing, feature selection, model training, and evaluation.
• Understand the ethical considerations and implications of using AI and data mining across various industries, with an emphasis on responsible and transparent AI practices.
• Explore the integration of AI with data mining in big data environments, focusing on scalability, efficiency, and the management of large-scale data.
• Develop skills in visualizing data and presenting findings in a clear and actionable manner, utilizing appropriate visualization tools and techniques.
• Comprehend the role of AI in enhancing decision support systems, optimizing business processes, and fostering innovation through data-driven insights.
• Gain practical experience through hands-on projects and case studies, applying AI and data mining techniques to real-world datasets to address complex challenges and generate significant insights.

Prerequisiti

It is recommended to pass the final examination in the Fundamentals of Computer Science course before proceeding.

Contenuti del corso

Programming
• Elements of Python: variables and data types, operators, conditional statements, loops, lists, tuples, and sets, dictionaries, functions and data handling.
• NumPy: Fundamental package for numerical computations.
• Pandas: Data manipulation and analysis.
• Matplotlib: Data visualization and analysis.
The Machine Learning Process
• Introduction to the Machine Learning Pipeline: Understanding the steps from data collection to model deployment.
• ML vs. DL: Distinguishing between Machine Learning and Deep Learning.
• Supervised vs Unsupervised Learning: Differentiating the learning paradigms.
Data Preprocessing Techniques
• Training and Test Set Splitting: Allocating data for training and testing.
• Feature Scaling: Standardization and normalization to normalize feature scales.
• Handling Categorical Data: Using dummy variables to encode categorical features.
Regression Models
• Simple Linear Regression: Modeling a linear relationship between two variables.
• Multiple Linear Regression: Extending simple linear regression to multiple predictors.
• Polynomial Regression: Modeling non-linear relationships.
• Overfitting: Understanding bias-variance tradeoff.
• Support Vector Regression
• Decision Tree Regression
• Random Forest Regression

• Model Evaluation: Techniques to assess regression models.
Classification Models
• Logistic Regression: Modeling binary outcomes.
• k-Nearest Neighbors (k-NN): A distance-based classification technique.
• Support Vector Machines (SVM): Advanced algorithm for classification boundaries.
• Kernel SVM: Extending SVM to handle non-linear separation.
• Naive Bayes: Probabilistic classifier based on Bayes' theorem.
• Decision Trees and Random Forests: Tree-based methods for classification.
• Model Evaluation: Techniques to assess classification models.
Validation Techniques
• Holdout and Random Subsampling: Basic techniques for model validation.
• Cross-Validation: Including K-fold and Leave-One-Out strategies.
• Stratified Methods: Maintaining the proportion of categories across folds.
• Bootstrap: Using resampling techniques for model validation.
Hyperparameter Tuning
• Grid Search: Exhaustive search over specified parameter values.
• Random Search: Randomized search over parameters.
Clustering Techniques
• K-Means: A centroid-based clustering algorithm.
• Hierarchical Clustering: Building clusters by merging or splitting them.
• DB-Scan: Density-based spatial clustering.
• Expectation-Maximization: Probabilistic clustering approach.
• Model Evaluation: Assessing the effectiveness of clustering models.
Dimensionality Reduction
• Feature Selection: Techniques including correlation analysis, hypothesis tests, and recursive feature elimination.
• Feature Extraction: Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), and Kernel PCA.
Association Rule Learning
• Apriori: Identifying frequent item sets and association rules in data.
• Eclat: A faster approach based on the Apriori principle.
Deep Learning Frameworks
• Artificial Neural Networks (ANN): Foundations for deep learning models.
• Convolutional Neural Networks (CNN): Specialized deep networks for processing grid-like data.
• Autoencoders: Used for learning efficient codings.
Natural Language Processing
• Bag of Words: A simple representation of textual data.
• Cosine Similarity: A metric used to measure how similar two documents are.
• Word Embedding and Word2Vec: Techniques for representing words in vector space.
• Sequence-to-Sequence (seq2seq) Encoder-Decoder Neural Networks: Used for tasks like machine translation.

Metodi didattici

The course is structured to include frontal theoretical lectures (55%), flipped classes (10%), laboratory exercises with open-source tools (20%), and comprehensive project development in small groups (15%, plus individual work). This format is designed to facilitate the application of acquired knowledge and skills.

Modalità di verifica dell'apprendimento

Knowledge assessment methods and criteria:
Specific learning outcomes are assessed through the development of a project conducted in small groups under the supervision of a teacher, followed by an oral examination. The project involves experimental work, either presented in the classroom or during an oral interview, designed to test the student's ability to use computational models to solve classification, clustering, and regression problems using available software tools for ML methods.
The assessment of the knowledge and skills acquired by each student culminates in a final exam that includes a discussion of the project and the theoretical topics covered in the course. Students are provided with a real dataset and tasked with proposing a solution.
In the experimental work, evaluation criteria include:
• The logic used by the student in approaching the problem.
• The correctness of the identified solution procedure.
• The suitability of the proposed solution, given the expected competencies at the course’s end.
Each criterion is equally weighted in the evaluation of the laboratory test. Achieving at least 60% in these aspects is necessary to obtain a minimum grade of 18. Higher marks are awarded to students who meet all the above criteria comprehensively.
The oral examination tests the student’s understanding of the theoretical foundations of the main computational models for AI and Data Mining. Evaluation during the oral exam focuses on:
• The logic used by the student in answering questions.
• The correctness of the solution procedure.
• The adequacy of the proposed solution relative to the competencies expected by the course's end.
• The use of appropriate technical language.
Like the laboratory test, each of these elements is equally important, and satisfying these criteria by at least 60% is required to achieve a minimum mark of 18. Higher marks are awarded proportionally to students who excel in all

listed aspects.

Criteria for measuring learning and defining the final grade:
The evaluation is out of thirty, with the possibility of awarding honors. The final grade is based equally on the project (50%) and the oral test (50%).
The assessment of each component focuses on:
• The technical quality of the work developed, including external and internal documentation and software coding.
• The collaborative efforts undertaken during the project.
• The proficiency demonstrated during discussions related to the project's development.
For each component, the grading scale is as follows:
• A grade between 18 and 23 indicates that the student has achieved a sufficient level of understanding.
• A grade between 24 and 27 signifies an adequate level of understanding.
• A grade between 28 and 30 reflects a high level of understanding, demonstrating excellent knowledge of all course topics and the ability to logically and coherently connect them.
Honors are awarded to students who demonstrate:
• A high degree of knowledge regarding the course topics and simulation tools.
• Significant autonomy and judgment in their work.
• Exceptional quality in their presentation and exposition.

Testi di riferimento

• Bishop, C. (2006). Pattern Recognition and Machine Learning. Springer.
• Duda, R. O., Hart, P. E., & Stork, D. G. (2012). Pattern Classification (2nd ed.). John Wiley & Sons.
• James, G., Witten, D., Hastie, T., & Tibshirani, R. An Introduction to Statistical Learning with Applications in R. Springer Texts in Statistics.
• Géron, A. (2017). Hands-On Machine Learning with Scikit-Learn and TensorFlow: Techniques and Tools to Build Intelligent Systems. O'Reilly Media.
• Aggarwal, C. C. (2015). Data Mining: The Textbook. Springer.
• Aggarwal, C. C., & Reddy, C. K. Data Clustering: Algorithms and Applications. CRC Press.
• Floreano, D., & Matiussi, C. Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies. MIT Press.
• Notes provided by the lecturer.

Risultati di apprendimento specifici

Applying Knowledge and Understanding
Students should be able to:
• Correctly interpret the main steps of algorithms used in AI.
• Utilize computational models to solve classical classification, clustering, and regression problems.
• Address simple data analysis problems to synthesize new knowledge by implementing straightforward decision systems (e.g., making decisions based on the processing of signals or tabular data).
• Identify the most informative variables for describing a decision problem.
• Use available software tools effectively for applying AI methods.

Making Judgments
Students should be capable of:
• Making appropriate decisions for solving real application cases.
• Assessing the main characteristics of the computational models presented.
• Evaluating the suitability of experimental procedures.

Communication Skills
Students should be able to:
• Draft, present, and explain potential design solutions for real application cases.
• Clearly articulate the contents of the course using appropriate technical language.

Learning Skills
Students should develop the learning skills necessary to undertake further studies with a high degree of autonomy.

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2025)	comune	5	ING-INF/05

Stampa del 16/10/2026

Artificial Organs [1210407]

Offerta didattica a.a. 2026/2027

Docenti: LUISA DI PAOLA

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi
The purpose of the course is to provide students with the working fundamentals of artificial organs based on extracorporeal hemopurification through membrane devices. The first part of the course will provide the fundamentals of mass transfer and the main properties of membranes used in artificial organs. The second part of the course will focus on the application of these fundamentals to understand the operation of main artificial organs of interest – artificial kidney and ECMO – in the clinical practice.
KNOWLEDGE AND UNDERSTANDING ABILITY
The course aims at providing knowledge and consciousness about the operation of extracorporeal-artificial organs – artificial kidney and ECMO – and guide the conscious choose of devices and operation conditions.
APPLICATION ABILITY
The student will be stimulated to develop a critical approach to the analysis of clinical practice of artificial organs on the technological side; the student will be able to use the theoretical knowledge acquired during the course for the analysis and development of practical applications in the clinical practice.
AUTONOMY OF JUDGEMENT
The student will be solicited to independently test the plausibility of the solutions to their problems and develop projects using the knowledge acquired during the course. They will be also stimulated to follow a collaborative approach to reach a continuous improvement of their knowledge and consciousness about the course topics.
COMMUNICATION SKILLS
The student will be encouraged to reach a high level in the communication that will be purposedly evaluated as an essential part of the learning assessment. The correct acquirement of the glossary will be evaluated, providing the student with a strong background for communication in a multidisciplinary team.
LEARNING SKILL
The student will need to develop increasing ability to learn through a methodology of study that makes productive the frequency of lessons and exercises, through active participation in them.

Prerequisiti
None.

Contenuti del corso
1. Mass transfer and balance: The principles mass transport and mass balance, diffusivity, mass transfer coefficients. Mass transfer across different phases (gas-liquid transfer).
2. Fundamentals of Membrane Separations: Definition of the chemical-physical fundamentals for designing membrane technological systems, with a particular focus on applications in the biomedical field. Type of membranes: dense and porous. Elements of biomaterials for membrane in extracorporeal hemopurification devices. Hollow fibers membrane modules: mass transfer across membranes, type of fluxes (co-current and counter-current). Profile of solute concentration in hollow fibers modules.
3. Artificial Kidney: Renal replacement therapy (RRT); Clearance; Membrane-based methods for RRT: hemodialysis, hemodiafiltration, hemodiafiltration; Membrane modules for RRT; Mathematical modeling of hemodialysis; Compartmental modeling for the patient-device system.
4. ECMO: General featues of ECMO devices, operation modes; ECMO membranes; Hollow fibers membrane modules; Mathematical modeling of ECMO operations: chemical reactions of respiratory gases in blood; Mass transport of respiratory gases in ECMO membranes; Microporous membrane wetting; Reaction-diffusion mechanism for respiratory gases transport across ECMO membranes; Effect of membrane wetting in ECMO operations.

Metodi didattici
Teaching will be provided in the form of lectures thought to provide students with basic elements for the operational analysis of the artificial organs in the clinical practice. Practical applications will be shown at the end of the theoretical part of the coures and driving students to independently solve problems and acquire a general understanding of the technology of the artificial organs.
The teaching methods and the verification of learning listed below, may undergo changes during the entire academic year in compliance with any legal provisions issued.

Modalità di verifica dell'apprendimento

Learning level will be assessed through a written trial made up of two small problems to be solved numerically to compute and evaluate main properties of interest in the artificial organs field and one open question to discuss the use of the artificial organs in the clinical practice. Assessment will depend also on communication skills of the student in explaining in a clear and effective way the solution to practical cases under analysis.
The two numerical questions will compose as a whole 15/30 to the final grade (maximum 30/30): the distribution between the two questions will be determined case by case and explicitly communicated during the trial. The open question will cover the spare 15/30. The trial will last three hours. The minimum grade is 18/30, the maximum is 30/30 with honours.

Testi di riferimento

1. Annesini, M. C., Marrelli, L., Piemonte, V., & Turchetti, L. (2017). Artificial organ engineering. Eds. Springer Verlag.
2. Teacher's notes.

Risultati di apprendimento specifici

At the end of the course, the student will be able to apply operational knowledge to a conscious use in the clinical framework of artificial organs.
The student will need to learn how to expose the topics clearly and effectively. It will have to organize the exhibition in a consequential way from the basic knowledge required to develop the subject in a comprehensive way.
The course will pursue the following specific learning outcomes:
1. Comprehending the fundamentals of mass transfer and membrane operations in the framework of the artificial organs based on extracorporeal blood treatment;
2. Applying the mathematical models for the identification of key properties and solve easy mass transport balances;
3. Understanding the technology behind the artificial kidney and the ECMO devices, with a special focus on the relationship between operation conditions and device efficiency.

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2025)	comune	3	ING-IND/24

Stampa del 16/10/2026

Biochemistry [1210203]

Offerta didattica a.a. 2026/2027

Docenti: ALESSANDRO LEUTI, SILVIA ANGELETTI

Periodo: Ciclo Annuale Unico

Obiettivi formativi
The teaching aims at providing the essential knowledge to understand the chemistry behind the main cellular and physiological processes, and the role played by the main organic molecules in these functions. The student will study the structure and function of carbohydrates, lipids, proteins and nucleic acids, and will be introduced to the concept of metabolism and of its regulation in healthy and pathological conditions, while learning the thermodynamics that governs the metabolic fluxes. The course will also feature an application of these concepts to clinical biochemistry, to better understand how these processes are involved in the diagnostic process.

Prerequisiti
A basic knowledge of the cell structure (organelles and compartmentalization) and functions. A basic knowledge of inorganic chemistry concepts such as pH, pKa, solubility, buffer solutions, equilibria, as well as basic concepts of organic chemistry , such as functional groups and species, IUPAC nomenclature and the main reactions of organic molecules.

Contenuti del corso
Biochemistry syllabus

• Water: water structure and properties; hydrogen bonds and other electrostatic interactions; interaction between water and other organic compounds. Colligative properties.
• Amino acids and proteins: structure and function of amino acids. Classification and chemical-physical properties.
• Three-dimensional structure of proteins: primary, secondary, tertiary and quaternary structure of proteins; Ramachandran plot; protein folding.
• Protein Function: collagen, keratin and oxygen-transporting molecules: structure of hemoglobin and myoglobin, saturation, Bohr Effect, homotropic and heterotropic allosteric modulators of hemoglobin.
• Thermodynamics: concept of entropy, enthalpy and Gibbs free energy. - Enzymes: structure and properties of enzymes; catalysis; Michaelis-Menten kinetics; V0, Vmax and Km. Lineweaver-Burk plot. Reversible and irreversible inhibition
• Structure and role of carbohydrates: monosaccharides; oligosaccharides; polysaccharides; O- and N-glycosidic bond; starch; cellulose; glycogen.
• Nucleotides and nucleic acids: structure and functions; DNA and RNA.
• Structure and function of lipids: fatty acids; phospholipids; cholesterol; Eicosanoids and PUFA-derived endogenous signalling lipids.
• Biological membranes and transport.
• Biosignalling:
• Carbohydrate metabolism and its regulation: glycolysis; gluconeogenesis; pentose phosphate pathway; regulation of carbohydrate metabolism; glycogenesis; glycogen breakdown.
• Structural Biology
• Krebs Cycle: the role of pyruvate dehydrogenase, reactions and regulation of Krebs cycle.

• Lipid metabolism: lipoproteins;lipogenesis and lipolysis; beta-oxidation of odd- and even-chain, saturated and unsaturated fatty acids; ketogenesis; biosynthesis of fatty acids, phospholipids and cholesterol; regulation of lipid metabolism.

• Ammino acid metabolism: transamination; oxidative deamination; urea cycle; catabolism of ammino acids;
• Nucleotide metabolism.
• Heme synthesis and catabolism.
• Steroid Hormon biosynthesis
• Water- and fat-soluble vitamins: vitamin B complex and ascorbate, vitamin A, D, E, K; pathologies caused hypovitaminosis.
• Oxidative phosphorylation: chemiosmotic theory; mixed and pure electron transporters; redox loop and proton pump; mitochondrial complexes and ATP-Synthase.
• Examples of metabolic and enzyme-related diseases.
• Biochemistry of human organs: brain and immune system.

Clinical Biochemistry syllabus

• Biomarkers. Characteristics. Laboratory tests and results interpretation. Laboratory test automation: Total Laboratory Automation (TLA).
• Acid-base balance and blood gas. Definition of acids, bases, pH and buffer solution. pH homeostasis. Pulmonary and renal control of arterial pH. Simple acid-base disorders (metabolic and respiratory acidosis, metabolic and respiratory alkalosis. Anion GAP. Compensation. Mixed acid-base disorders. Blood gas analysis.
• Hydro-electrolyte balance. Fluid balance: body water and its distribution in body compartments. Gibbs-Donnan equilibrium. Osmotic pressure. Body water homeostasis: antidiuretic hormone, aldosterone and natriuretic hormone and related disorders from inappropriate secretion: SIADH, diabetes insipidus, hyperaldosteronism and hypoaldosteronism. Dehydration and overhydration. Electrolyte balance: Natremia, hypernatremia and hyponatremia. Kalaemia, hyperkalaemia and hypokalaemia. Chloremia, hyperchloremia and hypochloremia.
• Non-protein nitrogen. Overview of protein catabolism and nucleic acids. Determination of non-protein nitrogen in blood and urine. Blood urea nitrogen, ammonia, uric acid and creatinine.
• Carbohydrate metabolism. Glucose metabolism and hormonal regulation of glucose metabolism. Diabetes mellitus classification: type 1 diabetes, type 2 diabetes, impaired glucose tolerance, secondary diabetes, gestational diabetes, MODY (Maturity Onset Diabetes of the Young).
• Laboratory tests for the diagnosis and monitoring of the diabetic patient: assessment of fasting plasma glucose level, oral glucose loading curve test (OGTT), HbA1c assay, insulin assay, C-peptide assay, glycated hemoglobin and glycated plasma proteins (fructosamines). Laboratory tests in the acute and chronic complications of diabetes: ketonemia and ketonuria, lactic acid dosage, evaluation of acidosis and variation of the anion GAP, albuminuria dosage in diabetic nephropathy.
• Lipid metabolism. Metabolism, classification and composition of lipoproteins. Role of apoproteins in lipoprotein metabolism: apoA, apo B, apoC, apoE. Evaluation of the level of triglycerides, total cholesterol, HDL-cholesterol, LDL-cholesterol. Dyslipidemia and atherosclerosis.
• Blood cell count. Normal value and results interpretation. Laboratory diagnosis of thalassemia, hemoglobinopathies and anemia. Porphyria: disorders of porphyrins
• Hemostasis principles. Bleeding and thrombotic disorders
• Biomarkers in organ failure. The liver, the heart, the kidney, the pancreas
• Serum protein. Electrophoresis and results interpretation
• DNA technology: Large Probes used to detect copy number variations; Small Probes to detect point mutations; DNA Amplification by Polymerase Chain Reaction; Allelic Heterogeneity in the molecular genetic diagnosis; normal polymorphisms used as genetic markers;DNA Microarrays for genetic screening and gene expression analysis; DNA sequencing and Whole-Genome seuqnecing (WGS).

Metodi didattici
Ex-cathedra lectures, reading and interpretation of scientific literature, weekly student counselling.

Modalità di verifica dell'apprendimento
The written exam consists of 25 multiple-choice questions, each with five answer options.
Students who answer correctly at least 15 out of 25 questions (corresponding to a grade of 18/30) will obtain a passing mark and will be admitted to the oral examination.
Each correct answer is worth 1.2 points, while each incorrect or unanswered question is worth 0 points.
The score achieved on the written test will serve as the entry grade for the oral interview.

Testi di riferimento
Biochemistry
• Lehninger Principles of Biochemistry (D.L. Nelson and M.M. Cox) (main text)
• Voet's Principles of Biochemistry (facultative)

Clinical Biochemistry
• Marshall - Lapsley - Day – Ayling. Clinical Biochemistry: Metabolic and Clinical Aspects - With Expert Consult access, 3rd Edition, Churchill Livingstone.
• Michael L. Bishop, Edward P. Fody, Carleen Van Siclen. Clinical Chemistry: Principles, Techniques, and Correlations. Jones and Bartlett Publishers, Inc, 2022
• Michael J. Murphy, Rajeev Srivastava, Kevin Deans. Clinical Biochemistry. Elsevier, 2023

The teacher will provide all the slides used in the lectures, as well as learning objectives of each topic covered in class.

Scientific papers

Risultati di apprendimento specifici

Knowledge and understanding
At the end of the course, the student must be able to describe the structure and general functions of the main organic molecules in human biology, as well as to describe the main pathways that orchestrate the metabolism of carbohydrates, lipids, proteins and nucleic acids, as well as the main elements of clinical biochemistry to which these elements are applied.

Applying knowledge and understanding
At the end of the Course, the student must be able to act to understand the main roles of organic molecules involved in cellular processes, and should be able to describe the connections between different metabolic pathways as they are constantly modulated during cellular homeostasis. He/she/they should be able to apply these concepts to the human pathologies that will be covered during the lectures.

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2025)	comune	12	BIO/10, BIO/12

Stampa del 16/10/2026

Biology [1210101]

Offerta didattica a.a. 2026/2027

Docenti: GIULIA LEANZA

Periodo: Ciclo Annuale Unico

Syllabus non pubblicato dal Docente.

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2026)	comune	9	BIOS-08/A, BIOS-10/A, BIOS-10/A

Stampa del 16/10/2026

Biomechatronics Biomaterials and Telemedicine [1210401]

Offerta didattica a.a. 2026/2027

Docenti: ALBERTO RAINER, DOMENICO FORMICA, ANNA SABATINI

Periodo: Primo Ciclo Semestrale

Obiettivi formativi
This course introduces students to the theoretical and scientific foundations of biomechatronic systems, focusing on their key components, and to the properties of biomaterials—materials designed for interaction with biological tissues. Additionally, students will gain a foundational understanding of healthcare systems and explore emerging approaches in telemedicine.

Prerequisiti
Knowledge on Mathematics, Physics, Electronics, Chemistry is recommended. To facilitate access to the course, at its outset the instructor will conduct a survey to assess students' level of attainment of the recommended prerequisite competences and, together with the students, will identify and evaluate possible reinforcement actions to address any potential gaps through targeted in-depth activities.

Contenuti del corso
Biomaterials Module (A. Rainer)
• Introduction to biomaterials science.
• Host response to biomaterials.
• Mechanical properties and structure-property relationships.
• Elasticity, plasticity, dynamic properties. Corrosion.
• Metallic biomaterials: stainless steel, titanium alloys, cobalt alloys
• Ceramic biomaterials: bioinert and bioactive ceramics.
• Biocompatible polymers.

Biomechatronic Module (D.Formica)
• Introduction to Biomechatronics
• Biomechatronic systems – Case studies and architecture modelling
• Electronic circuits and components
• Semiconductor electronics
• Sensors and Actuators
• Control unit
• Data acquisition in biomechatronic systems.
• Data analysis and reporting.

Telemedicine Module (A.Sabatini, E.Cordelli)
• Healthcare Information Systems and the evolution of telemedicine.
• Electronic Health Records (EHR) and interoperability.
• Medical data governance: informed consent, privacy, and security.
• Remote patient management strategies (short- and long-term).
• Intelligent methods in telemedicine and practical case studies.
• Computer networking basics: networks, OSI/TCP-IP, data link, switches/routers.
• IP network design: addressing plans, subnetting, and VLANs.
• Core protocols and service integration
• Database systems: architecture, ER logical design, relational model, SQL.
• NoSQL and data warehousing; user/clinician interfaces for querying, quantitative analysis, and visualization.

Metodi didattici
Teaching is organized into classroom lectures and laboratory activities. During the multidisciplinary classroom lectures, students will acquire the theoretical knowledge necessary to: i) develop and test a specific device in the bioengineering field; ii) to characterize biomaterials; iii) design digital health solutions for data acquisition, storage, and analysis.In the practical laboratory activities, students will be guided by instructors to apply the fundamentals presented in the theoretical module.

Modalità di verifica dell'apprendimento

Biomechatronics and Biomaterials Module
Students' knowledge and skills will be evaluated through an individual written examination comprising three open-ended questions, designed to assess both theoretical understanding and quantitative reasoning.
Telemedicine
Students' knowledge and skills will be evaluated through a single integrated theory–practice examination comprising closed-ended questions and brief code-writing tasks, designed to assess both conceptual understanding and hands-on problem-solving.
The exam grade will be the weighted average of the grades obtained for each module. Each question will be graded out of 30. An optional distinction ("lode") will correspond to a grade of 31.

Testi di riferimento

• Notes provided by the teacher.
• Alciatore D.G & Histand B. M.(2012). Introduction to mechatronics and measurement systems. New York, NY, USA: McGraw-Hill.
• J. Kurose, K. Ross Pearson, "Reti di calcolatori e Internet. Un approccio top-down", 2017 (7a ed.)
• P. Atzeni, S. Ceri, S. Paraboschi, R. Torlone, "Database Systems concepts, languages and architectures", McGraw-Hill, 1999
• Dee W. Ford, Shawn R. Valenta, "Telemedicine. Overview and Application in Pulmonary, Critical Care, and Sleep Medicine", Humana Cham, 2021
• Joan M. Kiel, George R. Kim, Marion J. Ball, " Healthcare Information Management Systems", Springer Cham, 2022 (5a ed.)

Risultati di apprendimento specifici

Knowledge and understanding
• Understanding the multidisciplinary nature of biomechatronics and its applications in the medical field.
• Understanding relevant problems in developing biomechatronic systems and biomaterials
• Understanding how to select and sizing components for development of biomechatronic devices and biomaterials.
• Understanding the principles of healthcare information systems and telemedicine.
• Understanding the computer networking foundations that enable e-health platforms.
• Understanding modern data management and human–data interfaces

Applying knowledge and understanding
• Capacity to analyze real-world case studies of biomechatronic systems.
• Capacity to model the architecture of biomechatronic systems, understanding the integration of mechanical, electronic, and biological components.
• Capacity to produce preliminary projects of hardware/software sub-models of a biomechtronic systems
• Capacity to analyze real e-health case studies and translate clinical requirements into end-to-end system designs—workflows, data models, and privacy/consent controls.
• Capacity to build and validate a functional prototype: design database schemas and queries, implement APIs, and deliver data visualizations.

Autonomy in judging
Students will be stimulated to develop their analytical and critical skills in the understanding of theoretical concepts, in the identification of solutions for design, development and testing issues and in the evaluation of results of the experimental activities carried out in lab.

Learning skills
Students will learn the ability to autonomously extent the acquired knowledges and to apply and contextualize bioengineering methods to different problems not addressed within the course.

Communication abilities and soft skills
Students will be introduced to the preparation of technical presentations through in-class examples and laboratory activities. Particular attention will be given to the quality of technical communication, with specific reference to the technical language (clarity, effectiveness, appropriateness, and formal correctness) used in the written exam.

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2025)	comune	12	ING-IND/34, ING-INF/05

Stampa del 16/10/2026

Biophysics [1210107]

Offerta didattica a.a. 2026/2027

Docenti: GIOVANNI DI PINO

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi
Students must acquire an adequate knowledge and understanding of the main aspects of cellular biophysics and must comprehend the morpho-functional organization of the musculoskeletal system, mastering the quantitative aspects of the models and the rules that govern its functions.

Prerequisiti
None

Contenuti del corso
[Byophysics and Cell Physiology]

• Control theory (policies and components of control systems, general modelling rules, negative and positive feedback, feedforward controls and their examples, and homeostasis)
• Biophysics (diffusion and transport of solutes and water across the cell membrane)
• Ion channels, transporters, and their kinetics
• Basic electricity physics, resting membrane potential (Nernst and GHK equations), and action potential (experiments and Hodgkin-Huxley model)
• Equivalent RC circuit of the membrane
• Electrical signal conduction in nerve fibers (electrical model of the axon, Kirchhoff's laws, electrotonic conduction, space and time constants, point-by-point regeneration, saltatory conduction)
• Synapses (electrical and chemical), molecular mechanisms of exocytosis and synaptic integration, Hebbian learning and neuroplasticity
• Impulse transmission from nerve endings to skeletal muscle fibers
• Molecular biology of Acetylcholine synthesis and release
• Physiological anatomy of skeletal muscle and the general mechanism of muscle contraction
• Skeletal muscle excitation (neuromuscular transmission, excitation-contraction coupling, and muscle action potential)
• Muscle fiber types and motor units
• Smooth muscle
• Hill's experiment, configuration and model of extrafusal and intrafusal fibers
• Biomechanics of the human body

Metodi didattici
The course objectives will be achieved through a combined approach that integrates traditional teaching methods with innovative educational strategies, thanks to the use of problem-based learning and interactive learning

Modalità di verifica dell'apprendimento
Learning assessment will take place through both written and oral examinations.
The written test is designed to evaluate the knowledge acquired and the understanding of homeostatic control, cellular biophysics, the foundations of neuronal activity, and muscle physiology.
The oral test, on the other hand, will focus on students' communication skills and their ability to critically rephrase and elaborate on the concepts learned. Students will also be required to graphically represent models and relationships between physiological parameters.

The exam will be held at the end of the course, during the sessions scheduled in the academic calendar.
The written test consists of two consecutive steps to be completed on the same day:
• First step (18 points): 18 multiple-choice questions (each correct answer is worth 1 point). The final score is the sum of correct answers. Incorrect answers and unanswered questions are worth 0 points. The maximum score for this step is 18 points. A minimum score of 12 points is required to proceed to the second step. The time allowed for the first step is 45 minutes.
• Second step (12 points): 3 open-ended questions, each with a maximum of 200 words. Students must discuss and elaborate on the studied topics. Some questions may require calculations. Each open-ended question is worth 4

points. The maximum score for this step is 12 points. The time allowed for the second step is 45 minutes.

The final score of the written test (maximum 30 points) is the sum of the scores from both steps.

If the total score of the written test is:
• Below 18/30: the student does not pass the exam.
• Equal or above 18/30 and below 24/30 ($18 \leq x < 24$): the student keeps the written exam score as the final grade for Biophysics.
• 24/30 or higher: the student may choose to keep 24/30 as the final grade without taking the oral test or attempt the oral test to confirm or improve the grade (note: the grade may also be lowered in case of poor performance). The oral test must be taken during the same call and within the same session as the written test.

The final grade for Biophysics is the average of the written and oral (if taken) tests and may reach up to 30 cum laude.

Testi di riferimento
After each lesson, students will be provided with the corresponding teaching materials.

Biophysics and quantitative aspects:
Joseph Feher, Quantitative Human Physiology: An Introduction, II edition, 2016

Organ Physiology (which will be studied mainly during the second year):
Boron and Boulpaep, Medical Physiology, 3th Edition. Elsevier 2016;

Neurophysiology:
Kandel/Schwartz/Jessell, Principles of neural science, VI edition, McGraw-Hill Education 2021.

Risultati di apprendimento specifici
At the end of the course, the student should be able to:
• Describe the mechanisms regulating flow and membrane potential
• Describe the general organization of the human body, with a more detailed understanding of the musculoskeletal system and the anatomical-functional foundations of movement
• Quantitatively model the interaction between the studied physiological parameters, knowing their normal ranges, as well as the methods and technologies used for their assessment
• Understand the main theories underlying the studied physiological functions and their most important experimental foundations

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2026)	comune	4	BIOS-06/A

Stampa del 16/10/2026

Body Structural Organization [1210108]

Offerta didattica a.a. 2026/2027

Docenti: MARIA ZINGARIELLO, GIORGIO VIVACQUA

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi

Starting with the fundamentals of Chemistry, Biology, and Physics, the student must acquire in-depth knowledge and understanding of the organization of the human body from an anatomical, histological, and embryonic development perspective.Furthermore, the student must know the systematic and functional anatomy of the locomotor system and the general organization of the body cavities and various body regions, with particular attention to clinical anatomy aspects.By leveraging the understanding of the embryonic development of the various organs and systems, the student will need to grasp the principles of histogenesis and embryogenesis as an essential prerequisite for understanding the structure of tissues and their organization in the formation of the various organs and systems.Particular emphasis will be placed on the ability to recognize and describe anatomical structures on both real specimens and radiological images, as well as the ability to analyze and describe histological preparations under the microscope.

Prerequisiti

To be eligible to take the Body Structural Organization exam, students must have passed the following exams:
• Biology
• Chemistry
• General Physics

Contenuti del corso

Histology and Embryology:
Cytology: General organization, shapes and sizes of different cell subtypes. The concept of cells specialization and differentiation. Stem cells and pluripotent cells. Biological membranes. Membrane specializations. Cytoplasmic matrix. Cytoplasmic membrane and cytoplasmic specializations. The nucleus and the nucleolus. Chromatin and methodologies for chromatin visualization. Organization and function of the cytoskeleton. Cell junctions and mechanisms of intercellular communications.
- Epithelial tissues: types of epithelial cells, classification of epithelia. Lining epithelia. The skin. The Endothelia. Glandular epithelia: exocrine and endocrine glands: secretion modalities, neuro-endocrine correlations.
- Connective tissues: classification, structural components: protein intracellular matrix and cellular components. Specialized connective tissues: cartilaginous tissue; Bone tissue; blood and Immune tissue: circulating blood cells, serum and plasma, biological mechanisms of coagulation. Hematopoiesis: precursors of blood cells and their maturation and differentiation. Adipose tissues and mechanisms of thermogenesis.
- Muscular tissue: Skeletal muscle structure: endomysium, perimysium. Skeletal muscular cells: sarcomeres and myofibrils, actine/myosin interactions. Sarcolemma, sarcoplasmic reticulum. Extra-myofibrillar cytoskeletal proteins. Mechanism of muscular contraction. Neuromuscular junction. Muscular stems cells. Cardiac muscular tissue: myocardial cells. Gap junctions and inter-cellular communications. Mechanisms of myocardial contraction. Conduction myocardial tissue. Smooth muscular tissue.
- Nervous tissue: white matter and grey matter. The Neuron: size, shape and morphology of different neuronal subtypes. The neuronal cytoskeleton: axons, dendrites and axonal transport. Neuronal membrane and its specializations. Principal classes of neurotransmitters ad their receptors. The synapses: morphological classification and ultrastructure. The glial cells: astrocytes, oligodendrocytes, Schwann cells. Formation and constitution of myelin sheets. Microglia and mesenchymal cells of the central nervous system. Neuronal stem cells and neuronal precursors. Ependymal cells. The peripheral nerve: axonal organization, histological classification of neuronal fibres. Myelin sheets, endonervic and perinervic sheets. Unmyelinated peripheral fibres.
Embryology: Life cycle stages. Gametogenesis. Development of the gonads. Spermatogenesis. Oogenesis. Fertilization. Embryo implantation. Segmentation. Gastrulation. Cellular and molecular mechanisms of cells differentiation. Germ layers and derivatives. Endoderm and formation of primitive intestine. Mesoderm and mesenchima. Notochord formation. Ectoderm and neuro-ectoderm, neuronal crests. Somites. General development of the fetus. Embryonic appendages.

Anatomy:
Overview of the organization of the body. Nomenclature and Anatomical terminology. Superficial Anatomy.

Reference planes. General classification of the organs.
Topographic and superficial Anatomy of the body regions: the head and the neck, the thorax, the abdomen and the pelvis. Clinical importance of superficial anatomy. General organization of the different body regions and of the body cavities.
Locomotor Apparatus. Classification of bones: long bones, short bones and flat bones. Classification of joints. Diarthrosis and sinarthrosis. Classification of muscles. Nomenclature and classification of movements. The skull: splancnocranium and neurocranium. The jaw. Muscles of the head and the neck. Masticatory muscles. The spine: vertebrae. Joints of the spine. Intervertebral disks and ligaments of the spine. The thorax: ribs and sternum. Muscles of the spine, thorax and abdomen: postural muscles, muscles involved in breathing and myo-fascial organization of the abdominal wall. The inguinal region and the inguinal canal. Bones, joints and muscles of the upper limb. Bones, joints and muscles of the lower limb. Principles of kinematic and systematic kinematics of the different joints.
Introduction and general organization of the nervous system.
Cardiovascular layout and blood supply to the parietal regions of the neck, the thorax, the abdomen and the upper and lower limbs.

Metodi didattici

The course objectives will be achieved through a combined approach that includes the traditional teaching method, innovative teaching strategies, problem-based learning, and interactive learning with anatomical specimens and histology slides analysed under the microscope.

Modalità di verifica dell'apprendimento

he acquisition of knowledge and skills will be assessed through a final examination held at the end of the course, during the sessions scheduled in the academic calendar.
The final exam consists of written and oral tests for each module, followed by an integrated oral interview. Emphasis is placed on students' communication skills and their ability to critically reformulate the concepts learned.

Histology and Embriology
The assessment test will consist of an oral exam of histology, including a microscopy assessment to test the student's ability to recognize and analyze a histological specimen. This exam will be preceded by a written test comprising two open-ended questions of cytology and two open-ended questions of embryology.

The final grade in Histology and Embryology will be determined by the grade obtained in the oral exam, averaged with the grade obtained in the written exam. A minimum grade of 18/30 will be considered to pass the exam.

Anatomy
The assessment of learning will consist of an oral exam covering the general anatomy and the locomotor apparatus focused more specifically on the analysis of an anatomical specimen or radiological image, followed by a written test consisting of four open questions about locomotor apparatus, general aspects of cardiovascular and nervous system and kinematics.

The final grade for Anatomy will be determined by the score obtained in the written exam, averaged with the score of the oral exam with the proportion of 6:4.
The exam will be considered passed with a minimum score of 18/30.

The final grade of the course will be based on the weighted average of the two module exams and the performance in the integrated oral exam. The final score may reach up to 30 cum laude or decrease down to 18.

Testi di riferimento

After each lecture, students will be provided with the corresponding teaching materials.

Anatomy

Primary textbook
- Anastasi et al. Treatise of Human Anatomy, Topographic Approach and Atlas. 1st Edition, EdiErmes.

Additional textbooks
- Susan Standring et al. Grey's Anatomy: The Anatomical Basis of Clinical Practice. 41st Edition. Elsevier;

Additional Anatomy Atlas
- Friedrich Paulsen et al. Sobotta Atlas of Human Anatomy. 15th edition. Urban & Fisher (Elsevier);
- Frank H. Netter. Atlas of Human Anatomy. 7th edition. Elsevier.

Embryology and Development
- Keith Moore and T.V.N Persaud et al. The Developing Human. Clinically oriented Embryology. 11th revisited edition. Elsevier.

Histology and Embryology
- Wojciech Pawlina. Histology: A Text and Atlas, International Edition: With Correlated Cell and Molecular Biology. 8th Edition.

- Lippincott Williams & Wilkins
Barbara Young et al. Weather: Histology and Microscopic Anatomy. 6th edition. Elsevier.

- James Lowe and Peter Anderson. Stevens and Lowe's Human Histology. 5th edition. Elsevier

- Larsen's HUMAN EMBRYOLOGY Elsevier.

- Keith L.Moore,T.V.N Persaud et al. BEFORE WE ARE BORN Elsevier.

Risultati di apprendimento specifici
Students will acquire a solid understanding of the general organization of the human body, including both macroscopic, radiological, and clinical anatomy, as well as histological and developmental aspects. This understanding focuses on cellular differentiation and tissue specialization as a basis for understanding physiology and pathology, and embryological development as a basis for understanding histogenesis, anatomical organization, and the relationships between organs.

More specifically, by the end of the course, students should be able to:
• identify, describe, and contextualize anatomical specimens;
• describe radiological images;
• understand the processes of histogenesis and embryogenesis;
• understand cellular differentiation and recognize different cell types, understanding the relationship between structure and function;
• understand the organization, structure, and function of different tissues;
• be able to recognize and analyze histological preparations under the microscope and understand the physical principles of optical microscopy;
• Understand and analyze in detail the musculoskeletal system in its structural, topographical, and kinematic components;
•Understand the general organization of the nervous system and the cardiovascular system.

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2026)	comune	8	BIOS-12/A, BIOS-13/A

Stampa del 16/10/2026

Cancer Medicine [1210503]

Offerta didattica a.a. 2026/2027

Docenti: BRUNO VINCENZI, TEA ZEPPOLA, OMBRETTA ANNIBALI, VALERIA TOMARCHIO, SARA RAMELLA, MICHELE FIORE, GIORGIO MINOTTI, DAMIANO ARCIUOLO, MARCO CARICATO

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi
The course aims to provide students with a comprehensive multidisciplinary overview of modern cancer medicine by integrating the principles of medical oncology, radiation oncology, diagnostic imaging, pathology, molecular biology, and precision medicine. Biological, epidemiological, diagnostic, therapeutic, and supportive aspects of the major solid malignancies will be addressed, with particular emphasis on the integration of local and systemic treatments and on the role of multidisciplinary teams in cancer care.
The course also aims to develop evidence-based clinical reasoning while introducing students to predictive biomarkers, molecular profiling, personalized therapeutic strategies, and selected technological innovations that are contributing to the evolution of contemporary oncology.

Prerequisiti
Students are expected to possess the knowledge acquired in Anatomy, Histology, Physiology, General Pathology, Pathology, Pharmacology, and Diagnostic Imaging. Basic knowledge of general oncology and cancer biology is recommended.

Preparatory exam: Pathology Immunology and Microbiology

Contenuti del corso
• Principles of cancer biology and carcinogenesis
• Cancer epidemiology, prevention, and screening
• Cancer diagnosis, imaging, and staging
• Pathology, molecular pathology, and predictive biomarkers
• Precision oncology and molecular profiling
• Principles of surgical oncology
• Principles of radiation oncology
• Systemic therapies: chemotherapy, immunotherapy, targeted therapies.
• Lung cancer
• Breast cancer
• Gastrointestinal malignancies
• Hepatobiliary and pancreatic cancers
• Genitourinary cancers
• Gynecological malignancies
• Melanoma and skin cancers
• Head and neck cancers
• Primary brain tumors and brain metastases
• Bone and soft tissue sarcomas
• Treatment-related toxicities
• Supportive care
• Cancer survivorship and follow-up
• Principles of clinical research and evidence-based medicine
• Emerging developments in oncology (liquid biopsy, digital pathology, and selected applications of artificial intelligence)
• Multidisciplinary clinical case discussions

Metodi didattici
The course consists of interactive lectures integrated with multidisciplinary clinical case discussions, guided interpretation of radiological images and pathological findings, presentation of international clinical guidelines, and critical appraisal of scientific literature. Representative real-world clinical scenarios will be used to promote the integration of theoretical knowledge with clinical decision-making.

Modalità di verifica dell'apprendimento

The final examination consists of a written test including 20 multiple-choice questions. Students must correctly answer at least 15 questions to proceed to the oral examination. Final assessment will evaluate the student's ability to integrate biological, diagnostic, and therapeutic knowledge into multidisciplinary clinical reasoning. Critical thinking, appropriate scientific terminology, and understanding of evidence-based medicine will also be assessed.

Testi di riferimento

Lecture slides provided by the faculty, international guidelines (ESMO, NCCN, ASTRO, ESTRO), selected scientific publications, landmark clinical trials, multidisciplinary clinical cases, radiological images, pathology teaching material, and additional educational resources available through the Moodle platform.

Risultati di apprendimento specifici

At the end of the course, students will be able to:
• describe the epidemiology, biology, and natural history of the major malignancies;
• understand the principles of cancer diagnosis, staging, and molecular characterization;
• understand the complementary roles of surgery, radiation oncology, and systemic therapies in integrated cancer care;
• understand the role of predictive biomarkers and precision oncology in treatment selection;
• interpret the main diagnostic investigations used in clinical oncology;
• critically discuss evidence-based multidisciplinary treatment strategies;
• apply clinical reasoning to common oncological scenarios;
• recognize the contribution of clinical research and technological innovation to the advancement of modern cancer medicine.

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2025)	comune	19	MED/36, MED/18, BIO/14, MED/08, MED/06, MED/06, MED/15, MED/36, MED/06, MED/15

Stampa del 16/10/2026

Cardiac Diseases [1210306]

Offerta didattica a.a. 2026/2027

Docenti: FRANCESCO STILO, GIAN PAOLO USSIA, MASSIMO CHELLO, RAFFAELE BARBATO, VINCENZO CATANESE, BIANCA ROCCA, MARIAVITTORIA VESCOVO

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi

Cardiac Disease is an integrated course that includes the teaching of cardiovascular diseases and pharmacology. The course aims to address the themes of the individual subjects in a multidisciplinary manner, sharing different views in the approach to diagnosis and therapy, both medical and surgical, to the pathologies under study. This Course provides knowledge and experience through formal lectures and seminars, problem-based and case-based learning, and practical sessions at the bedside or in the simulation center.

Prerequisiti

To follow the course and make a profit from the proposed program, students should have a solid background in basic human anatomy and physiology, general pathology, and semiotics. Furthermore, students wishing to enroll in the course should possess the knowledge and critical understanding of biology, chemistry, physics, and mathematics and the integration of principles across the preclinical sciences.
Organs Anatomy and Physiology, Biochemistry, (Pathology, Immunology and Microbiology strongly suggested)

Contenuti del corso

Cardiology: Physiology of the heart and coronary circulation. Clinical and instrumental diagnostics of the heart and vascular system. Pathophysiology of atherosclerosis and complications. Acute myocardial infarction with ST-segment elevation. Acute coronary syndromes without ST-segment elevation. Stable coronary syndromes. Coronary angiography and indications for coronary angioplasty. Heart failure. Cardiomyopathies. Aortic and mitral valve diseases. Hypertension. Arrhythmias. Cardiac arrest – sudden death. Conduction system disorders. Indications for pacemaker implantation, defibrillator, resynchronization therapy. Pericarditis, myocarditis, endocarditis. Congenital heart pathologies. Pulmonary embolism. Aortic dissection and aneurysms. Cardiac tumors.
Pathology:
Brief overview of cardiac anatomy, histology and myocardial histopathology.
Main myocardial diseases: primary and secondary cardiomyopathies, acute myocardial infarction and myocarditis, with particular emphasis on the role of autopsy and endomyocardial biopsy in diagnosis, etiopathogenetic definition, and assessment of the main patterns of disease progression and complications, including ventricular remodeling, reperfusion injury, sudden death and progression to heart failure; brief overview of rejection in heart transplantation and the main cardiac tumours.

Cardiac surgery: Pathophysiology and clinic of coronary artery disease, including indications and basic techniques of coronary artery bypass grafting. Pathophysiology, clinic and surgical indications of aortic and mitral valve disease. Basic principles of cardiac surgery techniques. Indication for the positioning of mechanical cardiovascular assistance devices and cardiac transplantation. Pathophysiology and surgical treatment of congenital heart defects. Indications and surgical techniques for the treatment of elective aortic pathology and in urgent conditions.
Vascular surgery: Atherosclerosis and principles of hemodynamics. Clinical and instrumental diagnostics of the circulatory system and vascular pathologies. Acute and chronic ischemia of the lower limbs (diabetic arterial disease, Leriche syndrome and Buerger disease). Cerebrovascular insufficiency (subclavian steal syndrome). Acute and chronic mesenteric ischemia. Renovascular hypertension. Aortic and visceral aneurysms. Aortic dissection. Vascular trauma. Venous pathology (insufficiency and thromboembolic disease – deep vein thrombosis and pulmonary embolism). Lymphatic pathophysiology (lymphangitis and lymphedema). Thoracic outlet syndrome. Vascular tumors.
Pharmacology:
General and applied pharmacology of cardiovascular diseases (drugs for Arterial hypertension, Arrhythmias, Heart failure, Ischemic cardiomyopathy). General and applied pharmacology of respiratory diseases (drugs for Asthma, Chronic Obstructive Pulmonary Disease).
Focus seminars will then follow to deepen knowledge of clinically oriented mechanisms of action, main toxicities, overall risk:benefit of each drug or classes of drugs.

Metodi didattici

The course contents will be delivered by integrating the different topics taught using lectures, problem-based and case-based learning, and interactive sessions. The first part of the course will consist of a three-week intensive period of formal lectures and seminars. Afterward, clinical practice sessions will start and integrate with formal teaching and interactive sessions. Students will be required to participate in discussions actively and join the multidisciplinary examination of clinical cases.

Modalità di verifica dell'apprendimento

The final exam will take place on completion of the class, in accordance with the sessions scheduled in the academic calendar. For this course, knowledge acquired and the ability to put in practice each of the topics taught will be evaluated with a written test. Students need to demonstrate adequate levels of whole-round understanding of all topics covered in the course alongside with suitable communication and judgement skills.

Practical test evaluation (clinical skills), written exam and oral exam.

The exam consists of a written and an oral optional test. The preparation acquired during the course will be assessed by administering a test, with equivalent questions based on the teaching modules. Within the test there will be questions of Cardio-Vascular pathophysiology and Pharmacology, there will be examples of clinical cases such as those shown in lessons or dealt with during internships, the ability of critical analysis by the learner will be tested beyond to the patient, developing the most appropriate diagnostic path. In the written test the student will have to demonstrate knowledge of the biological bases that lead to the development and progression of Cardiovascular pathology and states of emergency starting from the genetic, environmental and pathophysiological bases up to the clinical evolution of symptoms. Clinical cases will be included in the written test in order to assess the student's ability to coordinate the diagnostic-therapeutic process of acute patients.
The written test will consist of 60 multiple choice quizzes to be solved in 60 minutes.
The quiz will be divided as follows: 30 questions on Cardiology, 10 questions on Cardiac Surgery, 10 questions on Vascular Surgery, and 10 questions on Pharmacology.
For each correct answer one point will be given, for each wrong answer 0.20 will be deducted. In the end the score will still be calculated out of thirty.
With the written exam you can obtain a maximum mark of 26/30, to obtain higher marks it is necessary to take the oral exam.
The oral test will be carried out immediately after the communication of the scores of the written test or on a subsequent date and it will be possible to take it only if a score equal to or higher than 18 out of thirtieth is obtained in the written test. The grade of the oral exam is made up of the average of the 3 evaluations expressed by the 3 teachers/commissions.

Testi di riferimento

Cardiology:
• Braunwald's Heart Disease: A Textbook of Cardiovascular Medicine. Authors: Braunwald - Mann - Libby - Bonow - Zipes – Tomaselli. Publisher: Elsevier, 11th Edition, 2018; ISBN: 9780323462990
Pathology:
• Robbins, Cotran & Kumar. Pathologic Basis of Disease. 11th Edition. Elsevier.
• Rubin R, Strayer DS. Rubin's Pathology: Clinicopathologic Foundations of Medicine. Wolters Kluwer.
• Buja LM, Butany J. Cardiovascular Pathology. Elsevier.

Cardiac Surgery:
• Master Techniques in Surgery: Cardiac Surgery by Frederick Grover and Michael J. Mack | 10 Mar 2016 Wolters Kluwer
Vascular Surgery:
• Rutherford's Vascular Surgery and Endovascular Therapy, 2-Volume Set, 9th Ed., Elsevier (textbook). By Anton N Sidawy and Bruce A Perler. ISBN Number 9780323427913
• Vascular and Endovascular Surgery: A Comprehensive Review, 9th Ed., Elsevier (textbook). By Wesley S. Moore. ISBN Number 9780323480116
• Comprehensive Vascular and Endovascular Surgery - 2nd Ed., Mosby Ltd. (textbook). By John W. Hallett, Jr., Joseph L. Mills, Jonothan Earnshaw, Jim A. Reekers, and Thom Rooke. ISBN Number 9780323057264
Pharmacology:
• Bertram G. Katzung and Anthony J. Trevor. Basic and Clinical Pharmacology 15th edition. Lange Publishing Co.
• Goodman and Gilman's The Pharmacological Basis of Therapeutics 14th edition. McGraw Hill Publishing Co.

Original and Review articles on specific and interesting topics will be recommended by the teachers during the course.

Risultati di apprendimento specifici

All areas could perform evaluation during flipped classroom testing students on the exposition and the treatment of clinical cases.

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2025)	comune	14	BIO/14, MED/08, MED/11, MED/22, MED/23, MED/11, MED/22, MED/23

Stampa del 16/10/2026

Chemistry [1210102]

Offerta didattica a.a. 2026/2027

Docenti: SARA MARIA GIANNITELLI

Periodo: Primo Ciclo Semestrale

Obiettivi formativi
The course provides an overview of general inorganic and organic chemistry.

Prerequisiti
Prerequisite: none
Basic notions of mathematics and physics.

Contenuti del corso
Introduction remarks: The Scientific Method, Measurements, Scientific Notation, Density, Temperature, Matter and energy, Chemical vs. Physical Changes.
Atoms and Molecules: Dalton's Theory, Bohr Theory, Modern Atomic Theory, Periodic Table, Electronic Structure of Atoms.
Chemical bond: covalent bond, ionic, metallic, Inorganic Nomenclature, hydrogen bond, Electronegativity, Weak interactions.
Chemical Reactions: Mole Concept, Stoichiometry, Types of Reactions, Oxidation-Reduction.
States of Matter: Gas Laws, Intermolecular Forces, Liquids, Solids, Changes of State.
Solutions: Concentration Terms (%w/w, %w/v, v/v %, M, b, N), Colligative Properties.
Chemical Equilibrium: Law of Chemical Equilibrium, Kp, Kc and Kx, van't Hoff Equation, Le Chatelier's Principle.
Solubility Equilibria: Sparingly Soluble Compounds, Kps Concept and Calculations.
Chemical Kinetics: Concepts, Rate Equations, First Order, Second Order, Half-Life, Rate Constants, Energy Profile Diagrams, Activation Energy.
Acids and Bases: Definitions (Arrhenius, Brønsted-Lowry, Lewis), Weak vs. Strong, Hydrolysis, Neutralization, pH, titrations, buffers (e.g. bicarbonate and phosphate buffers).
Electrochemistry: Faraday's Law, Galvanic Cells: Concepts, Cell Diagrams, Anode and Cathode, Half-Cell Reactions, Overall Cell Reactions, Nernst Equations and e.m.f.

Organic Chemistry: Functional Groups and their main reaction mechanisms, Nomenclature, Structural or spatial arrangements of organic molecules, Main classes of organic compounds.

Metodi didattici
Face-to-face lectures (75%, approx. 65 hours).
Exercises on the application to specific problems of the knowledge learned in lectures (18%, approx.16 hours).
Laboratory sessions to teach the work in a chemical laboratory, prepare chemical solutions and see the application of written exercises on solubility, pH, titration (7%, approx. 6 hours).

Modalità di verifica dell'apprendimento
Knowledge and skills will be verified by a multiple choice questions test to be carried out on the University's elearning platform. In the test, the Student will have to answer 30 multiple choice questions in 50 minutes. The Student will receive the result of his test as a score expressed in thirtieths.
In the test, the Student will have to answer 30 multiple choice questions in 50 minutes, of which:
- each question will have 4 answers (A, B, C, D) of which only one is corrected;
- only one answer can be selected for each question;
- points are assigned as follows: 1 (one) point for each correct answer; 0 (zero) points for each incorrect or not given answer.
Each student will receive a different test, randomly assigned by the system.
The tests will be evaluated automatically through the e-learning system, on the basis of preloaded correct responses. The test score will be provided only to each individual student. Correct answers will be also provided and the Commission will be available to discuss the test answers.

Minimum passing grade is 18/30. In the event of a full grade (30/30), the student will have the opportunity to try for an honor grade (cum laude) through a satisfactory answer to a single-question oral test, carried out immediately after the written test evaluation. In the event of an unsatisfactory answer, the final grade could be reduced by up to 3

points.

Testi di riferimento

Face-to-face lectures and exercises are carried out on an electronic whiteboard. The saved whiteboards will be uploaded on the e-learning platform at https://elearning.unicampus.it/.
These whiteboards allow the student to review and deepen the topics covered and transform into knowledge what has been learned in class and into skills and competences what has been done during the exercises.
Teaching materials recommended for independent study by the Student interested in learning more about the discipline (theory and exercises):
- Whitten, Davis, Peck, Stanley, CHEMISTRY, 10th Edition, Cengage Learning.

Risultati di apprendimento specifici

Knowledge and understanding
The course will transfer the following knowledge and understanding to the student:
• the atomic bases of chemistry for the construction of the periodic table of elements and a reasonable prediction about how and why the atoms react;
• the chemical bond and its correlation with the properties of matter; spontaneity and equilibrium of chemical reactions; the main classes of organic compounds and their reactivity.
The student will: understand the meaning of chemical reaction and perform stoichiometry calculations; describe the properties and structure of gas, liquid and solids; understand the kinetic aspects of the chemical transformations.

Applying knowledge and understanding
At the end of the course the student will be able to:
• make predictions on the reactivity of an element based on its position in the periodic table;
• write a formula of Lewis structure by sorting the compounds on the basis of the chemical bond and properties;
• discuss a chemical balance and the factors that influence the reaction with particular attention to the acid/base balance;
• define a species oxidant and reductant;
• write formulas of organic compounds and use them to synthesize other.
The student must also be able to solve stoichiometric problems of practical utility (e.g., calculation moles, balance reactions, limiting reagent, definition and ways of expressing concentration, preparation of diluted solutions).

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2026)	comune	7	CHEM-06/A, CHEM-06/A

Stampa del 16/10/2026

Clinical Neuroscience [1210504]

Offerta didattica a.a. 2026/2027

Docenti: VINCENZO DI LAZZARO, GIULIANO ALBERGO, FRANCESCO MOTOLESE, DOMENICO D'AVELLA, CARLO AUGUSTO MALLIO, GIOVANNI ASSENZA, FRANCESCA FIORI

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi

Clinical Neuroscience is an integrated course that includes the teaching of neurology, neurosurgery and psychiatry. The main objective is to understand the foundations of these fields and move towards the knowledge of the diseases and the basis for medical and surgical treatment.
The course aims to address the themes of the individual subjects in a multidisciplinary manner, sharing different views in the approach to diagnosis and therapy, both medical and surgical, to the pathologies under study. Clinical Neuroscience provides knowledge and experience through formal lectures and seminars, problem-based and case-based learning, and practical sessions at the bedside or in the simulation centre.

Prerequisiti

The correct acquisition of knowledge and understanding of this integrated course requires a good knowledge of anatomy and physiology and students should possess the knowledge and critical understanding of biology, chemistry, physics, and mathematics and the integration of principles across the preclinical sciences. However, there are no prerequisites for other courses.

Contenuti del corso

NEUROLOGY:
The Neurology course is designed to provide a thorough understanding of the scientific basis of the main neurological diseases and how this relates to diagnosis and treatment. By the end of the course, students will be able to explain the basic nature of neurological disease processes from the standpoint of causation, epidemiology, natural history, and the clinical manifestations that result. This will allow the students to clinically assess patients with neurological diseases (symptoms and signs), as well as to interpret invasive and non-invasive instrumental diagnostics (laboratory tests, electroencephalogram, electromyography, motor and somatosensory potentials, neuroradiological exams and angiography). During practical sessions, they will develop further skills in history taking, physical examination, clinical reasoning. The course will also provide the scientific basis of established and novel neurological treatments (pharmacological and surgical) according to the latest guidelines and with a strong translational emphasis. Furthermore, the students will be able to understand and apply the fundamental methods of scientific research within the field of neurological sciences.

History and neurological examination. Cranial nerves: semiology and main syndromes. Motor syndromes: semiology and main syndromes. Sensory syndromes: semiology and main syndromes.
Deep and superficial reflexes: diagnostic significance. Neuro-otology: vertigo, dizziness, spinocerebellar syndromes. Cortical functions and related deficits. Disorders of consciousness, coma and brain death.
Neurophysiological tests (EEG, EMG, evoked potentials), Lumbar puncture: indications and contraindications, Neuroradiological exams (CT, MRI, Angiography and PET), Classification of seizures, epilepsies and epileptic syndromes, Cerebrovascular diseases: hemorrhage and cerebral ischemia, Dementias, Demyelinating diseases, Parkinson's disease, parkinsonian syndromes, dystonia, chorea, Motor neuron diseases, Myelopathies, Encephalitis and meningitis, Peripheral nerve compression syndromes, Polyneuropathies, Myopathies and Muscular disorders, Myasthenia gravis and myasthenic syndromes, Headache syndromes: clinical pictures and differential diagnosis, Diagnosis and treatment of neurological emergencies (intracranial hypertension, stupor and coma, acute spinal compressions, status epilepticus, acute meningoencephalitis, haemorrhages, acute visual impairment), Sleep disorders.

NEUROSURGERY
Prerequisites: Basic knowledge of the anatomy and physiopathology of the Central Nervous System.
The student will have to know the clinical presentation of neurological diseases susceptible to surgical therapy, the diagnostic work-up, and the surgical indication suitable for the specific situation showing that she/he knows the aims of the intervention and possibly proposes alternative approaches. Finally, she/he will have to outline the conditions that require physical and psychological rehabilitation, to indicate the best time to start, to know the theoretical bases and the pathophysiological mechanisms of action, to remember the great human utility and its relapse on the life of the disease by the patient.
The student's assessment will be based on the understanding of the topics during the frontal lessons, lectures,

neuro physiopathology laboratory, observation of surgical procedures, and papers and slides on topics presented in frontal lessons.
Topics include: Intracranial hypertension. Definition of Intracranial System. Concept of "intracranial compliance" Concept of "cerebral self-regulation". Therapy of intracranial hypertension.
Cranio-cerebral trauma. Evaluation of post-traumatic neurological status. Coma state. Assistance and treatment of "severe" cranial trauma. Early complications of cranial trauma (hematomas, etc.). Late complications (hydrocephalus, epilepsy, etc.).
Cerebrovascular diseases of neurosurgical interest. Subarachnoid hemorrhage and intracranial aneurysms. Arteriovenous malformations. Cavernous angiomas. Primary intracerebral hemorrhages.
Neoplastic Pathology of the Central and Peripheral Nervous System. Benign intracranial tumors (diagnosis and anatomic pathology). Primitive and secondary malignant intracranial tumors (pathological diagnosis and anatomy). The surgical treatment of intracranial neoplasms (including the prospects offered by the use of new technologies). Notes on complementary therapies (radiant, chemotherapeutic, genetic).
Expansive pathology of the diencephalo-pituitary region (pituitary adenoma and other non-neoplastic pathology). Anatomy and physiology of the diencephalo-pituitary region. Pituitary adenomas and trans-nasal approaches. Other neoplastic and non-neoplastic pathologies. Neurological syndromes of this region. Benign endocranial hypertension and "empty sella". Hydrocephalus. The genesis of various types of hydrocephalus and their treatment. The circulation of CSF. The obstructive hydrocephalus. The normal pressure hydrocephalus. The child's hydrocephalus.
PSYCHIATRY
General Psychopathology, Schizophrenia Spectrum Disorders, Unipolar, Depression and Anxiety Disorders, Bipolar Disorder, Personality Disorders, Autism Spectrum Disorders, PTSD and Dissociative Disorders, Dual Diagnosis and Addiction, Eating Disorders
MEDICAL IMAGING
The course of medical imaging is intended to foster reasoning and cognitive skills in the process of differential diagnosis of diseases based on images obtained by means of ultrasound, conventional X-ray, Computed Tomography, Magnetic Resonance and Nuclear Medicine techniques.
Problem identification begins with a complete history and physical examination. From the information thus obtained, it is possible to select appropriate imaging procedures that may assist in establishing a diagnosis.
The course will guide the students throughout the challenges of problem-solving with imaging in clinical practice with highlights on image interpretation errors and image artifacts as well as workflow requirements oriented to minimize “finding misses” (false negatives) or “overdiagnosis” (false positives).
During the course, discussion on imaging findings will support differential diagnosis of first approach scenarios and post-treatment imaging changes (expected and unexpected).
Image-guided diagnostic and therapeutic procedures will be theoretically described along with specific indications and technical challenges. Clinical training in the units of diagnostic imaging and interventional radiology will allow the students to verify the acquired knowledge in “real-life” scenarios.

Topics to be covered:
- Imaging of pathologies affecting the Brain, Spine and Neck
- Neuroimaging after surgical, medical and radiation treatment
- Diagnostic imaging and interventional radiology in infectious diseases
- Imaging of inflammatory immune-mediated processes
- Management of allergic reactions to contrast media and risk mitigation

ANATOMIC PATHOLOGY
Pathology of CNS
- Intracranial hypertension.
- Cerebral edema.
- Hydrocephalus.
- Infectious pathology of brain and meninges.
- Vascular diseases (ischemic and hemorrhagic).
- Tumours of CNS.
- Demyelinating diseases.

RADIATION AND MEDICAL ONCOLOGY
Management of low-grade primary CNS tumors and high grade CNS tumors.
Treatment of Brain metastases. Principles of Supportive care and palliation in brain tumors and brain metastases.
Treatment of tumors of PNS (MPNST and others). Spine metastases and their management.
Neurologic paraneoplastic syndromes. Primary brain lymphomas.
Arteriovenous malformation , Acoustic Neuroma and Meningioma, Radionecrosis and medical management

Second part
INFECTIOUS DISEASES
Sepsis, Endocarditis, Meningitis, Encephalitis, Pneumonia, Malaria, Typhus, Cholera, Tuberculosis, Influenza, Diarrhea, Hepatitis, Parotitis, Amoebiasis, Tetanus, Botulism
Herpetic infections, infectious mononucleosis, CMV, Leishmaniasis, HIV/AIDS, Nosocomial Infections, COVID-19

SURGERY:

Surgical infections:
Risk factors for infections in surgical patients; The immunosuppressed patient.
Trauma and sepsis; Interactions between the host and therapy: blood transfusion, blood sugar, nutritional support, thermal homeostasis

Prevention of infections in surgical patients: asepsis and antisepsis. Hand hygiene. Preoperative skin care.
Clean, clean-contaminated, contaminated procedures.
Surgical site infections: superficial, deep, organ/space infections
Wound care, catheter care, vascular lines, role of drains, open abdomen, wound irrigation
Antibiotic use in surgery:
Antibiotic prophylaxis: principles; Antibiotic treatment: principles
Antibiotic choice, Antibiotic toxicity

Clostridium-difficile associated disease
Postoperative pneumonia: prevention and treatment
Urinary tract infections
Intra-abdominal infections: Diverticulitis, appendicitis, bowel perforation from penetrating injury, anastomotic disruption
Skin and soft tissue infections, Fournier gangrene, Vacuum assisted treatment
Fungal infections: prevention and treatment
Surgical tuberculosis
HP disease
Microbioma in the pathogenesis of diseases

IMMUNOLOGY AND ALLERGOLOGY

The Allergy and Clinical Immunology course will focus on the pathogenesis, epidemiology, clinical manifestations, diagnosis, and principles of treatment of autoimmune diseases, allergies, and primary immunodeficiency states. In particular, the following topics will be covered:

-Cellular and molecular mechanisms of immune and allergic diseases;
• Connective tissue diseases:
o Systemic lupus erythematosus;
o Antiphospholipid syndrome;
o Systemic sclerosis;
o Sjogren's syndrome;
o Idiopathic inflammatory myopathies;
o Undifferentiated connective tissue disease;
o Mixed connective tissue disease;
o Overlap syndromes.
• Vasculitis:
o Giant cell arteritis;
o Takayasu arteritis;
o Polyarteritis nodosa;
o Kawasaki disease;
o Microscopic polyangiitis;
o Granulomatosis with polyangiitis;
o Eosinophilic granulomatosis with polyangiitis;
o Cryoglobulinemic vasculitis;
o IgA vasculitis;
o Primary central nervous system vasculitis;
o Behçet syndrome.
• Allergy:
o Asthma;
o Rhinitis;
o Food allergy;
o Drug allergy;
o Insect allergy;
o Urticaria and angioedema;
o Atopic and contact dermatitis;
o Anaphylaxis.
• Primary immunodeficiency states:
o Principles of antibody deficiencies:
• ☐ Common variable immunodeficiency in adults;
• ☐ Selective IgA deficiency;
• ☐ Agammaglobulinemia.
• Principles of chromosomal breakage syndromes associated with immunodeficiency:
• ☐ Ataxia-telangectasia
• Principles of combined immunodeficiencies;

• Principles of phagocytic and complement system disorders;
• Principles of other well-defined immunodeficiency syndromes:
• ☐ DiGeorge syndrome;
• ☐ Wiskott-Aldrich syndromes.

PHARMACOLOGY
General and Clinical Pharmacology of CNS and PNS active drugs, Antimicrobial and antiviral agents
Main anticancer drugs, with emphasis on taxonomy and risk: benefit profile
Principles of development and clinical application of immunomodulating-immunosuppressive agents

Metodi didattici
The teaching methodology will consist of a combination of traditional platform lessons, class seminars, interactive discussion on selected topics or on topics of interest for the students, and practical activities will be performed in the clinics. The students will also be stimulated to select and understand an article from the medical literature and to briefly expose its contents to the whole class.

Modalità di verifica dell'apprendimento
Learning Assessment Methods
Students' learning will be assessed at the end of the course, within the examination period established by the academic calendar, through an examination consisting of both a written and an oral component. The written examination consists of a multiple-choice test, followed by an oral examination for students who successfully pass the written test. The assessment is designed to evaluate the students' acquisition of the knowledge and competencies covered during the course.
Assessment Criteria
The written examination consists of a 30-item multiple-choice test covering the following areas: Neurology (15 questions), Neurosurgery (5 questions), and Psychiatry (10 questions). A minimum score of 18/30 (18 correct answers) is required to pass the written examination.
Students who pass the written examination will proceed to an oral examination consisting of the discussion of a clinical case related to the disorders covered during the course. During the oral examination, students are expected to demonstrate an adequate overall understanding of all course topics, as well as appropriate communication skills and critical judgment.
The final grade will be determined by considering the student's performance in both the written and the oral examinations.

Testi di riferimento
Neurology
Bradley and Daroff's Neurology in Clinical Practice, 2-Volume Set, 9th Edition

Neurosurgery
Ramez Kirollos, Adel Helmy, Simon Thomson, Peter Hutchinson “Oxford Textbook of Neurological Surgery”
Mark S. Greenberg “Handbook of Neurosurgery”

Psychiatry
Kaplan & Sadock’s Pocket Handbook of Clinical Psychiatry (Sixth Edition)

Risultati di apprendimento specifici
Knowledge and understanding
Students must achieve an adequate comprehension and knowledge of neurology, neurosurgery and Psychiatry. Students will learn how different diseases may relate to each other and understand the importance of a multidisciplinary approach to patients.
Applying knowledge and understanding
Students will learn how to build a clinical path that starts from the pathophysiological bases of diagnostics and lands at outlining the optimal treatment based on the specific characteristics of the individual patient.
Making judgments
Students will become independent in clinical reasoning. When confronted with clinical challenges, they should be able to correctly process the available data and propose an adequate sequence of diagnostic and therapeutic interventions.
Communication skills
Students are expected to develop accurate and correct scientific language, which is crucial for an adequate understanding of medical subjects. At the same time, they will develop communication skills to interact with colleagues and patients effectively.
Learning skills
Students will become able to develop and constantly update the knowledge of the subjects under study, with particular reference to the consultation of textbooks, bibliographic material, scientific journals, international practice guidelines, and other information on the web.

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2025)	comune	15	M-PSI/08, MED/25, MED/26, MED/27, MED/37, MED/39, MED/26, MED/27

Stampa del 16/10/2026

Dermatology, Clinical Immunology and Infectious Diseases [1210406]

Offerta didattica a.a. 2026/2027

Docenti: ROBERTO GIACOMELLI, VINCENZO PANASITI, DAMIANO CURRADO, NICOLA PETROSILLO, GIOVANNI MARANGI

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi

CLINICAL IMMUNOLOGY AND RHEUMATOLOGY
The course aims to provide students with knowledge of the pathogenesis, clinical manifestations, diagnostics, and differential diagnosis of major rheumatic, systemic autoimmune, and allergic diseases. Particular attention will be devoted to clinical and translational research methodologies in this field.

DERMATOLOGY
The course focuses on the main concepts of Dermatology that can be relevant for every medical doctor.
During the course, the students would learn the basic principles of main skin diseases and acquire how to analyse skin lesions by non-invasive diagnostic tools such as dermoscopy

PLASTIC SURGERY
The Plastic Surgery course aims to provide students with a comprehensive knowledge of the fundamental principles and main applications of the discipline, both in the reconstructive and aesthetic fields. Particular attention will be paid to understanding the biological mechanisms that regulate tissue healing and to the ability to choose and apply the most appropriate surgical techniques in different clinical contexts.
Students will be guided to acquire the ability to correctly assess conditions that require plastic surgery, to identify the indications and contraindications of various treatments, and to evaluate the expected outcomes, also considering potential complications.
In addition to strictly clinical and surgical skills, the course is intended to develop awareness of the psychological, ethical, and medico-legal aspects of the discipline, thus promoting a global view of the patient and their therapeutic journey. The educational approach will not only focus on the transmission of knowledge but also on the development of critical thinking and clinical reasoning, useful for working in a multidisciplinary team and for providing patient-centered care.

INFECTIOUS DISEASES
To enable students to acquire epidemiological, clinical, diagnostic, and therapeutic knowledge of the main infectious diseases, both autochthonous and imported.

Prerequisiti

CLINICAL IMMUNOLOGY AND RHEUMATOLOGY
Cellular and molecular immunology

DERMATOLOGY
Students must have completed all exams of the 3rd year.
Good knowledge of normal human anatomy, anatomical pathology, human physiology and immunopathology is mandatory.

PLASTIC SURGERY
• Knowledge of Human Anatomy, Histology, and Embryology.
• Knowledge of Physiology and Biochemistry.
• Basic knowledge of General Pathology, Immunology, and Microbiology.

INFECTIOUS DISEASES
Basics of microbiology, immunology and pharmacology.

Contenuti del corso

CLINICAL IMMUNOLOGY AND RHEUMATOLOGY
Connective tissue diseases (systemic lupus erythematosus, antiphospholipid antibody syndrome, idiopathic inflammatory myopathies, Sjögren's disease, systemic sclerosis, mixed connective tissue disease, undifferentiated connective tissue disease)
Vasculitis of small, medium, and large vessels

Rheumatoid arthritis
Spondyloarthritides (axial spondyloarthritis, psoriatic arthritis, reactive arthritis, SpA-IBD)
Crystal arthropathies
Osteoarthritis
Fibromyalgia
Autoinflammatory diseases
DISH (diffuse idiopathic skeletal hyperostosis)
CRPS (complex regional pain syndrome)
Infectious arthritis
Sarcoidosis
IgG4-related disease

DERMATOLOGY
Melanoma and non-melanoma skin cancers
• Alopecia
• Syphilis and other sexual transmitted diseases
• Psoriasis
• Bullous dermatosis
• Eczema
• Lichen
• Urticaria angio-oedema
• Principles of dermoscopy

PLASTIC SURGERY
• Classification and pathophysiology of burns.
• Acute phase management: airway control, fluid balance, infection prevention.
• Local treatments: dressings, escharotomies, debridement.
• Surgical treatment: skin grafts, flaps, advanced coverage techniques.
• Long-term rehabilitation and reconstructive aspects.
• Psychological and social impact of burn patients.

INFECTIOUS DISEASES
• General aspects of infectious diseases. Microorganism-host interaction.
• Main infectious syndromes (respiratory, urinary, intra-abdominal, cardiovascular, central nervous system, bone and bone prosthesis, bacteremia, sepsis)
• Imported infectious diseases
• Healthcare-associated infections
• Basics of antibiotic therapy and antibiotic stewardship
• Principles of infection prevention and control

Metodi didattici
CLINICAL IMMUNOLOGY AND RHEUMATOLOGY
- lectures
- TBLs
- discussions of clinical cases
- lab sessions

DERMATOLOGY
Frontal lessons
Practical sessions
Practical sessions will focus on clinical cases presentations.
Students will be invited to participate at the weekly interdisciplinary meeting on melanoma e non-melanoma skin cancer

PLASTIC SURGERY
• Lectures with multimedia support.
• Interactive clinical case discussions.
• Clinical training in Plastic Surgery wards and outpatient clinics.

INFECTIOUS DISEASES
Lectures
Seminars with clinical case presentations

Modalità di verifica dell'apprendimento
Written exam: 63 single-best-answer question (in 63 minutes)

Testi di riferimento

CLINICAL IMMUNOLOGY AND RHEUMATOLOGY
- EULAR Textbook on Rheumatic Diseases (3rd edition, 2018)
- Harrison's principles of internal medicine (2025)
- Lecture handouts and slides provided during the lectures

DERMATOLOGY
- Dermatology 5th Edition, Autore: Bolognia Schaffer Cerroni, Editor: Elsevier, 2024, ISBN: 9780702082252

PLASTIC SURGERY
• Lecture handouts and slides provided by the instructor.
• Textbook: Grabb and Smith's Plastic Surgery, Kevin C. Chung, ISBN-10: 1975214269 / ISBN-13: 9781975214265, Publisher: LWW, 2024.
• Updated scientific articles from indexed journals.

INFECTIOUS DISEASES
Slides from the lessons
Book: John E. Bennett, Martin J Blaser, Raphael Dolin. Mandell, Douglas and Bennett's Infectious Disease Essentials. Elsevier - Health Sciences Division

Risultati di apprendimento specifici
CLINICAL IMMUNOLOGY AND RHEUMATOLOGY
Knowledge and understanding of the basic pathogenetic mechanisms of systemic autoimmune and allergic diseases;
Knowledge and understanding of the clinical manifestations of systemic autoimmune and allergic diseases;
Ability to manage the diagnostic pathway of a patient affected by systemic autoimmune and allergic diseases;
Knowledge and understanding of the use of the main therapies for systemic autoimmune and allergic diseases;
Ability to apply knowledge and understanding to the analysis of scientific literature in rheumatology and clinical immunology.

DERMATOLOGY
The students must achieve the knowledge of:
1) primary morphology in dermatology
2) nevi and Melanoma
3) non-melanoma skin cancer
4) hair diseases.
5) sexual transmitted diseases
6) inflammatory cutaneous diseases
7) infectious skin diseases

PLASTIC SURGERY
At the end of the course, students will be able to:
• Understand the basic principles of reconstructive and aesthetic plastic surgery.
• Assess the main surgical indications.
• Recognize and manage the most common complications.
• Integrate theoretical knowledge with clinical practice.
• Collaborate effectively in a multidisciplinary team.

INFECTIOUS DISEASES
At the end of the course, the student will be able to know symptoms, clinical signs and functional changes of each infectious pathology treated, in addition to the main instrumental and laboratory diagnostic pathways, and the fundamentals of therapy and prophylaxis of the infectious pathologies treated.

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2025)	comune	11	MED/16, MED/17, MED/19, MED/35, MED/16, MED/17, MED/19, MED/35

Electronics [1210303]

Offerta didattica a.a. 2026/2027

Docenti: GIORGIO PENNAZZA

Periodo: Primo Ciclo Semestrale

Obiettivi formativi
To provide students with the basic knowledge about electronic components and devices, methodologies for circuit analysis, and on the analog and digital topologies used in the most common IC.

Prerequisiti
No preparatory.
Suggested prerequisites: basic knowledge of electrical quantities, electronic components and circuit calculation strategies

Contenuti del corso
INTRODUCTION (6 h)
STC Circuits

SEMICONDUCTORS, DIODE AND TRANSISTOR (12 h)
Semiconductors. Diode. Circuits with diodes. BJT and MOSFET: I-V characteristics, functioning as an amplifier and logic inverter.

ANALOG INTEGRATED CIRCUITS (2 h)
Operational Amplifier. Feedback.

INTRODUCTION TO DIGITAL ELECTRONICS (7 h)
The inverter; logic family; A / D and D / A conversion. Combinatory circuits. Sequential circuits. Microcontrollers.

Metodi didattici
Lectures presenting the basic topics of electronics, the functioning of the fundamental devices and the most common circuit topologies (12 h).

Practical training using simulation SW and during laboratory session to show the application to specific real problems (12 h).

Workgroups in lab for testing simple electronics circuits (13 h).

Modalità di verifica dell'apprendimento
The Knowledge assessment methods will be based on oral tests.
This strategy for oral test will allow the verification of the student's communication skills regarding the specific topics of the course. The oral exam will take place gradually, allowing to verify the consolidation of basic knowledge and, gradually developing the required topic, allowing the student to demonstrate her/his ability to generalize the operation to more complex systems and apply this knowledge to the resolution of real simply problems.

The knowledge and skills acquired will be verified by means of a test structured into two moments in the context of a single oral test: a written question in which the student will have to demonstrate her/his mastery of the fundamental topics for which she/he will have 30 minutes; the content of this work will be presented by the student at the beginning of the oral exam (score from 0 to 15); a second question with which the student will be asked to apply their knowledge to the solution of a real problem (score from 0 to 15). The final mark out of thirty will be the sum of the two scores obtained in the two steps above.
The minimum sufficient mark to pass the exam, equal to 18/30, can be achieved by the student who will have demonstrated knowledge of the components and circuits presented in the course, knowing how to explain them in their most basic contents.

Testi di riferimento
Material provided by the teacher

Suggested texbooks

The Art of Electronics
Paul Horowitz, Winfield Hill
Cambridge University Press, Third Edition (2015)

Risultati di apprendimento specifici

Applying knowledge and understanding
The acquired knowledge will give the student the ability to engage in a conscious and proactive way with the latest and most common IC and electronic technologies used in her/his professional field.
Making judgements
The student will gain the ability to enrich his/her knowledge thanks to his/her skill in reading ant interpreting technical documentation (e.g. datasheets).
Communication skills
The student will have to develop the ability to communicate, in a synthetic way and in general terms, the functioning of a component or an electronic circuit and to justify the choices made.
Learning skills
The student will be able to expand his knowledge thanks to the ability to read and interpret the technical documentation.

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2025)	comune	3	ING-INF/01

Stampa del 16/10/2026

Endocrinology and Metabolism [1210405]

Offerta didattica a.a. 2026/2027

Docenti: NICOLA NAPOLI, DARIO TUCCINARDI, DOMENICO BORZOMATI

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi
The course provides a comprehensive and academically rigorous framework for studying endocrine and metabolic disorders, from molecular and physiological mechanisms to clinical management and technological innovation. Endocrinology is presented as a paradigmatic multidisciplinary discipline, interconnected with many specialties through shared pathophysiological pathways and integrated models of care. Focus is given to endocrine–organ interactions (cardio–reno–metabolic continuum, bone and mineral metabolism, gonadal physiology, metabolic and bariatric surgery). The course addresses new pharmacological agents for diabetes and obesity, biomedical technologies (CGM, artificial pancreas, DXA, HR-pQCT, QCT, elastography, thermoablation, HIFU, tele-endocrinology, organoids) and medical nutritional therapy. A distinctive component is the use of the simulation room for endocrine emergencies and hands-on technology practice.

Prerequisiti
Anatomy and physiology of endocrine systems- Basic pathophysiology and pharmacology

Contenuti del corso
Module 1 – Endocrinology and Metabolism (MED/13 – 3 CFU – 62.5 hours)• Frontal teaching (37.5 h): hormonal signaling and circadian rhythms; pituitary disorders (Sheehan, acromegaly, prolactinomas); neurohypophyseal disorders (diabetes insipidus, SIADH); thyroid disorders (Graves', Hashimoto's, goiter, cancer); parathyroid and calcium-phosphate metabolism; adrenal disorders (Addison, Cushing, pheochromocytoma); pancreatic disorders (T1/T2 diabetes, MODY, insulinoma); gonads (PCOS, Turner, Klinefelter, hypogonadism); obesity and phenotyping; osteoporosis; dyslipidemia; autoimmune polyendocrine and MEN syndromes; medical nutrition therapy.• Clinical practice (25 h): simulation labs in CUBO (DKA, Addison crisis, HHS, hypoglycemia, hypocalcemia), device use (CGM, pumps, closed-loop), digital tools, outpatient rotations, scientific paper reading and medical writing.Module 2 – Bariatric and Endoscopic Surgery (MED/18 – 2 CFU – 37.5 hours)• Frontal teaching (12.5 h): bariatric surgery (indications, outcomes, techniques), endoscopic obesity treatments (balloons, ESG, DJBL), device innovation lab, procedural simulation.• Clinical practice (25 h): observation of surgical/endoscopic procedures, perioperative case discussions, industry guest lectures, usability testing in CUBO.

Metodi didattici
Frontal lectures- Clinical simulation- Device handling and usability labs- Case-based discussions- Research proposal development- Group innovation projects with final pitch

Modalità di verifica dell'apprendimento
Oral exam based on discussion of clinical cases- Active class participation

Testi di riferimento
Pozzilli – Handbook of Endocrinology and Metabolic Diseases (2023)- Williams Textbook of Endocrinology, 15th Edition- Igaz P. – Practical Clinical Endocrinology Textbook (2021)

Risultati di apprendimento specifici
By completing the course, students will be able to:- Acquire knowledge of hormonal axes and endocrine diseases- Interpret hormone assays, laboratory diagnostics, imaging and genetics- Understand phenotyping and therapeutic options (nutrition, pharmacology, endoscopy, surgery)- Use endocrine and metabolic technologies- Apply medical nutritional therapy- Simulate and manage endocrine emergencies in high-fidelity environments- Collaborate across multidisciplinary teams

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2025)	comune	6	MED/13, MED/18, MED/13, MED/18

Stampa del 16/10/2026

English Language [1210109]

Offerta didattica a.a. 2026/2027

Docenti: ADAM JAMES MARTIN

Periodo: Ciclo Annuale Unico

Obiettivi formativi
The course reinforces level C1 general English and starts the study of the scientific terminology focusing on medical presentations.

Prerequisiti
NONE

Contenuti del corso
The course focuses on level C1 general English and on the ability to talk about medical topics.

Metodi didattici
The whole course is taught through frontal lessons. Students will also work in groups on projects...

Modalità di verifica dell'apprendimento
The final exam is a level C1 written test

Testi di riferimento
The material will be provided by teachers.

Risultati di apprendimento specifici
By the end of the course, students will be able to talk about medical topics with the proper technical scientific language.

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2026)	comune	4	ANGL-01/C

Stampa del 16/10/2026

Fundamentals of Computer Science [1210105]

Offerta didattica a.a. 2026/2027

Docenti: LUCA VOLLERO

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi
Introduction to the organization and use of a computing system, with special focus on problem solving through computer programming.

Prerequisiti
Besides the prerequisites required for accessing the Laurea programme, it is requested knowledge about the notions concerning vectors and matrices which is acquired in the course of Mathematics. Also, the ability to interact with a computer system as a user is a prerequisite.

Contenuti del corso
Elements of computer architecture and data representation. Structure and components of a computer system. Number systems: binary, octal, and hexadecimal; conversions between bases. Representation of numerical and alphanumeric data. Computer arithmetic. Boolean algebra: fundamental logical operators, truth tables, logic gates, and elementary combinational circuits. (20 hours)

Computational thinking and problem solving. The concept of an algorithm and its properties. Flowcharts and pseudocode. Systematic approaches to problem decomposition and solving. Intuitive introduction to computational complexity. (10 hours)

The Python language: fundamentals. Compiled and interpreted languages. Structure of a Python program; interactive development environments. Elementary data types and arithmetic/logical operators. Input/output instructions. Control structures: selection and iteration. Functions and parameter passing. (20 hours)

Metodi didattici
Lectures/flipped classrooms, and practical exercises (total of 40 hours, with 30% devoted to present examples and develop exercises).
Laboratory sessions to teach the use of software tools needed for Python programming and to develop exercises (22.5 hours).

Modalità di verifica dell'apprendimento
The knowledge and skills acquired during the course will be assessed through a quiz consisting of 32 multiple-choice questions. The questions cover the entire course syllabus and are designed to verify:
– knowledge and understanding of the fundamentals of computer architecture, number systems, data representation, and Boolean algebra;
– the ability to apply computational thinking and problem-solving techniques to decompose and solve algorithmic problems;
– the capacity for independent reasoning in the analysis of algorithms, pseudocode, flowcharts, and Python code fragments;
– communication skills in the correct interpretation of technical questions presented in written form;
– learning ability demonstrated through the progressive acquisition of Python syntax and control structures.

The final grade is expressed out of 30. The exam is passed with a minimum score of 18/30.

An optional oral examination is also available, which students may request upon completion of the written test. The oral exam covers the theoretical topics of the course and may result in an adjustment of the final grade.

Testi di riferimento
Lecture notes, Powerpoint presentations, exercises, freely distributed in electronic format at http://elearning.unicampus.it/.

The contents of the course can be found in English in the following textbooks:
• J. Hunt, "A Beginners Guide to Python 3 Programming", Springer

Risultati di apprendimento specifici

Knowledge and understanding.
The course will transfer the following knowledge and understanding to the student:
• Knowledge and understanding of basic elements of computer architectures
• Knowledge of user interfaces for interaction with a computing system
• Knowledge of data representation and storage in computer systems
• Knowledge of one programming language that support modular development and reuse of software
• Knowledge and understanding of basic principles of Object-Oriented Programming

Applying knowledge and understanding.
At the end of the course the student will be able to:
• Manage data and software applications in a standard computing environment
• Understand how to employ reusable software components from available documentation
• Use a programming language to design simple algorithms for data processing
• Develop data processing applications assembling reusable software components

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2026)	comune	5	IINF-05/A

Stampa del 16/10/2026

Gastrointestinal Diseases [1210403]

Offerta didattica a.a. 2026/2027

Docenti: FRANCESCO MARIA DI MATTEO, GIANLUCA ANDRISANI, DOMENICO BORZOMATI, FILIPPO CARANNANTE, GIORGIO MINOTTI, DAMIANO ARCIUOLO, ROSARIO FRANCESCO GRASSO

Periodo: Primo Ciclo Semestrale

Syllabus non pubblicato dal Docente.

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2025)	comune	10	BIO/14, MED/08, MED/12, MED/18, MED/36, MED/12, MED/18

Stampa del 16/10/2026

General Physics [1210103]

Offerta didattica a.a. 2026/2027

Docenti: ALESSANDRO LOPPINI, MARCO CAMPETELLA

Periodo: Ciclo Annuale Unico

Obiettivi formativi
The course aims to provide knowledge about the fundamentals of classical mechanics, thermodynamics and electromagnetism and give a basic knowledge of physical laws. The primary learning objective is the development in the student of the ability to grasp the essential aspects of physical processes, framing them with coherent descriptive and quantitative mathematical models related to biomedical engineering applications.

Prerequisiti
To access the final exam, passing the Mathematics exam is required.
Basic knowledge of calculus and algebra is also required to follow the course effectively.

Contenuti del corso
Modulus 1 (1st Semester)
- Introduction. Physical quantities, measurement units systems. Scalar and vector quantities.
- Kinematics in one and two dimensions. Displacement, velocity, acceleration. Motion at constant acceleration. Falling body. Circular motion. Projectile motion.
- Single particle dynamics: Newton's laws. Inertia principle. Mass and force. The second and third laws of motion. Inertial and non-inertial reference systems. Weight force. Constraints and contact forces. Strings and springs. Friction. Drag forces
- Work and kinetic energy. Conservative forces and potential. Conservation of mechanical energy. Impulse and linear momentum. Systems of particles. Center of mass.
- Conservation of linear momentum. Kinetic energy of a system. Collisions.
- Rotations and rigid bodies dynamics. Torque. Moment of Inertia. Rotational kinetic energy. Rigid body rotation with fixed axis. Rolling motion. Static equilibrium. Elastic properties of solids.
- Angular momentum and conservation of angular momentum. Newton’s law of gravity and gravitational field. Kepler’s laws.
- Oscillations. Harmonic motion. Damped oscillations. Driven oscillations and resonance.
- Fluids. Density and pressure. Stevin's law. Buoyant force and Archimedes' principle. Fluids in motion: inviscid fluids and Bernoulli equation. Torricelli's law. Viscid fluids and Poiseuille's law.
- Thermodynamics and thermodynamic systems. Equilibrium states. Temperature and Kinetic theory of gases. Thermal equilibrium and thermometers. Zero law of thermodynamics. Ideal gases. Heat and specific heats. Latent heat. Thermodynamic processes. Work. Joule's experiment and first law of thermodynamics. Internal energy. Transfer of heat. Heat engines and the second law of thermodynamics. Thermodynamic cycles. Carnot engine. Irreversibility and Entropy.

Practical sessions on selected problems will be delivered for a total of 24 hours.

Modulus 2 (2nd Semester)
- Electric charge. Conductors and insulators. Coulomb's law. Electric field of discrete charge distributions.
- Electric field of continuous charge distributions. Gauss's law.
- Electrostatic potential energy and electric potential. Capacitance and capacitors. Electrical energy. Batteries.
- Electric current and Direct-Current circuits. Ohm's laws. Kirchhoff's rules. Combination of capacitors and resistors. Joule's effect. RC circuits.
- Magnetic force on moving charged particles, straight current-carrying wires and current elements. Torques on current loops. Hall effect.
- Sources of magnetic field. Biot-Savart law. Gauss's law for magnetism. Ampère's law.
- Magnetic flux. Induced electromotive force and Faraday's law. Len's law. Inductance. Magnetic energy. RL circuits.
- Displacement current and Maxwell-Ampère law. Maxwell's equations in integral and local form. The wave equation for electromagnetic waves. Electromagnetic spectrum.
- Properties of light. Reflection and Refraction. Polarization.
- Geometrical optics: lenses, mirrors, optical systems.

Practical sessions on selected problems will be delivered for a total of 16 hours.

Metodi didattici
Theoretical and practical lectures focused on the topics of the course. Teaching methods involve frontal lectures, slides and whiteboard.

Modalità di verifica dell'apprendimento
Methods and Criteria for Learning Assessment:
Learning is evaluated through two written tests designed to assess the student's preparation on the theoretical and practical topics presented during the course. The first test focuses on the content of the first module (Mechanics and Thermodynamics) and it will be delivered at the end of the first semester. The second test is focused on the content of the second module (Electromagnetism and Optics) and it will be delivered at the end of the second semester. Each test lasts 2 hours and 30 minutes and includes 4 practical problems and 2 theoretical proofs on physical laws presented in class. Problems solution and theoretical proofs must be carried out by explicitly detailing all the mathematical steps required to derive the final results. Following each written test, in case of a grade equal or greater than the minimum score to pass, the student may take an optional oral exam. The oral exam grade will be considered as the final one. If the student fails the oral exam or rejects the final grade, the written test will be invalidated.

Criteria for Measuring Learning and Assigning the Final Grade:
The final grade is calculated based on the results of the exams related to each module. Each problem and theoretical proof is evaluated with a minimum of 0 points and a maximum of 5 points, depending on the correctness of the solution and the clarity of the mathematical steps. The maximum score is 30 for each module. To pass the exam, a minimum score of 18 is required on each test. The final grade will be computed as the weighted average of the scores of the exams related to the two modules. Cum Laude is awarded at the discretion of the lecturers in case of maximum score and particular clarity and completeness in the exposition of the topics.

Testi di riferimento
- Slides and material produced by lecturers and uploaded on the e-learning platform.
- Suggested textbooks: Physics for Scientists and Engineers, Extended Version. 6th Edition, 2020. Paul A. Tipler, Gene Mosca. Macmillan.

Risultati di apprendimento specifici
Knowledge and understanding
Students will achieve an adequate knowledge of physical laws and related mathematical aspects on broad aspects of classical physics, including:
- Kinematics and Newtonian dynamics.
- Fluids.
- Calorimetry and thermodynamics.
- Electromagnetism and geometrical optics.

Students will learn methodological-operational aspects of physics to interpret and describe medical and engineering problems.

Applying knowledge and understanding
At the end of the course, students will be able to correctly use theoretical knowledge to solve for practical problems and applications. Students will be able to interpret physical laws and apply them in different fields typical of medical and bioengineering applications.

Making judgments
At the end of the course, students will be able to combine the acquired theoretical knowledge and practical experience to assess and analyze physical phenomena, by making assumptions and decisions in a consistent and reasoned way.

Communication skills
Students will develop the ability to describe physical laws at different levels of detail. In particular, they will be able to use both a proper technical vocabulary and calculus skills to explain physical processes and the models behind them.

Learning skills
The class will provide individual skills in learning new topics by working on the basic knowledge acquired during the lectures. Students will acquire the capacity to learn advanced details on the topics presented and to extend their knowledge on further aspects of modern physics and on biomedical and bioengineering applications.

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2026)	comune	12	PHYS-06/A, PHYS-03/A, PHYS-06/A

Stampa del 16/10/2026

Patologie Genitourinarie [1210404]

Offerta didattica a.a. 2026/2027

Docenti: ROCCO PAPALIA, FRANCESCO PRATA, SANDRO FERIOZZI, MARIAVITTORIA VESCOVO, ROSARIO FRANCESCO GRASSO, ROBERTO ANGIOLI, CORRADO TERRANOVA, GIORGIO MINOTTI

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi

The course aims to provide students with an in-depth and updated understanding of the major diseases affecting the genitourinary system. Through an integrated and multidisciplinary approach, students will acquire theoretical knowledge and practical competencies related to the epidemiology, pathophysiology, diagnosis, and both medical and surgical treatment of common urological conditions, with particular focus on urological oncology, emergencies, and functional disorders.
A significant component of the course will address the application of medical technologies, with emphasis on minimally invasive and robotic surgery, complex reconstructive procedures, intraoperative imaging, and an introduction to augmented reality and artificial intelligence in surgical practice. The course is designed to foster clinical reasoning, decision-making skills, and a multidisciplinary approach to patient care.

Prerequisiti

To attend the course and benefit from the proposed program, students should have a solid background in human anatomy, physiology, general pathology, and semiotics, with particular reference to the genitourinary system. Furthermore, students wishing to enrol in the course should possess knowledge and critical understanding of biology, chemistry, physics, and mathematics, as well as the ability to integrate principles across the preclinical sciences.

Contenuti del corso

The course provides a systematic overview of the main diseases of the genitourinary system, with particular focus on urological oncology and the technological and surgical aspects of their management. Theoretical lectures, clinical case discussions, and interactive activities will be organized as follows:
1) Urological oncology
• Prostate cancer
• Kidney cancer
• Bladder cancer
• Upper tract urothelial carcinoma
• Testicular cancer
• Penile cancer
• Diagnostic approach and staging
• Therapeutic options
• Principles of robotic oncological surgery (radical prostatectomy, nephrectomy, cystectomy with intracorporeal neobladder reconstruction)
2) Technology and innovation in urology
• Minimally invasive and robotic surgery
• Intracorporeal neobladder
• Main robotic platforms and their application in urology
• Artificial intelligence and augmented reality in urological surgery
• Multidisciplinary discussion of clinical cases
3) Functional disorders
• Benign prostatic hyperplasia
• Ureteropelvic junction obstruction
• Voiding dysfunctions
4) Infectious diseases
• Urinary tract infections
• Prostatitis and chronic pelvic pain syndromes
• Epididymo-orchitis
5) Urinary stone disease
• Diagnosis and management of renal and ureteral lithiasis
• Endourological and minimally invasive treatments
6) Urological emergencies
• Renal colic

• Urinary retention
• Testicular torsion and acute scrotum
• Priapism

Metodi didattici

The course adopts an integrated teaching approach that combines lectures, problem-based learning (PBL), case-based learning (CBL), and interactive sessions. Theoretical teaching runs in parallel with clinical and practical training, actively involving students in guided discussions and multidisciplinary evaluations.
Real clinical cases, decision-making simulations, digital tools, and innovative technologies in surgery and diagnostics will be used to promote dynamic, participatory, and clinically oriented learning.

Modalità di verifica dell'apprendimento

Student learning will be assessed through two mandatory components: a written test and an oral exam.
The written test will consist of multiple-choice questions designed to assess the student's knowledge and applied understanding of the topics covered during the course, with particular attention to urological oncology, functional disorders, infectious diseases, urinary stone disease, urological emergencies, and technologies applied to robotic and minimally invasive surgery. Questions based on representative clinical scenarios will be included to evaluate the student's ability to apply acquired knowledge to practical clinical contexts and to develop appropriate diagnostic and therapeutic reasoning.
The written test will consist of 30 multiple-choice questions to be completed in 45 minutes. Each correct answer will be awarded 1 point; 0.25 points will be deducted for each incorrect answer.
The oral exam is mandatory for all students and will assess clinical reasoning, clarity of presentation, appropriate use of medical-scientific terminology, synthesis skills, and the ability to integrate clinical, surgical, and technological aspects.

Testi di riferimento

Used materials
• Slides and teaching materials presented during lectures and interactive sessions.
• Educational videos of robotic, laparoscopic, and endourological surgical procedures.
• Access to surgical simulators and immersive platforms, when available.

Recommended readings/textbooks
• EAU Guidelines on Urological Diseases – European Association of Urology, latest available edition.
• Campbell-Walsh-Wein Urology, 13th Edition, Elsevier – selected chapters.
• Smith & Tanagho's General Urology, 19th Edition, McGraw-Hill Education – selected chapters for core clinical concepts.
• Selected peer-reviewed articles on medical technology, robotic surgery, artificial intelligence, and augmented reality, provided by the instructor.
• Additional resources available through the university's digital platforms.

Risultati di apprendimento specifici

At the end of the course, the student will be able to:
• Describe the epidemiology, pathophysiology, clinical presentation, diagnostic workup, and main therapeutic approaches for the most relevant genitourinary diseases, with a particular focus on urological oncology.
• Recognize common clinical and syndromic presentations in urology and suggest appropriate diagnostic strategies.
• Understand the indications and basic principles of minimally invasive and robotic surgical techniques in urology.
• Integrate theoretical knowledge with clinical reasoning skills through the discussion of simple clinical cases.
• Use appropriate medical-scientific terminology to describe diseases, investigations, and procedures.
• Collaborate in group work and actively contribute to the multidisciplinary discussion of clinical cases, demonstrating sound clinical reasoning and critical judgment.

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2025)	comune	12	MED/36, MED/40, BIO/14, MED/08, MED/14, MED/24, MED/40, MED/14, MED/24

Stampa del 16/10/2026

Locomotor System Diseases [1210501]

Offerta didattica a.a. 2026/2027

Docenti: GIANLUCA VADALÃ¿, STEFANO CAMPI, FEDERICA BRESSI, SANDRA MICCINILLI, LAURA OLIVIERI, FRANCESCA CORDELLA, FRANCESCO SCOTTO DI LUZIO

Periodo: Primo Ciclo Semestrale

Obiettivi formativi
Students are expected to acquire adequate knowledge and understanding of the biomechanics, diagnosis and treatment of the major musculoskeletal disorders, as well as of emerging technological developments related to robotics, artificial intelligence, prosthetics, and rehabilitation.

Prerequisiti
Basic knowledge of Human Anatomy, Physiology, Radiology, and General Pathology is required for the understanding and interpretation of the course content. According to the Degree Program Regulations, no prerequisite courses are required for enrolment in this Integrated Course.

Contenuti del corso
Orthopaedics and Traumatology
• The musculoskeletal system: general principles, gross and microscopic anatomy, physiology, medical history, and physical examination
• The musculoskeletal system in systemic diseases: musculoskeletal manifestations of metabolic disorders, endocrine diseases, hematologic disorders, neurological diseases, and infectious diseases
• Traumatology: fractures (definition, risk factors, classification, clinical presentation, and complications); fracture healing and the physiology of bone callus formation; principles of fracture management. Sprains and dislocations: anatomical locations, classification, clinical features, complications, and treatment. Epiphyseal injuries: pediatric fractures and physeal fractures; the Salter–Harris classification
• Osteoporosis: definition, epidemiology, classification, osteoporotic fractures, diagnostic evaluation, and treatment
• Osteoarthritis: pathophysiology, epidemiology, clinical presentation, diagnosis, and treatment. Major involved joints: hip osteoarthritis and knee osteoarthritis
• Knee disorders: physical examination, diagnostic investigations, major clinical conditions, meniscal injuries, cruciate ligament injuries, extensor mechanism disorders, and patellofemoral dysplasia
• Shoulder disorders: physical examination, diagnostic investigations, and major conditions including impingement syndromes, rotator cuff disorders, glenohumeral instability and laxity, and osteoarthritis
• Hip disorders: physical examination, diagnostic investigations, slipped capital femoral epiphysis, osteoarthritis, traumatic conditions, avascular necrosis of the femoral head, and femoral fractures in older adults.
• Spinal Disorders: cervical spine: cervical spondylosis, cervical spondylotic myelopathy, cervical spine tumors, and cervical spinal cord injuries. Lumbosacral spine: lumbar spondylosis, intervertebral disc degeneration and lumbar disc herniation, lumbar spinal stenosis, spondylolysis and spondylolisthesis, thoracolumbar spinal cord injuries, and extrinsic causes of low back pain.
• Foot and ankle disorders: gait physiology, physical examination of the foot, and major foot disorders and their effects on the hip and spine.
• Hand and wrist disorders: trauma of the wrist and hand, thumb carpometacarpal osteoarthritis (rhizarthrosis), stenosing tenosynovitis, Dupuytren's disease, peripheral nerve entrapment syndromes (canalicular and pseudocanalicular syndromes), nerve injuries, and reconstructive surgery of the upper-limb and hand nerves
• Bone tumors: epidemiology, staging, clinical presentation, diagnosis, and treatment. Benign and malignant tumors of osseous, cartilaginous, hematopoietic, and reticuloendothelial origin, as well as metastatic bone disease.
• Pediatric orthopaedics: developmental dysplasia of the hip, congenital clubfoot, lower-limb alignment disorders, deformities associated with cerebral palsy, scoliosis, kyphosis, juvenile round back, and flat back. Osteochondroses: etiopathogenesis, epidemiology, pathophysiology, pathology, clinical presentation, and imaging. Major conditions include Legg–Calvé–Perthes disease, Scheuermann disease, Köhler disease types I and II, Osgood–Schlatter disease, Sever–Blanke disease, and König disease (osteochondritis dissecans).
• Osteoarticular infections: osteomyelitis, septic arthritis, osteoarticular tuberculosis, spondylitis, and spondylodiscitis
• Navigation, robotics, and augmented reality in orthopaedic surgery
• Artificial intelligence in the prevention, diagnosis, preoperative planning and follow-up of muscoloskeletal disorders
• Regenerative medicine and tissue engineering applied to the musculoskeletal system

Rehabilitation
• Principles of Rehabilitation Medicine

• The International Classification of Functioning Disability and Health (ICF) Robotic Rehabilitation
• Rehabilitation and Emerging Technologies, Cerebrovascular Diseases Neurorehabilitation
• Spine Disorders and Rehabilitation
•Rehabilitation in Oncology

Radiology and Interventional Radiology in Orthopaedics
• Introduction to imaging in orthopaedics: conventional radiography (X-ray), computed tomography (CT), magnetic resonance imaging (MRI), and ultrasound; indications, advantages, and limitations
• Shoulder: radiological anatomy, rotator cuff disorders, and glenohumeral instability.
• Elbow, wrist, and hand: common traumatic injuries and musculoskeletal disorders
• Hip: hip osteoarthritis, femoroacetabular impingement, osteonecrosis of the femoral head, and fractures
• Knee: meniscal injuries, cruciate ligament injuries, and knee osteoarthritis
• Ankle and foot: sprains, tendinopathies, and major fractures
• Spine: degenerative disorders (degenerative disc disease and spinal canal stenosis), spinal trauma and vertebral fractures, assessment of spinal stability, tumors, and infections (metastatic disease, spondylitis, and spondylodiscitis)
• Interventional radiology in orthopaedics: introduction to image-guided procedures, including injections, vertebroplasty, and image-guided biopsies

Biomechanics
1. Foundations of biomechanics
2. Biomechanics of the upper limb
• Kinematics analysis
• Dynamics analysis
• Methods for data collection and processing
• Tools for data interpretation and usage for practical cases
3. Muscular activity
• Introduction to the muscular system
• Generation and modeling of electric muscular signals
• Monitoring of muscle activity through surface and high-density electromyography
• Analysis of the electromyographic signal
4. Evaluation of physical and cognitive fatigue
• Origin of physiological parameters (heart rate, respiration rate, galvanic skin response)
• Monitoring of physiological data
• Analysis of signals from physiological sensors
• Cognitive and Muscular Fatigue

Rehabilitation Robotics and Prosthetics
• Role of robotic technologies during patient's rehabilitation treatment
• Introduction to aids and technologies for personal assistance: definition and state of art
• Models for activity, human, assistive technology and context
• Taxonomies of main robots for rehabilitation, classification of their working principles and examples
•Taxonomies of upper- and lower-limb prosthesis and their working principles

Metodi didattici
The course objectives will be achieved through a combined approach integrating traditional teaching methods with innovative educational strategies, including problem-based learning and interactive learning activities.

Modalità di verifica dell'apprendimento
Student learning will be assessed through both written and oral examinations.

The written examination is designed to evaluate the knowledge acquired in a concise and objective manner, using a format similar to that employed in the national admission test for residency training programs. The oral examination aims to assess the student's communication skills, the depth and solidity of the acquired knowledge, and the ability to critically discuss and reformulate the concepts learned during the course.

The examination will take place at the end of the course during the sessions scheduled in the academic calendar.

The written examination will consist of 31 multiple-choice questions, with the number of questions allocated proportionally to the ECTS weight of Orthopaedics and Traumatology, Rehabilitation e Radiology and Interventional Radiology in Orthopaedics modules. One point will be awarded for each correct answer (maximum score: 31 points). Incorrect answers will not result in any penalty.

Students obtaining a score below 18/30 in the written examination will not pass the exam. Students obtaining a score of 18/30 or higher will be admitted to the oral examination, during which the grade may be confirmed, improved, or reduced in the event of an unsatisfactory performance. The oral examination must be completed within the same session as the written examination.

For the Biomechanics module, knowledge and competencies related to the course topics will be assessed through the presentation of a group project addressing subjects covered during the course. During the project presentation, the lecturer will evaluate the student's mastery of the theoretical concepts and their practical application (acquired through both classroom activities and independent study), as well as the student's analytical skills and level of methodological rigor.

For the Rehabilitation Robotics and Prosthetics module, the oral examination will consist of two questions, one posed by the course lecturer and one by the tutor, covering the topics presented during their respective teaching sessions.

The final grade for Locomotor System Diseases will be calculated as the average of the written and oral examination scores and may be awarded up to a maximum of 30/30 cum laude.

Testi di riferimento

Orthopaedics and Traumatology
• Thompson S., Miller MD – Miller's Review of Orthopaedics, Ninth Edition, Elsevier
• U.G. Longo, V. Denaro - Textbook of Musculoskeletal Disorders, First Edition, Springer
• Scientific publications and learning materials provided by the lecturers

Rehabilitation
• Lecture slides provided by the lecturers
• Selected scientific articles and recent literature
• Handouts and supplementary educational materials recommended during the course by the lecturers

Radiology and Interventional Radiology in Orthopaedics
• Scientific publications and learning materials provided by the lecturers

Biomechanics
• N. Ozkaya, M Nordin - Fundamentals of Biomechanics, Second Edition, Springer
• Scientific publications and learning materials provided by the lecturers

Rehabilitation robotics and prosthetics
• A.M. Cook, S.M. Hussey – Assistive technologies: principles and practices, Elsevier, 2015 (4th edition) cap 1-3
• Scientific publications and learning materials provided by the lecturers

Risultati di apprendimento specifici

Upon completion of the course, students will be expected to demonstrate the competencies outlined below, as specified for each individual module of the integrated course.

Orthopaedics and Traumatology
• Obtain an appropriate orthopaedic and musculoskeletal medical history
• Identify and interpret the main clinical signs and symptoms related to the musculoskeletal system in both physiological and pathological conditions, accurately relating them to their anatomical location and underlying pathophysiological mechanisms
• Formulate a diagnostic hypothesis based on the medical history and physical examination findings and explain the clinical reasoning process leading to the diagnosis
• Propose and justify the selection of appropriate laboratory and imaging investigations, explaining the criteria guiding their choice
• Develop an appropriate treatment plan, whether conservative or surgical, for the observed musculoskeletal condition.
• Recognize the scope and limitations of the non-specialist physician's role in the management of musculoskeletal disorders
• Describe the fundamental principles of emergency management of traumatic injuries involving the limbs and spine, and perform the essential steps in the initial assessment and management of the traumatized patient
• Describe the early and late complications of musculoskeletal disorders, as well as associated injuries involving other organs and systems in the context of traumatic conditions
• Establish a differential diagnostic approach among musculoskeletal disorders and other conditions affecting different organs and systems that may present with similar clinical manifestations
• Communicate effectively with patients and their families, providing clear and appropriate information regarding health status, diagnostic procedures, and therapeutic options

Rehabilitation
• Understand the fundamental principles of Rehabilitation Medicine and its role within multidisciplinary healthcare
• Describe the biopsychosocial model of disability and apply the ICF framework in clinical practice
• Explain the indications, benefits, and limitations of robotic rehabilitation systems
• Discuss the application of innovative technologies, including robotics, virtual reality, tele-rehabilitation, wearable devices, and artificial intelligence in rehabilitation
• Understand the main rehabilitation approaches for patients affected by cerebrovascular diseases, particularly

stroke
• Recognize the functional implications of common spinal disorders and the principles of their rehabilitation management
• Describe the role of rehabilitation in the multidisciplinary care of oncological patients
• Evaluate the contribution of technological solutions to functional recovery, patient autonomy, and quality of life

Radiology and Interventional Radiology in Orthopaedics
• Understand the normal and pathological radiological anatomy of the major musculoskeletal regions.
• Understand the main imaging modalities available, including their indications and contraindications.
• Understand the principal interventional radiology techniques and their main applications in orthopaedic practice.

Biomechanics
• Understand the principles of biomechanical analysis of the human body, with particular emphasis on the musculoskeletal system
• Consolidate theoretical and practical knowledge of kinematic analysis, the assessment of muscle activity, and the analysis of physiological signals

Rehabilitation robotics and prosthetics
• Be able to select and appropriately use technological tools for patient rehabilitation, ensuring optimal allocation of human performance and effective human–technology cooperation and interaction
• Critically analyze and understand the functioning and application of advanced technological devices designed to support individuals throughout the main phases of the rehabilitation process
• Understand the principles, functioning, and clinical applications of upper- and lower-limb prostheses

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2025)	comune	18	MED/33, MED/34, MED/36, ING-IND/34, ING-IND/34, MED/33, MED/34

Stampa del 16/10/2026

Mathematics [1210104]

Offerta didattica a.a. 2026/2027

Docenti: MARTA MENCI

Periodo: Primo Ciclo Semestrale

Obiettivi formativi
The course provides the students with the basic mathematical tools needed in engineering
and is designed to increase their knowledge and understanding skills in the framework of Mathematical Analysis and Linear Algebra. Students get also acquainted with setting up and solving mathematical problems, with the aid of many examples. By the end of the course, students should successfully tackle and solve nontrivial mathematical exercises, together with a clear understanding of the most important theoretical results discussed in the course. The course equips students with the essential theoretical and practical foundations to build upon in their future engineering studies and applications.

Prerequisiti
Attendance of the course and admission to the exam do not require the completion of previous exams.
Educational background in the following areas is recommended as significantly of help for the students:

Fundamentals of algebra: first and second degree equations and inequalities, rational and irrational equations and inequalities, exponential and logarithmic equations and inequalities, systems of equations and inequalities. Fundamentals of trigonometry. Geometry: line, circle, parabola, ellipse, hyperbola.

Contenuti del corso
Linear Algebra:
Vector spaces. Vector subspaces. Linear Independence. Generator sets. Bases and dimension of a vector space. Vectors in Euclidean space. Matrices. Elementary matrices. Operations with matrices and properties. Transpose and Inverse of a Matrix and properties. Rank and Determinant of a Matrix and properties. Systems of linear equations: existence of solutions and calculation. Rouchè-Capelli Theorem.

Calculus and Real Analysis:
Number sets. Properties of real numbers and inequalities. Complex numbers: operations with complex numbers and properties, roots of complex numbers. Functions and limits. Fundamental functions and compound functions. Definition of limit of a function of a real variable. Computation of limits. Derivatives: definition and geometric meaning. Derivation rules. Monotony, convexity and concavity. Critical and inflection points. Relative and absolute minima and maxima. Continuity and differentiability of functions. Approximation of functions, Taylor polynomials. Integration. Riemann Integral. Riemann sums. Integrable functions. Fundamental theorem of calculus. Primitives of a function. Indefinite integrals. Rules for calculating indefinite integrals. Definite integrals. Application to the calculation of areas. Linear ordinary differential equations of first and second order.
Differential calculus for functions of several variables.
Partial derivatives, tangent plane, directional derivatives. Hessian matrix. Optimization: maxima, local minima, saddle points. Constrained optimization.

Metodi didattici
The course topics will be addressed during the lessons with the lecturer.
At the end of each topic, in-class exercises will be conducted to illustrate the use of the proposed problem-solving methodologies and their application in specific contexts.

Modalità di verifica dell'apprendimento
Knowledge and skills will be verified by means of a written test including 5 practical open-form exercises and 5 multiple choice questions. The exercises and the questions will focus on the following topics: vector spaces, matrices, systems of linear equations, functions of one real variable, integration of real functions, Linear Ordinary Differential Equations, functions of several variables.
The choice of the open-form for the exercises is aimed to assess the effective degree of learning and the autonomous elaboration ability of the students, as described in the course objectives. In particular, the written test aims to reward the ability to identify the most important aspects of each topic and to expose them correctly but also in a synthetic fashion. In the theoretical questions students are called to answer to questions mainly related to the theoretical contents of the course program. The written test total score is 32 (maximum) and the time assigned for

the test completion is 2.5 hours.
The exam involves an evaluation which is expressed as a grade of out of 30. An exam is deemed to be passed successfully if the grade of written test is equal to or higher than 18/32. If the grade of the written test if higher than 30, the final mark of the exam is 30 cum laude.

Testi di riferimento
- Notes of the lessons, accessible through the elearning page of the course on the online platform https://elearning.unicampus.it/.
- Book “Mathematics – solved exercises and theory review”.
Authors: M. Buscema, F. Lattanzi, L. Mazzoli, A. Veredice, M. Papi
Editor :Società Editrice Esculapio
-Teaching material on the Lecturio platform recommended by the lecturer

Risultati di apprendimento specifici
The course will provide students with knowledge and understanding in the following areas:
- Linear Algebra: vector spaces, matrices, systems of linear equations;
- Differential and Integral Calculus: study of the main analytical properties of real-valued functions, linear ordinary differential equations, two-variables functions and optimization.
By the end of the course, students will be able to describe the nature of vector spaces, discuss the consistency of systems of linear equations, solve linear ordinary differential equations of first and second order, study and represent real-valued functions using the tools of differential and integral calculus.
Students will apply the acquired knowledge to solve problems of practical use (problems involving operations with matrices, vectors, calculation of areas by means of definite integrals and dynamics described by linear differential equations).

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2026)	comune	10	MATH-03/A

Stampa del 16/10/2026

Measurements, sensors and instrumentation [1210305]

Offerta didattica a.a. 2026/2027

Docenti: DANIELA LO PRESTI

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi
The course aims to provide fundamental knowledge about the methodologies and techniques used for estimating physical parameters and interpreting both measurements and their uncertainties. Additionally, it will cover the working principles and performance of the most widely used measuring systems, sensors, and transducers in medical and biomedical applications giving basic knowledge of the main medical instrumentations and the essential standards that medical devices must meet.

Prerequisiti
No prerequisites except those required for access to the Laurea programme.

Contenuti del corso
The contents of the course are:

• Fundamental principles and concepts of measurement methods
Measurements of a physical parameter. Overview of general measurement systems. Units of Measurement: the International System of Units and other systems with a special focus on measurement units used in medical fields. Fundamental constants. Techniques for measurement unit conversion. Measurand and influencing factors. Measurement uncertainty. Analysis of static and dynamic measurements. Law of uncertainty propagation. Operation and significant figures. Significant difference between two experimental data. Experimental data representation: plots and tables.
• Measurement System Behavior
Measurement system behavior. Static metrological properties: range of measurement, calibration curve, sensitivity, resolution, discrimination threshold, accuracy, precision, linearity, signal-to-noise ratio. Dynamic metrological properties: response time, settling time, frequency response (magnitude ratio and phase shift). Repeatability and reproducibility. First- and second-order systems, error function gamma and logarithmic decrement. Loading errors. Load effects. Design of a measuring chain. Circuits for signal conditioning and processing. Amplification stages with a special focus on the ones used in some medical devices (e.g., electrocardiograph). Sampling and ADC. Displaying measuring instruments.
• Length and strain measurements
Measurement of length. Caliper, potentiometer. Measurements of strain. Mechanical and electrical strain gauge; electronics for strain gauge and temperature compensation.

• Measurements of mass, force, and moment.
Basic concepts of mass, force, and moment. Load cells.

• Pressure measurements
Basic concepts on pressure measurements. Barometer. Liquid manometer. Strain-based manometer. Differential pressure sensor.

• Flow measurements
Pitot Tube. Massive and volumetric flow. Venturi Tube. Flow measurements based on pressure drops: orifice meter. Rotameter. Hot wire and hot film anemometer.

• Temperature measurements
Temperature standards and definition. Temperature scale. Thermometry based on thermal expansion. Electrical resistance thermometry. Thermocouples.

• Medical device regulation; mechanical ventilators; laboratory activity on mechanical ventilators; electrocardiography (ECG) and electroencephalography (EEG); pacemakers and defibrillators; blood pressure measurement systems; infusion systems.

Metodi didattici

Lectures covered the course topics and included exercises to demonstrate their application to specific problems.

Modalità di verifica dell'apprendimento
The exam is designed to assess the knowledge and skills outlined in the specific learning objectives. These are evaluated through oral tests, where students are asked to explain specific topics from the course program. Each student will be required to discuss two topics from the course.

Testi di riferimento
- T. G. Beckwith, R. D. Marangoni, J. H. Lienhard. Mechanical Measurements Addison-Wesley Pub Company, Reading MA, USA.
- R.S. Figliola, D.E. Beasley. Theory and design for mechanical measurements. Wiley.
- Lecture notes which will be available vie the e-learning platform of the Università Campus Bio-Medico di Roma.

Risultati di apprendimento specifici
Students will learn to analyze and select the most appropriate measurement system for specific applications. They will be taught to choose measuring systems that meet well-defined requirements for performing specific measurements in healthcare. The course will encourage students to enhance their understanding and analysis of its content. Students will develop the ability to communicate effectively, both succinctly and with the correct technical terminology, about the course topics. They will also expand their knowledge by learning to read and interpret data from measurement processes, estimate uncertainty, and understand the working principles and metrological properties of measuring systems and sensors. Additionally, students will learn about the main medical instrumentations and standards for medical devices. Their learning ability will increase throughout the course due to the interactive teaching methods employed.

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2025)	comune	5	ING-IND/12

Stampa del 16/10/2026

Medical devices: design, regulation, sustainability and innovation [1210402]

Offerta didattica a.a. 2026/2027

Docenti: JOSEPH LOVECCHIO

Periodo: Primo Ciclo Semestrale

Obiettivi formativi

The module aims to provide students with theoretical knowledge and practical skills to understand and address the challenges related to the design, regulation, sustainability, and innovation of medical devices and health technologies (MedTech), within a rapidly evolving European and global context.
Moreover, the module seeks to equip students with a critical and systemic understanding of how biomedical engineering can be applied to global health challenges. Students will learn to analyze how biomedical technologies can contribute to achieving the Sustainable Development Goals (SDGs), particularly those related to health (SDG 3), innovation (SDG 9), equality (SDG 10), and global partnerships (SDG 17).
The module also supports the in-depth exploration of regulatory, strategic, and operational tools for the management of health technologies in global contexts, including those defined by the WHO (e.g., Health Technology Assessment – HTA; National Medical Policies – NMP; Universal Health Coverage – UHC).
Students will acquire an integrated, interdisciplinary perspective on the life cycle of biomedical technologies — from ideation and co-design to decommissioning and reuse — covering regulatory, evaluative, production, and distribution phases. The course trains professionals capable of engaging with diverse stakeholders (clinicians, engineers, regulators, companies, patients), with a particular focus on environmental sustainability, responsible innovation, and regulatory compliance.
Key objectives include:
• Providing tools and methodologies for technical and participatory health technology design in complex and constrained environments.
• Understanding the properties of biomaterials (e.g., implantable devices, tissue engineering scaffolds, clinical 3D bioprinters).
• Learning about biocompatibility (morphological, functional, biological) and its assessment methods.
• Defining combination products, particularly in relation to advanced therapy medicinal products (e.g., engineered tissues).
• Deepening the European regulatory framework (e.g., MDR 2017/745, AI Act, IVDR, ATMP, EHDS), and its interplay with national/regional systems (e.g., Italian Ministry of Health, ISS, regional health authorities).
• Introducing strategies for evaluating the value of medical devices in clinical, economic, environmental, and social terms.
• Exploring business models, public-private partnerships, open innovation, and digital transformation in the MedTech sector.
• Analyzing approaches for eco-design, environmental sustainability, and circularity in production and end-of-life.
• Providing an overview of emerging challenges (e.g., digitalization, AI, interoperability, cybersecurity) and the mechanisms for market surveillance, traceability, and post-market vigilance.
• Understanding ESG (Environmental, Social, and Governance) principles and ethics-based approaches for organizational impact evaluation.
The course emphasizes responsible innovation, addressing ethical, social, and environmental implications in biomedical technology development and deployment. Each year, the course focuses on emerging themes — such as AI, 3D printing, nano/micro devices — especially regarding their potential to enhance patient quality of life and healthcare system efficiency, including in low-resource settings.

Prerequisiti

None

Contenuti del corso

The module is organized into five main teaching units, designed to provide students with an integrated and operational vision of the MedTech sector, with reference to technical design, the European and international regulatory framework, environmental sustainability, and the management of innovation and research.
Teaching activities include lectures, exercises, laboratories, flipped classrooms, expert seminars, and the analysis of real-world cases.

Unit 1 – Biomedical Engineering for Global and Public Health (28 hours)
This unit introduces the concepts of global health, the organization of healthcare services, and the role of biomedical engineering, with a focus on the Sustainable Development Goals (SDGs), health inequalities, social determinants of

health, models of National Health System (SSN) management, and the role of global actors such as WHO, the World Bank, and NGOs.
The unit also explores the internatioanl legal framework for the use of health technologies in national and international contexts, covering key regulations (MDR, AI Act, EHDS, GDPR), solutions for resource-limited settings, Health Technology Assessment (HTA), procurement, and technology decommissioning.
Students will examine analytical tools for healthcare value generation, addressing cognitive biases that affect research methods and clinical evidence generation, types of clinical studies, economic and environmental evaluations, as well as organizational and decision-making models.
Finally, through practical case studies, the unit introduces principles and methods of participatory design (e.g., quintuple helix, co-design, stakeholder engagement), with particular attention to low- and middle-income country contexts.

Unit 2 – Design of Medical Devices and Health Technologies (20 hours)
This unit introduces students to the lifecycle of medical devices and the principles of design in the biomedical field. It covers the properties of biomaterials for medical device development (e.g., implantable devices, scaffolds for regeneration/tissue engineering, clinical 3D bioprinters), and deepens the concept of biocompatibility (morphological, functional, and biological), as well as methods and tools for its assessment.
The concept of combination products will be defined, with reference to advanced therapy medicinal products (e.g., engineered tissues).
Topics also include human-centered design, safety and usability, ergonomics, inclusive design, and the preparation of technical documentation (technical file). Harmonized technical standards and relevant ISO norms (e.g., ISO 13485, ISO 14971) will be discussed, together with principles of responsible and sustainable design.
Special attention will be given to the design of digital health solutions and AI-based devices, as well as their alignment with the United Nations Sustainable Development Goals.

Unit 3 – Regulation and Compliance in the MedTech Sector (22 hours)
This unit explores the European and international regulatory framework for medical devices, in vitro diagnostics, and digital solutions. It will cover EU Regulations 2017/745 (MDR) and 2017/746 (IVDR), the ATMP Regulation (2007/1394), the PPE Regulation (2016/425), the AI Act, the EHDS, and the GDPR, with specific reference to the Italian regulatory framework (Ministry of Health, ISS, Regional Health Authorities).
Students will examine processes including classification, CE certification, clinical evaluation, risk management, and post-market surveillance.
The final part of the unit is dedicated to the role of the WHO in defining regulatory and technological priorities, with particular reference to Health Technology Management (HTM) guidelines and lessons learned from the COVID-19 experience in low-income countries.

Unit 4 – Sustainability and Responsibility in Technological Design (14 hours)
This unit analyzes the environmental challenges related to the entire lifecycle of medical technologies, introducing tools and methodologies for sustainable design.
Students will learn to apply instruments such as Life Cycle Assessment (LCA), Life Cycle Costing (LCC), and Design for Disassembly. The unit explores the concepts of circular economy, reuse and refurbishment of devices, end-of-life management, and compliance with environmental regulations (RoHS, WEEE, REACH).
A critical reflection will be encouraged on the environmental and climate impact of health technologies.

Unit 5 – Innovation and Research Management (16 hours)
The final unit is dedicated to tools and models for driving technological innovation in the MedTech sector.
Students will study business models (e.g., Business Model Canvas), project management tools (e.g., Gantt Charts, Technology Readiness Levels – TRL), impact assessment mechanisms, and intellectual property rights (IPR) strategies.
The unit will also address the preparation of project proposals for competitive funding schemes, public-private partnerships, and emerging challenges related to digitalization, ethics of innovation, cybersecurity, and data governance.

Learning Methodology
Each unit includes case studies, interactive activities, and opportunities for dialogue with national and international experts, in order to foster active learning and close connections with the professional world.

Metodi didattici

The module is designed to integrate theoretical, practical, and interactive activities, aiming to train professionals capable of contributing at any stage of the medical device life cycle. Students will be equipped to critically, competently, and responsibly address the challenges of design, testing, regulation, sustainability, and innovation in the MedTech sector. Teaching activities follow a blended, interdisciplinary, and professionally oriented approach.

Lectures (approx. 40%) provide the theoretical foundation on topics such as:

* technical design and documentation for medical devices;
* European and international regulatory frameworks;
* environmental and social sustainability in design;

* innovation and research management;
* guided discussions on regulatory documents, scientific articles, and policy papers;
* co-taught sessions with guests from healthcare providers, regulatory bodies, and NGOs;
* group projects on real-world challenges proposed by healthcare organizations or NGOs.

The approach is enriched with case studies, practical examples, references to regulations and international standards, and the use of multimedia and institutional documents (e.g., MDR guidelines, ATMP, AI-ACT, WHO-HTM, RoHS, GMDN).

Hands-on exercises and flipped classrooms (approx. 20%) involve students in individual and group work on:
* analysis of technical documentation (e.g., technical file, risk analysis);
* life cycle assessment (LCA, LCC);
* development of business models (canvas, TRL);
* interpretation of regulations and directives;
* user needs elicitation and participatory design.

Flipped classrooms will enable students to work on preparatory materials (videos, reports, scientific papers) and discuss them critically and collaboratively in class. The goal is to foster autonomy, dialogue, and active learning.

Laboratories (15%): students will simulate the design of a medical device by:
* prototyping a simple device (e.g., PoC);
* planning risk evaluation tests;
* simulating the preparation of a technical file for CE marking.

Expert seminars and guest talks (approx. 10%): the module includes sessions with professionals from:
* MedTech companies, startups, and innovative SMEs;
* regulatory authorities and notified bodies;
* public health institutions (Ministry of Health, ISS, Regional Health Authorities);
* international organizations (e.g., WHO, European Commission);
* NGOs active in expanding access to technologies in low-income countries.

These seminars offer a direct and up-to-date perspective on real-world challenges in the design, certification, adoption, and dissemination of medical technologies.

Modalità di verifica dell'apprendimento

Assessment
The assessment strategy is designed to be integrated and multimodal, valuing both the theoretical knowledge acquired and the practical, analytical, and transversal skills developed throughout the module. The adopted approach aims to stimulate active student engagement, autonomous learning, critical thinking, and effective communication.
Assessment consists of three components:
1. Active participation in collaborative activities and laboratories – 10%
2. Final project – 55%
3. Written exam – 35%

Active participation and contribution to collaborative activities (10%)
Active behavior during lectures, exercises, seminars, and group work will be monitored and evaluated. Emphasis will be placed on collaboration, initiative, relevance of contributions, and the ability to interact constructively with peers and external experts.

Final Project (55%)
The central element of assessment is the final project, which may be carried out individually or in groups, and will be based on a real or simulated case study provided by the instructors or by partner organizations (e.g., hospitals, startups, regulatory authorities, international organizations).
For each project, students are required to produce both a written report and an oral presentation.
Through the project, students must demonstrate the ability to:
• address a design or regulatory challenge in the MedTech sector;
• prepare technical documentation or a project proposal;
• evaluate regulatory, environmental, economic, and ethical aspects;
• present and discuss results effectively in class.
The project will be evaluated on the basis of methodological coherence, technical accuracy, originality, impact, and clarity of communication. The oral presentation will be delivered at the end of the course, either individually or in groups.
For students unable to attend, an alternative thematic in-depth analysis may be presented.
Assessment criteria will be defined together with the students during the course and will include:
• structure and clarity of exposition;
• communicative effectiveness;
• use of data, figures, and sources;

• ability to respond to questions and objections.

Oral Exam (35%)
The oral exam will be held at the end of the module. Students will present their project work and discuss their results or, alternatively, a thematic in-depth analysis. The oral exam will assess mastery of the subject, ability to integrate theory with practice, and the capacity for critical discussion.

Formative Assessment (not graded)
In addition to the summative components, formative assessment opportunities will be provided through exercises, case studies, and flipped classroom activities. These are designed for self-assessment and feedback, allowing students to monitor their own learning progress.
Practical exercises will include:
• risk analysis according to ISO 14971;
• regulatory mapping (MDR, ATMP, AI Act, GDPR, REACH, RoHS);
• LCA/LCC assessment of a medical device;
• business model development and impact evaluation.
These exercises will be assessed in terms of accuracy, applicability, relevance of proposed solutions, and rigor in the use of sources.

Flipped classroom sessions will focus on regulatory documents, case studies, and policy papers. Students will be asked to study assigned topics, prepare short essays and multimedia-supported presentations, and explain these contents to the rest of the class. This will test comprehension, critical thinking, autonomous learning, and communication skills.

The written examination is designed to assess students' understanding of the theoretical concepts, methodologies, regulatory frameworks, and practical applications covered throughout the module. Questions may include multiple-choice, short-answer, and open-ended formats aimed at evaluating knowledge acquisition, critical reasoning, and the ability to apply concepts to real-world MedTech scenarios.

Testi di riferimento
Teaching Materials
• Slides and handouts prepared by the instructor.
• Guided exercises, lab briefings, and templates for the project work.
• Video lectures, expert interviews, selected webinars.
• Official documents (updated versions):
o European Regulations (EU 2017/745 (MDR) and 2017/746 (IVDR), EC 1394/2007 (ATMP), AI Act, EHDS, GDPR)
o ISO standards (e.g., ISO 13485: Quality Management Systems for Medical Devices; ISO 14971: Risk Management for Medical Devices)
o WHO documents and guidelines (e.g., WHO Global Model Regulatory Framework for Medical Devices, WHO Health Technology Assessment tools and HTM guides)
o MDCG (Medical Device Coordination Group) guidelines
o European environmental regulations: RoHS, WEEE, REACH
o EU Framework for Sustainability

Recommended (non-mandatory) learning materials for further study
• Books and monographs:
o D. Dean et al., Medical Device Design for Regulatory Compliance: A Guide for Engineers and Quality Assurance Professionals, Elsevier.
o M. Drummond et al., Methods for the Economic Evaluation of Health Care Programmes, Oxford University Press.
o J. Glover et al., Sustainability in Engineering Design, Academic Press.
o M. Schmid, Product Design and Lifecycle Sustainability, Springer.
o R. Pietrabissa, Biomateriali per protesi e organi artificiali, Pàtron Editore, Bologna.
o A. von Recum, Handbook of Biomaterials Evaluation, Taylor & Francis, London.
o B.D. Ratner, A.S. Hoffman, F.J. Schoen, J.E. Lemons (Eds.), Biomaterials Science: An Introduction to Materials in Medicine, Elsevier Academic Press.
• Scientific articles and reviews (provided during the course):
o Selections from Nature Biomedical Engineering, Nature Scientific Reports, Biotechnology and Bioengineering, Health Affairs, Journal of Medical Devices, The Lancet Digital Health, IEEE Transactions on Biomedical Engineering.
• Databases and online resources:
o EUDAMED (European Database on Medical Devices)
o ClinicalTrials.gov
o MedTech Europe – position papers and industry reports
o WHO eHealth Observatory
o EMA, FDA, and GMDN Agency

Risultati di apprendimento specifici
KNOWLEDGE AND UNDERSTANDING

Students will gain an advanced understanding of core principles in MedTech design, regulation, sustainability, and innovation. They will describe the lifecycle of medical devices and understand technical, regulatory, and environmental constraints. Students will become familiar with EU regulations (MDR, IVDR, ATMP, AI Act, EHDS, GDPR) and key national systems (e.g., Italian Ministry of Health, ISS, Regions), as well as concepts like sustainable design, circular economy, and responsible innovation.
APPLIED KNOWLEDGE AND UNDERSTANDING
Students will apply design concepts to create functional prototypes of medical devices considering clinical, ergonomic, regulatory, and technical requirements. They will produce essential documentation for medical device certification (e.g., MDR, ISO 13485), evaluate environmental impact through life cycle tools, and implement eco-design strategies. Real-life examples will be used to address technical and regulatory challenges and propose improvements, including through AI or 3D printing. Students will work in teams, manage the innovation pipeline from ideation to market, and communicate solutions effectively.
CRITICAL THINKING AND INDEPENDENT JUDGMENT
Students will critically evaluate design and management decisions concerning medical devices, analyzing scenarios from multiple perspectives, assessing risks, benefits, and trade-offs. They will develop awareness of the biomedical engineer's role in innovation and regulation, collaborating with regulatory bodies, companies, and healthcare institutions.
COMMUNICATION SKILLS
Students will refine communication skills to tailor content to different audiences (technical, clinical, regulatory, patient). They will prepare technical documentation, strategic plans, and dissemination materials. They will also learn how to communicate innovation responsibly and explain its social and environmental implications.
LEARNING SKILLS
Students will cultivate continuous learning habits, staying up to date with evolving regulations and technologies using institutional documents (e.g., MDCG, EMA, WHO), databases, and webinars. They will gain autonomy in professional development using resources like ISO standards, EU guidelines, and specialized platforms.

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2025)	comune	8	ING-INF/06

Stampa del 16/10/2026

Medical Humanities I [1210106]

Offerta didattica a.a. 2026/2027

Docenti: GIAMPAOLO GHILARDI, LUCA BORGHI, FRANCESCA FIORI

Periodo: Ciclo Annuale Unico

Obiettivi formativi
According to E. Pellegrino, one of the most famous and prominent Medical Humanities experts, fundamentally Medicine is moral. It is neither a natural nor a science although it often depends upon both for its technical and communal progress. Medicine, especially as clinical practise, is moral because the defining element of its practise is the patient-physician relationship, and that relationship is profoundly principled and often based upon ethical rules and duties. The integrated course “Medical Humanities 1” aims to provide students with some essential tools from the humanities (Anthropology, Ethics, and History) necessary to understand the nature of the patient-physician relationship, keeping in mind what William Osler, a pioneer of modern Medicine said: “The good physician treats the disease; the great physician treats the patient who has the disease.” In order to be able to reach this goal in their profession, medical students need to know themselves, as well as their future patients as human beings in the context of histories, cultures and values.
The course therefore aims to provide a clear understanding of the rich and large set of values, virtues, and moral characteristics which are connected with medical practice. Within this framework, the Social Psychology module will introduce students to the interpersonal and cultural dynamics that shape medical relationships, helping them understand how social identity, bias, communication, and group processes influence both patient care and professional behavior. It will support students in developing greater self-awareness, empathy, and ethical sensitivity in clinical encounters—core competencies for practicing medicine as a moral enterprise.
Elements of Human Flourishing will be presented within the course.

Prerequisiti
None

Contenuti del corso
Anthropology:
Introduction/general overview.
What anthropology is.
On Truth.
Anthropology and Technologies.
Homo faber/homo sapiens.
Anthropology and industry 4.0.
Anthropology and Medicine.
Transhumanism. Posthumanism.
Humanism and humanities.
Leonardo and humanism.
There is a module with specific contents on the Human Flourishing as a multidimensional framework of the human well-being. Particular attention will be paid to significant social relationships and to the relevance of the human work for the common good.
Recap of the programme.

Ethics:
Introduction/general overview.
What ethics are.
Why ethics in medicine.
Ethical schools. Free will.
Libet’s experiments on free will.
The trolley dilemma.
Utilitarianism and consequentialism.
Consciousness. Agency: what does it mean to be a moral agent.
Ethics and Rhetoric. The good words.
Ethics and communication between doctor and patient.
The notion of personhood.
Virtues. Epistemic virtues.
Recap of the programme.

The History of Medicine in Twelve Machines:
1. Introduction. Specula and forceps: to the roots of medicine.
2. The stethoscope and the instrumental diagnostic revolution.
3. The inhaler. When surgery knocked out pain.
4. The ophthalmoscope. At the origins of modern ophthalmology.
5. Under pressure. The sphygmograph, the sphygmomanometer and their two visionary inventors: Étienne-Jules Marey and Scipione Riva Rocci.
6. The X-rays apparatus. Wilhelm Röntgen and the radiological revolution.
7. The negative pressure chamber and the controversial figure of Ernst Ferdinand Sauerbruch.
8. The electrocardiograph. How to cope with a crazy heart.
9. The iron lung and the long battle against polio.
10. The microscope and the discovery of the invisible.
11. The heart-lung machine and the taboo of open-heart surgery.
12. The electroconvulsive therapy machine. Just a skeleton in the closet of modern psychiatry?

One hour class will be dedicated to each of these subjects.

Social Psychology
• 1. Introducing social behaviour
2. Social cognition: How we think about the social world
3. How we come to understand other people
4. The self: understanding ourselves in a social context
5. The need to justify our actions:the costs and benefits of dissonance reduction
6. Attitudes and attitude change: influencing thoughts and feelings
7. Conformity: influencing behaviour
8. Group processes: influence in social group
9. Interpersonal attraction: from first impressions to close relationship
10. Prosocial behaviour: why do people help?
11. Aggression: why do we hurt other people? Can we prevent it?
12. Prejudices: causes, consequences and cures

Metodi didattici
The aims of the class will be achieved by a combined approach involving a traditional inductive teaching method, video projections, and interactive learning. These different teaching approaches will be combined in the same weeks, as well as within the same lectures. The students will always be stimulated and will not be treated as passive learners but will be called to actively participate in the lectures. The teaching methods promote classroom engagement and cooperation. Both the interactive lectures and group activities will entail the active involvement of students.

Modalità di verifica dell'apprendimento
The final exam will take place at the end of each course, in the sessions scheduled by the academic calendar. The exam will be both written (anthropology and Ethics and Social Psychology), involving a combination of multiple choice and short answer questions, and oral (History of Medicine and Social Psychology). The questions will evaluate the students' ability to critically reformulate the learnt concepts and their ability to critically apply the knowledge and understanding.

Testi di riferimento
Besides the material uploaded on the E-Learning platform:

Anthropology:

Il testo del corso è G. Ghilardi, Elements of Anthropology and Ethics, KDP Publishing, (in press)

• James. A. Marcum, The virtuous physician, the role of virtue in Medicine, Springer, 2012
• G. Ghilardi, "Analogia Sensuum: The knowing body", in: N. Di Stefano, V. Tambone (eds.), About the living body, Nova science, New York 2016, pp. 15-31
• G. Ghilardi, L. Campanozzi, V. Tambone, "Humanities: Methods for Medical Training", in Journal of Medical Diagnostic Methods, vol. 5, Issue 1, 2016

Ethics:
• J. Seifert, The philosophical diseases of medicine and their cure, philosophy and ethics of medicine, Springer,

2004
• V. Tambone, G. Ghilardi, “An ethical evaluation methodology for clinical cases”, Persona y Bioética, 20 (1), 2016, pp. 48-61
• G. Ghilardi, “Epistemological remarks on Libet’s experiments on free will”, Rivista Internazionale di Filosofia e Psicologia, 6 (1), 2015, pp. 110-119
• V. Tambone, G. Ghilardi, Philosophy and Deontology of Medical Practice, Ethics of the work well done in bio-medical sciences, SEU, Roma 2020

History of medicine:

The textbook of the course is:
• Jessica Casaccia, Luca Borghi, Tools of the Trade. The History of the Relationship between Medicine and Engineering in Twelve Machines, KDP Publishing 2025

For a general overview of the history of medicine and healthcare a recommended reading is also:
• Luca Borghi, Sense of Humors. The Human Factor in the History of Medicine, KDP Publishing 2022

Social Psychology

Slides of the lectures will be shared with the students before the lessons.
- Aronson, E., Wilson, T.D., Akert, R.M., Sommers, S. R. “Social Psychology” Pearson (chapters: 1,3,4,5,6,7,8,9,10,11,12,13)

Risultati di apprendimento specifici

The final mark will be in the range of 18-30/30 it will be a weighted average of the final grades in Anthropology (1/4), Ethics (1/4), History of Medicine (1/4), Social Psychology (1/4). The “laude” will be assigned to highlight an optimal integration among the topics of the different modules.

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2026)	comune	4	MEDS-02/C, PHIL-03/A, PHIL-03/A, PSIC-03/A

Stampa del 16/10/2026

Medical Humanities II [1210206]

Offerta didattica a.a. 2026/2027

Docenti: FRANCESCO DE MICCO, FRANCESCA FIORI

Periodo: Primo Ciclo Semestrale

Obiettivi formativi
The Bioethics module aims to provide students with the knowledge and skills (a) to understand the main deontological issues of the medical profession (general duties of the medical doctor, relations with the citizen, relations between patient and physician, relations with other healthcare workers).
The communication skills module (CS) introduces core clinical communication skills with a focus on tech-enhanced medical environments. Students will learn how to effectively interact with patients, colleagues, and technical staff using clear, empathetic, and professional language. The course emphasizes patient-centered communication, the use of a plain language to explain complex procedures involving technology, and strategies for effective collaboration in interprofessional teams.

Prerequisiti
According to the Study Manifesto, there is no propaedeuticity for this Integrated Course.

Contenuti del corso
Bioethics
- Deontology and Code of Ethics
- The medical profession
- The Professional Order
- Freedom and independence of the profession
- Professional secrecy and the protection of confidentiality
- Emergency services
- Resource Utilization
- Patient safety and clinical risk management
- Relations with the citizen in specific care contexts
- Respect for the dignity of the patient in a relationship of trust
- Informing the patient and obtaining consent to the medical act
- Issues at the beginning of human life
- Issues at the end of human life
- Experimentation
- Intra- and inter-professional relations
- Relations with public and private healthcare facilities
- Empowering and aesthetic medicine
- Informatisation and healthcare innovation

Communication Skills
- Introduction to Clinical Communication
Overview of the role and importance of communication in medical and technological contexts.
- Patient-Centered Communication
Principles of empathy, respect, and shared decision-making.
- The Calgary-Cambridge Model
Structured approach to clinical interviews and consultations.
- Active Listening and Empathic Response
Techniques to build trust and understand patient perspectives.
- Nonverbal Communication in Clinical Settings
Recognizing and using body language, eye contact, and tone effectively.
- Clear and Respectful Language
Explaining complex medical information in accessible, jargon-free English.
- Handling Difficult Conversations
Strategies for managing emotional distress, disagreement, and conflict.
- Communicating Risk and Uncertainty
How to discuss probabilities, outcomes, and decision-making under uncertainty.
- Intercultural Communication in Healthcare
Navigating cultural differences and language barriers in diverse patient populations.

- Communication in Telemedicine and Digital Tools
Maintaining professionalism and empathy in virtual and tech-mediated interactions.
- Simulations and Role-Plays with Feedback
Practical application of skills in realistic clinical scenarios.

Metodi didattici
Lectures, case analyses, reflective learning, Advanced role-playing with feedback. peer observation and debriefing, video observation and discussion

Modalità di verifica dell'apprendimento
Bioethics
- Written examination aimed at testing the actual degree of learning, the ability to critically rework the acquired knowledge and present it in a comprehensible manner, the ability to identify the elements characterising the course topics.
- 16 multiple-choice questions
- Each correct answer counting for 2 points; either incorrect answer or answer not given count for 0 points
- The minimum grade to pass written exam is 18 (9 correct multiple-choice questions); the maximum grade is 32 (16 correct multiple-choice questions), which corresponds to 30 cum laude.

Communication Skills
- Individual Role-Play (20 points): Students will participate in a simulated clinical encounter involving complex communication scenarios (e.g., delivering bad news, managing emotions, risk communication). Performance will be evaluated using a structured checklist focusing on clarity, emotional management, risk communication, empathy, and adaptability.
- Oral Examination (10 points): A follow-up oral interview will assess students' understanding of communication strategies, their ability to critically reflect on their practice, and their grasp of theoretical foundations.

The final examination mark is expressed in thirtieths (minimum mark 18/30, maximum attainable mark 30/30 with distinction), and is the result of the weighted average of the marks obtained for each module.

Testi di riferimento
Bioethics
- Slides and material produced by the lecturer will be uploaded onto the e-learning platform.
- Laura Palazzani. Bioethics and Biolaw: theories and questions. G. Giappichelli Editore, Torino, 2018

Communication Skills:
The teaching material (downloadable from the e-learning platform) will be provided approximately two days before each class.
- Baile WF et al. SPIKES Protocol for Delivering Bad News
- Silverman, Kurtz, Draper, Skills for Communicating with Patients, Radcliffe (Ch. 3–7, from the 3rd edition)
- Ha, JF, Longnecker, N. Doctor-Patient Communication: A Review (Ochsner Journal, 2010)
- FDA, U.S. Department of Health and Human Services: Communicating Risks and Benefits: An Evidence-Based User's Guide (selected chapters: 3, 4, 5, 6, 8)

Risultati di apprendimento specifici
Bioethics
- Knowledge and Understanding
To know and understand the deontological principles that characterise the professional autonomy and responsibility of the physician.
- Applied Knowledge and Understanding
Deciding, planning and implementing effective and safe care interventions that comply with quality standards and are based on scientific evidence, respecting legal and ethical responsibilities, with a personalised and integrated approach that considers individual and community needs, thus improving the health status and general well-being of the people involved.
- Autonomy of Judgment
Use critical thinking to understand the phenomena that characterise the reality of care and deontological reflection.
- Communication Skills
Presenting and discussing one's decisions with colleagues and other professionals, even in situations of moral distress, in order to ensure transparency, accountability and enrich one's point of view, contributing to a collaborative and understanding working environment.
- Learning Ability
Deal autonomously and critically with the study of deontology for the acquisition of new knowledge and understanding of new phenomena.

Communication Skills
- -Knowledge and Understanding
Understand core principles of patient-centered communication and their relevance in tech-enhanced clinical

practice.
- -Applying Knowledge and understanding
Apply communication models and techniques to interact effectively with patients and healthcare teams.
- Autonomy of Judgment
Adapt communication strategies to diverse clinical, emotional, and cultural contexts with critical awareness.
- Communication Skills
Communicate clearly, empathetically, and professionally in English using appropriate verbal and nonverbal cues.
- Learning Ability
Reflect on personal communication style and integrate feedback to improve continuously.

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2025)	comune	3	MED/43, M-PSI/05

Stampa del 16/10/2026

Medical Humanities III [1210301]

Offerta didattica a.a. 2026/2027

Docenti: MARTA BERTOLASO, LAURA LEONDINA CAMPANOZZI, MARTA GIOVANETTI

Periodo: Ciclo Annuale Unico

Obiettivi formativi

MODULE 1 – The module prepares students to interpret global health as part of complex systems, where understanding the interfaces between biology, environment, and technology is central. It also introduces key concepts for reflecting on the management of scientific uncertainty and shared responsibilities in health and environmental contexts, in line with the topics that will be further explored in the second-semester modules.

KNOWLEDGE AND UNDERSTANDING
By the end of the module, students will have acquired foundational knowledge to understand the dynamics linking health, environment, and society, with particular attention to the biological, ecological, and technological factors that influence global health. They will be able to recognize the importance of a systemic and transdisciplinary approach to addressing contemporary health challenges and to critically reflect on the ethical and social implications of scientific production.

APPLYING KNOWLEDGE AND UNDERSTANDING
Students will be able to apply the acquired knowledge to analyze complex scenarios in health and environmental contexts, integrating data and perspectives from different fields. They will be capable of critically evaluating situations characterized by scientific uncertainty, proposing sustainable and collaborative solutions, and contributing to the design of interventions aligned with the principles of global health and shared responsibility.

MODULE 2 – This module provides students with the critical thinking tools necessary for analysing, evaluating and managing the dynamics of complex systems and their interactions. Building on the topics covered in the first-semester module, the epistemological and philosophical foundations for a critical and constructive, scientifically based analysis of physiopathological processes, will be laid. The different types of uncertainty (epistemic, epistemological, intrinsic to data or theory, and so on) will be clarified, equipping students with the tools to engage in biomedical practices that are more aware of the scope and limitations of the scientific method, and therefore more responsible and sustainable (Human Ecology).

KNOWLEDGE AND UNDERSTANDING
The objective is to enable students to deepen their basic philosophical and epistemological knowledge, which is essential for understanding the methodological assumptions underlying the critical analysis of the complexity of living systems. The course aims to provide knowledge and understanding of the theoretical principles of human ecology, particularly in relation to new biotechnologies.

APPLICATION SKILLS
By the end of the course, students will be able to apply critical knowledge and conceptual maps to experimental and clinical design, as well as to the development of more informed and responsible application programmes.

MODULE 3 – This module guides students in a critical reflection on the relationship between ethics and technologies in the medical field, with particular attention to the impact of biomedical technologies on the physician–patient relationship and on the very concept of care. The distinction between technique and technology will be examined in order to understand how technological innovations transform clinical practices and decision-making processes. The concept of prudential governance will also be introduced, understood as an ethical and regulatory approach to the responsible management of biomedical progress, in continuity with the themes explored in previous modules.
KNOWLEDGE AND UNDERSTANDING
The aim of the module is to provide students with conceptual and critical tools to understand the interplay between technological development and ethical reflection in the medical field. Through the analysis of the theoretical foundations distinguishing technique from technology, the course explores the impact of biomedical innovations on the patient–physician relationship, clinical decision-making processes, and the very definition of care, health, and illness. Particular emphasis will be placed on the notion of prudential governance, understood as an ethical and regulatory framework for the responsible management of biomedical progress, in continuity with the topics addressed in previous modules.
APPLYING KNOWLEDGE AND UNDERSTANDING
By the end of the course, students will be able to critically apply the acquired knowledge to analyse the introduction

of technologies in medical practice, assessing their ethical, relational, and regulatory implications. They will also be able to identify and critically reflect upon the transformations affecting clinical practices and decision-making dynamics, and to develop approaches aimed at a prudent and sustainable governance of biomedical innovation.

Prerequisiti

none

Contenuti del corso

MODULE 1 – The module introduces the One Health paradigm as a systemic approach to the interconnection between human, animal, and environmental health. The following topics will be addressed:

• The conceptual foundations of the One Health paradigm and its evolution
• Zoonoses and the role of animal reservoirs in the transmission of emerging pathogens
• Environmental and climate change as drivers of viral spillover
• The role of human activities and urbanization in ecosystem transformation
• Emerging methods and technologies for monitoring, identifying, and studying emerging pathogens (e.g., sequencing, metagenomics, molecular diagnostics)
• Analysis of recent case studies (e.g., SARS-CoV-2, emerging viruses in Europe, vector-borne epidemics)
This module introduces epistemological and philosophical issues related to systemic approach and the integrated development of living systems and their modes of interaction, even when mediated by technology.

MODULE 2 – The following topics will be addressed:
- Philosophical foundations of critical thinking in the study and management of complex systems, paying particular attention to living beings and humans (discussing the notion of evidence, etc.).
- Epistemology of certainty and uncertainty, reflecting on the most relevant philosophical categories for accounting for the integrated development of living systems.
- Ontology and relational epistemology of living beings. Organisms and biological time.
- The notion of relationships, emergent properties and complex causality, and the role of the (micro)environment.
- Historical and philosophical reasons for revising the molecular notion of biological information (the central dogma of molecular biology). The possibilities and limitations of digital technology in modelling/simulating biological information.
- Models, functions and interfaces: the structure of explanations in the Life Sciences. Possibilities and limitations of digital technology in modeling/simulating biological information.
- Analysis and discussion of case studies (e.g. systemic models of carcinogenesis, approaches to predicting the onset of Alzheimer's disease etc). The module introduces the ethical implications of the development and use of technologies in medicine, providing tools to analyse the various moral positions that arise in response to the issues and dilemmas they entail.

MODULE 3- The following topics will be addressed:
• Distinction between technique and technology; the quantitative and qualitative "novelty" of biomedical technologies; challenges in interacting with new technologies and the paradox of control; implicit ethics embedded in new technologies; ethics as action in relation to emerging technologies.
• Systematic framework of biomedical technology ethics (transparency, algorithmic bias, confidentiality, fairness, autonomy, informed consent, accountability).
• Ethics of artificial intelligence: trust and reliability, sustainability, distributive justice.
• Ethical implications of virtual relationships: telemedicine and remote care; transformations in the therapeutic relationship and the quality of interaction.
• Human–machine interaction: roboethics and the question of responsibility (active and passive responsibility, moral and professional responsibility, shared responsibility).
• Prudential governance of biomedical technologies: ethical and reflective approach, responsible regulation, and evaluation of uncertainties; the issue of singularity.
• Ethical analysis and discussion of cases involving the use of technologies in healthcare (e.g. the use of artificial intelligence in medical diagnosis; clinical decisions supported by predictive algorithms, etc.).

Metodi didattici

MOD 1 – Lectures with active and engaged student participation and discussion.

MOD 2 – Lectures with active and engaged student participation and discussion.

MOD 3 – Lectures, guided case discussions, and videos related to the module content, supported by interactive platforms (e.g. Wooclap) and group work.

Modalità di verifica dell'apprendimento

MOD 1 – oral exams with scientific presentations at the end of the module as training test

MOD 2 – MOD 3 – oral exams with multiple-choice test at the end of the module as training test

Testi di riferimento

Modulo 1 (MG)

John S. Mackenzie, Martyn Jeggo, Peter Daszak, Juergen A. Richt. One Health: The Human-Animal-Environment Interfaces in Emerging Infectious Diseases. Springer Nature.
https://link.springer.com/book/10.1007/978-3-642-35846-3 Modulo 2 (MB)
• Bertolaso, M., Ilardo, M.L. (2024) “Epistemologia per un’Etica del One Health”, Volume Istituto Italiano di Bioetica.
• Bertolaso M, Marinucci A (2024) Le questioni aperte della vita. Epistemologia della complessità. Rubettino
• Bertolaso M (2024) Humanperspectives in healt sciences and technology, in Digital Environments and Human Relations Ethical Perspectives on AI Issues, DOI: https://dx.doi.org/10.1007/978-3-031-76961-0_1
• Marinucci A, Bertolaso M (2025) The precautionary principle in nutrition.
Epistemology and law, Teoria, in corso di pubblicazione

Modulo 3 (LC)
• Alcuni capitoli di: Hansson, S. O. (Ed.). (2017). The ethics of technology: methods and approaches. Rowman & Littlefield.
• Alcuni capitoli di: Fabris, A. (2021). Etica delle nuove tecnologie. Nuova edizione. Scholé.
• Maccaro, A., Stokes, K., Statham, L., He, L., Williams, A., Pecchia, L., & Piaggio, D. (2024). Clearing the Fog: A Scoping Literature Review on the Ethical Issues Surrounding Artificial Intelligence-Based Medical Devices. Journal of Personalized Medicine, 14(5), 443.
• Campanozzi, L. L., et al. (2019). Building trust in social robotics: A pilot survey. IEEE Technology and Society Magazine, 38(4), 45–54.

Risultati di apprendimento specifici

MODULE 1 - By the end of the module, students will be able to:
• Understand and explain the fundamental principles of the One Health paradigm, recognizing its relevance for analyzing and addressing global health challenges.
• Analyze the mechanisms underlying zoonotic transmission, with particular attention to the role of animal reservoirs, vectors, and environmental factors.
• Critically evaluate the impact of climate change, urbanization, and human activities on public health and ecosystem balance.
• Identify and describe key emerging technologies for monitoring and studying emerging pathogens (e.g., genomic sequencing, metagenomics, molecular diagnostics).
• Apply an integrated and multidisciplinary approach to the analysis of real-world case studies, linking scientific evidence with social responsibility in epidemic prevention and response.
• Effectively communicate complex concepts related to global health through scientific presentations and structured oral discussions.
MODULE 2 - By the end of the module, students should be able to:
• understand and apply the philosophical foundations of critical thinking to complex systems;
• Understand the specific tools and concepts of biological complexity, such as relationships, biological time and emergent properties.
• Recognise the importance of historical philosophical perspectives in the application of critical thinking to case studies. MODULE 3 - Knowledge and Understanding:
The module aims to cultivate an informed awareness of the ethical implications arising from the development and use of technologies in the medical field.

Applied Knowledge and Understanding:
By the end of the module, students should be able to apply the acquired knowledge to ethically relevant and/or conflicting situations involving the evaluation of technological development and use in healthcare.

Autonomy of Judgment:
Students will develop critical and reflective thinking skills concerning the topics addressed in the course, including dilemmas and ethical challenges related to biomedical technologies, and will be able to justify and defend their positions effectively.

Communication Skills:
Students will be able to communicate their learning clearly, thoughtfully, and personally, employing the specific terminology and discourse of the discipline.

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.

Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2025)	comune	3	MED/43, M-FIL/02, BIO/19

Stampa del 16/10/2026

Neuroanatamy and Neurophysiology [1210202]

Offerta didattica a.a. 2026/2027

Docenti: GIOVANNI DI PINO, GIORGIO VIVACQUA

Periodo: Primo Ciclo Semestrale

Obiettivi formativi

Starting from the fundamentals of Chemistry, Biology and Physics, students are expected to acquire in-depth knowledge and understanding of the morphological and functional organization of the nervous system and sensory organs.
In addition, students must be familiar with the anatomical taxonomy and spatial relationships of the various structures of the central and peripheral nervous systems.
By building on their understanding of neural development, students should comprehend the main functions of neural centers and their interactions, including references to potential dysfunctions.
Particular emphasis is placed on a clear understanding of the quantitative aspects of the models and rules that govern neural functions.

Prerequisiti

To be eligible to take the Neuroanatomy and Neurophysiology exam, students must have passed the following exams:
• Body Structural Organization
• Biophysics
• Biology
• Chemistry
• General Physics

Contenuti del corso

Neuroanatomy:

Development of the central nervous system. Overview of the nervous system: general organization, meninges, cerebrospinal fluid circulation, venous and arterial vascularization. Spinal cord. Brainstem and cerebellum. Reticular formation. Diencephalon. Telencephalon. Cellular and molecular organization of the cerebral cortex. Motor pathways. Basal ganglia and cerebellar pathways. Sensory and pain-temperature pathways. Special sensory pathways: visual, auditory, vestibular, olfactory, and gustatory pathways. Limbic system: memory and emotional circuits. Circumventricular organs. Neurochemical anatomy of the main neurotransmitter systems. Elements of comparative anatomy and neural networks.
Sensory organs and esthesiology: the eye, ocular adnexa, and lacrimal glands. Ocular muscles. The retina: cytology and functional anatomy. The ear: external, middle, and inner ear; the cochlea and the organ of Corti: histology and functional anatomy; the vestibular organ. Gustatory and olfactory receptors. Cutaneous sensory receptors.
Peripheral nervous system: cranial nerves. Nerve plexuses: cervical, brachial, lumbar, and sacral. Functional distribution of the main peripheral nerves of the upper and lower limbs.
Development of the sensory organs and the peripheral nervous system. Elements of comparative anatomy of sensory systems.
Topographic anatomy of the head and neck.

Neurophysiology:

• Molecular Neurobiology
• Spinal cord, motor and sensory tracts, spinal reflexes and their role in locomotion
• Brainstem, cranial nerves, and respiratory control (respiratory centers and rhythm generation)
• Hypothalamus and autonomic nervous system (peripheral branches and central components of the ANS and their effects on various organs)
• Enteric nervous system and neural control of the gastrointestinal tract
• Peripheral somatosensory system and peripheral pain
• Cortical structure, organization, and functions (somatosensory cortex and central pain processing)
• Motor cortex and motor control
• Functional neuroimaging (EEG, MEG, fMRI...)
• Basal ganglia

• Cerebellum
• Auditory system (inner ear, auditory transduction, vestibular system, and central auditory pathways)
• Language
• Chemical senses (olfaction and taste)
• Sleep and wakefulness (sleep stages, sleep regulation, associated EEG, and sleep disorders)
• Emotions (theories and neurophysiological substrates) and mood
• Multisensory integration, body representation, peripersonal space, and sensorimotor control
• Attention and cognition, thought and volition
• Visual system (eye and optics, visual transduction, visual receptive fields, visual processing, and gaze control)
• Learning, memory, and brain aging

Metodi didattici

The course objectives will be achieved through a combined approach that includes the traditional teaching method, innovative teaching strategies, problem-based learning, and interactive learning. This will involve open-ended problems or quizzes administered at the end of particularly significant topics to consolidate learning.

Modalità di verifica dell'apprendimento

The acquisition of knowledge and skills will be assessed through a final examination held at the end of the course, during the sessions scheduled in the academic calendar.
The final exam consists of written and oral tests for each module, followed by an integrated oral interview. Emphasis is placed on students' communication skills and their ability to critically reformulate the concepts learned.

Neuroanatomy

The assessment of learning will consist of an oral exam covering the central nervous system, cranial nerves, and sensory organs, followed by a written test focusing on the resolution of a clinical case based on neuronatomy.
The exams will evaluate student's ability to analyze and describe anatomical specimens and microscopic preparations, as well as their capacity to develop presentations or written work on innovative topics in neuroanatomy and its application to clinical practice.

The final grade for Neuroanatomy will be determined by the score obtained in the oral exam, plus or minus up to 3 additional points from the written test.
The exam will be considered passed with a minimum score of 18/30.
The written test will be assessed using a qualitative scale with three levels: Sufficient, Good, and Excellent.
The oral exam will be graded numerically, with a minimum passing score of 18/30 and a maximum of 30/30.

Neurophysiology
The assessment will evaluate the ability to associate anatomical structures with their primary physiological functions. Students are also expected to understand and model key neural functions, interpret relationships between physiological parameters, and graphically represent such dependencies.

The written exam of Neurophysiology (30 points) consists of two consecutive steps to be completed on the same day:
• First step (18 points): 18 multiple-choice questions, each worth 1 point. The final score is the sum of correct answers. Incorrect or unanswered questions receive 0 points. The maximum score for this step is 18 points. A minimum of 12 points is required to proceed to the second step. Duration: 45 minutes.
• Second step (12 points): 3 open-ended questions, each with a maximum of 200 words. Each question is worth 4 points. The maximum score for this step is 12 points.

The total score for the Neurophysiology written exam (maximum 30 points) is the sum of the scores from both steps.

If the total score is:
o Below 18/30: the candidate fails the exam.
o Equal or above 18/30 and below 24/30 (18 ≤ x < 24): the candidate retains the written exam score as the final grade of Neurophysiology.
o Equal or above 24/30: the candidate may choose to keep 24/30 as the final grade of Neurophysiology without taking the oral exam or may take the oral exam to confirm or improve the grade (note: the grade may also be lowered in case of poor performance). The oral exam of Neurophysiology must be taken during the same call and within the same session as the written exam.

The final oral interview, which can only be taken after passing both the Neurophysiology and Neuroanatomy exams, will assess the student's ability to integrate the knowledge and skills acquired in both modules.

The final grade of the course will be based on the weighted average of the two module exams and the performance in the integrated oral exam. The final score may reach up to 30 cum laude.

Testi di riferimento

After each lecture, students will be provided with the corresponding teaching materials.

Neuroanatomy

Primary text books
- Anastasi et al. Treatise of Human Anatomy, Topographic Approach and Atlas. 1st Edition, EdiErmes.
- David L. Felten et al. Netter's Atlas of Neuroscience. 4th edition. Elsevier.

Additional text Books
- Susan Standring et al. Grey's Anatomy: The Anatomical Basis of Clinical Practice. 41st Edition. Elsevier;
- Hal Blumenfield. Neuroanatomy trough Clinical Cases. 2nd Edition. Oxford University Press.

Additional Anatomy Atlas
- Friedrich Paulsen et al. Sobotta Atlas of Human Anatomy. 15th edition. Urban & Fisher (Elsevier);
- Frank H. Netter. Atlas of Human Anatomy. 7th edition. Elsevier.

Embryology and development
- Keith Moore and T.V.N Persaud et al. The Developing Human. Clinically oriented Embryology. 11th revisited edition. Elsevier.

Neurophysiology

Main textbook:
Kandel/Schwartz/Jessell, Principles of neural science, VI edition, McGraw-Hill Education 2021.

Integrative textbook (useful mainly for organ physiology, which will be studied during the second semester):
Boron and Boulpaep, Medical Physiology, 3th Edition. Elsevier 2016.

Risultati di apprendimento specifici

Students are expected to acquire a solid understanding of the principles underlying the functional organization and physiology of the human nervous system, taking into account the specific features of both central and peripheral structures. This knowledge will be quantitatively oriented, with a particular focus on the sensorimotor mechanisms of the nervous system, including perception and sensation, pain, motor control, and autonomic responses.
Students are also expected to understand the control policies involved in regulating human behavior, emotions, sleep-wake cycles, and cognitive functions.

More specifically, by the end of the course, students should be able to:
• Identify, map, and name key structures and functional pathways in the brain
• Understand the functional principles governing the organization of the nervous system
• Understand the link between human nervous system functions and molecular and cellular models in animals and cell systems, in light of research applications
• Distinguish between different methods and technologies used to investigate the human brain from both functional and structural perspectives
• Describe different brain regions, differentiate their functions, and assess their potential clinical relevance
• Be able to quantitatively model the interaction between investigated neurophysiological parameters and their methods and technologies of assessment

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2025)	comune	12	BIO/16, BIO/09

Stampa del 16/10/2026

Organs Anatomy and Physiology [1210204]

Offerta didattica a.a. 2026/2027

Docenti: MARCELLO D'AMELIO, GIORGIO VIVACQUA

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi
The Integrated course Organs Anatomy and Physiology includes two modules spread out over the second term of the medical course second year. Physiology is the study of how the human body works and is a core discipline area in medical sciences. In the course, physiological aspects will be integrated from the molecular and cellular levels through to the function and the organizations of the different organs and systems (Anatomy) to understand whole body function. Progressive knowledge of the function and the structure of the human body leads to a progressive understanding of the mechanisms of disease, and in several cases, to the development of an array of pharmacological strategies as well as surgical approaches aimed at blocking or slowing-down disease progression.

Prerequisiti
Knowledge of biophysics and cellular physiology, cellular and molecular biology are strongly recommended.

Contenuti del corso
Anatomy

- Cardiovascular System: the hearth and the pericardium: topography, gross anatomy and superficial anatomy. Radiologic anatomy of the hearth; the coronary system; the myocardial tissue. Development of the hearth and anatomical basis of cardiac malformations. The arteries and the veins: general organization of the arteries and veins systems, angiograms and radiological anatomy of the vascular system; microscopic structures of arteries, veins and capillaries.
- Respiratory System: the nasal cavities; the larynx and the anatomy of phonation; the trachea and the lower airways; the lungs and the pleura. Pulmonary circulation. The diaphragm and the respiratory mechanics. Radiological anatomy of the lungs and the thoracic cavity. The microscopic structure of the airways: respiratory epithelium, organization of the alveoli and of the blood/air barrier. Development of the respiratory system.
- Lymphatic system: overview of the lymphatic pathways. Topography and microscopic structure of the thyme, the spleen and the lymph nodes. Emocatheresys. Thymic selection and anatomical bases of dysimmune syndromes.
- Digestive system: The oral cavity, the pharynx and the salivary glands: position, clinical anatomy and histology; mechanism of swallowing. The alimentary tract (oesophagus, stomach, small and largne intestine): organization, topography, blood supply. Microscopic organization of the alimentary tract. The mucose associated lymphoid tissue (MALT). The Liver and the biliary pathways: topography, gross anatomy and microscopic organization. The portal system and its anastomosis. The pancreas: topography and microscopic organization. Endocryne function of the Pancreas. The peritoneum. Radiological and clinical anatomy of the abdominal cavity. The development of the digestive system and the peritoneal cavity.
- Urinary system: The kidney: topography, gross anatomy, radiological anatomy. Blood supply. The structure of the glomerulus. The ureter: topography, ureteral points, microscopic structure: Urinary bladder: position, gross anatomy and microscopic structure: detrusor muscle, transitional epithelium. Radiological anatomy of the excretive pathways. Micturition.
- Endocrine system: the hypophysis and the hypothalamus. Thyroid and parathyroid. Suprarenal glands and stress response. Pineal gland. Endocrine pancreas. Blood supply to the principal endocrine glands.
- Male and female reproductive system: the gonads: position, topography and histology. Blood supply. Oogenesis and spermatogenesis. The scrotal cavity. The Uterus and the falloppian tubes: position, topography and histology. The uterin cycle. Development of the reproductive system. External genitalia.

Human Physiology

- The cardiovascular system: Organization of the Cardiovascular System, Arteries and Veins, The Microcirculation, Cardiac Electrophysiology and the Electrocardiogram, The Heart as a Pump, Regulation of Arterial Pressure and Cardiac Output, Integrated Control of the Cardiovascular System.
- The Respiratory System: Organization of the Respiratory System; Mechanics of Ventilation; Acid-Base Physiology; Transport of Oxygen and Carbon Dioxide in the Blood; Gas Exchange in the Lungs; Ventilation and Perfusion of the Lungs; Control of Ventilation
- The Urinary System: Organization of the Urinary System; Glomerular Filtration and Renal Blood Flow; Transport of

Sodium and Chloride; Transport of Urea,Glucose,Phosphate,Calcium and organic solutes; Urine Concentration and Dilution
- The Gastrointestinal System: Organization of the Gastrointestinal System; Gastric Function; Pancreatic and Salivary Glands; Intestinal Fluid and Electrolyte Movement; Nutrient Digestion and Absorption; Hepatobiliary Function
- The Endocrine System: Organization of Endocrine Control; Endocrine Regulation of Growth and Body Mass; The Thyroid Gland; The Adrenal Gland; The Endocrine Pancreas; The Parathyroid Glands and Vitamin D; The Reproductive System: Sexual Differentiation; The Male Reproductive System; The Female Reproductive System; Fertilization, Pregnancy and Lactation

Metodi didattici
The aims of the course will be achieved by a combined approach between traditional inductive teaching method, problem based learning and interactive learning. Problem Based learning and Interactive learning, consisting of tests or open-ended problems to consolidate the learned topics.

Modalità di verifica dell'apprendimento
The ability to apply the knowledge and understanding of the main aspects of morpho-functional organization of the nervous system and the sense organs, reworking them in a reasoned manner is assessed. Students are also required to graphically represent models and interactions between physiological parameters and explain interactions between different organs and systems, with reference to the clinical relevance of their disfunction. Emphasis is placed on the students' communication skills and their ability to critically reformulate the learnt concepts.

The acquisition of knowledge and skills will be verified through a final exam taking place at the end of the term, in the sessions foreseen by the academic calendar.

Human Physiology

Students will be evaluated through a
- written test including a) multiple choice-test pertaining to all the subjects presented during physiology lectures of the second term (5 questions); b) problems of applied physiology, including clinical cases related to the topic (10 problems).
Students can try to improve the grade with the oral exam (the grade can also be decreased in case of poor performance).

Anatomy Exam modalities
The exam will consist of two parts:
- a written test including 8 questions (short essays - clinical anatomy cases - description of anatomy pictures). Each question will focus on a specific apparatus: 1 for Respiratory, 1 for lymphoid system, 2 for Gastrointestinal system/Liver and Pancreas, 1 for Urinary system, 1 for Male genital system, 1 for Female Genital System and 1 for Endocrine System. Answering completely wrong or not answering at all to one of the proposed questions will determine the exam not passed. The time of the written test will be 2 hrs and 45 minutes. Written test will account for 60% of the final mark.
- practical exam. it will be scheduled the same day of the written test and will include microscopy with a slide of a specific organ and a radiology examination at the Anatomy virtual table. Practical exam will account for 40% in the final mark.
If the student will be not able to pass both written test and practical exam, he will be asked to repeat the whole exam.

The final mark will be obtained by the arithmetic average between the marks of two exams (Anatomy and Physiology).

Testi di riferimento
After the lessons covering a section of the program, students will be provided with the related didactic materials.

Main textbook:

- Kandel/Schwartz/Jessell, Principles of neural science, VI edition, McGraw-Hill Education 2021.
- Boron and Boulpaep, Medical Physiology, 3th Edition. Elsevier 2016;

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Anatomy

Principal Text books
- Anastasi et al. Treatise of Human Anatomy, Topographic Approach and Atlas. 1st Edition, EdiErmes.

- Lippincott Williams & Wilkins - Barbara Young et al. Weather: Histology and Microscopic Anatomy. 6th edition. Elsevier.

Other books
- Susan Standring et al. Grey's Anatomy: The Anatomical Basis of Clinical Practice. 41st Edition. Elsevier;

Other Anatomy Atlas
- Friedrich Paulsen et al. Sobotta Atlas of Human Anatomy. 15th edition. Urban & Fisher (Elsevier);
- Frank H. Netter. Atlas of Human Anatomy. 7th edition. Elsevier.

Embryology and Development
- Keith Moore and T.V.N Persaud et al. The Developing Human. Clinically oriented Embryology. 11th revisited edition. Elsevier.

Risultati di apprendimento specifici

Human Physiology

The knowledge of physiological concepts essential for understanding mechanisms of disease is required. In particular, the student should be also able to:

- Describe cardiac muscle function and properties;
- Discuss unique characteristics of cardiac muscle;
- Discuss electrophysiology of the heart: the conduction system;
- Describe normal Electrocardiogram (ECG), and the main changes of ECG in cardiac arrhythmias;
- Describe and graph cardiac cycle details;
- Describe cardiac function in relation to change of preload, afterload and contractility;
- Understand the pressure, volume and flow changes during the cardiac cycle;
- Describe expected auscultation sounds in physiology and pathophysiology (murmurs);
- Discuss factors that related cardiac output to venous return;
- Delineate the way cardiac output can be regulated;
- Discuss the fundamentals of fluid dynamics and methods to measure blood flow and pressure;
- Describe and graph arterial pressure in systemic and pulmonary circulations;
- Discuss the regulation of arterial pressure (brief term, middle-term and long-term regulation);
- Discuss local control of blood flow (autoregulation and paracrine effects);
- Discuss unique characteristics and phasic aspects of coronary flow;
- Describe renal body fluids regulation;
- Describe structure and function of the kidney and nephrons;
- Describe and discuss renal clearance;
- Describe glomerular filtration rate and renal hemodynamics;
- Describe transport properties of nephron segments;
- Discuss urine concentration and dilution;
- Describe Na+ balance and regulation of extracellular fluid volume;
- Discuss K+ balance;
- Describe Ca2+ and phosphate balance;
- Describe pulmonary mechanics (pressure, volume, compliance, resistance, wall tension);
- Describe and graph lung volumes and capacity and alveolar ventilation;
- Describe unique characteristics of the pulmonary circulation;
- Describe pulmonary gas exchange;
- Discuss respiratory control;
- Discuss acid-base balance and role of buffers, kidneys and lungs;
- Describe the characteristics of the enteric nervous system and its interaction with the extrinsic nervous system in the regulation of the functions of each GI segment;
- Describe of GI reflexes and neurotransmitters involved;
- Describe the functions of each GI segment (secretion, digestion, absorption and motility);
- Indicate the composition of secretion of each GI segment and annexed glands; description of the functions of their components;
- Discuss the regulation of the secretory processes;
- Describe the cell type and anatomical location of the endocrine cells responsible for the production of the major GI hormones and their cellular targets; describe the stimuli that promote and inhibit the release;
- Describe the digestion of the nutrients;
- Describe the membrane transport mechanisms responsible for the absorption of: digestion products of sugars, proteins, lipids, vitamins and electrolytes by the intestinal epithelial cells;

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2025)	comune	12	BIO/16, BIO/09

Stampa del 16/10/2026

Pathology Immunology and Microbiology [1210302]

Offerta didattica a.a. 2026/2027

Docenti: ANDREA MARRA, SILVIA ANGELETTI, MARIAVITTORIA VESCOVO

Periodo: Primo Ciclo Semestrale

Obiettivi formativi

Course overview
• Experimental medicine and pathophysiology (11 CFU)
• Microbiology and clinical microbiology (3 CFU)
• Clinical pathology (1 CFU)
• Anatomical Pathology (4 CFU: 3+1 clinical practice)

EXPERIMENTAL MEDICINE AND PATHOPHYSIOLOGY [11 CFU]
(Dr. Andrea Marra, Prof. Mario Cioce, Dr. Veronica Gatti, Prof. Vito Michele Fazio)

Course overview and learning outcomes

The Experimental medicine and pathophysiology course aims to provide a comprehensive understanding of the mechanisms of human diseases at the molecular, cellular and systemic (organism-based) levels. Students will learn about the homeostatic mechanisms and the consequences of their disruption in disease. The course will cover the foundational aspects of pathology and immunology, as follows:

• Cellular and molecular pathology: this module will dissect i) the causes and consequences of damage to cells, tissues, and organs; ii) the mechanisms of how cells and tissues respond to different types of injury or stress, and how these responses can lead to the development of a disease; iii) the cellular and molecular processes underlying ageing, vascular pathology and cancer;

• Pathophysiology: this module will explore the mechanisms of disease development, focusing on the underlying pathogenetic processes that contribute to the onset and progression of the most common human diseases;

• Immunology and immunopathology: this module will dissect the mechanisms of defense against pathogens and responses to injury, as well as the causes and consequences of both innate and adaptive immune dysfunctions (immunopathology).

Expected learning outcomes

At the end of the course, students will gain knowledge on:
• The biological principles underlying the development of human diseases;
• Recognize the biological principles that govern the onset, progression, and outcomes of pathological processes, from molecular to organismal levels;
• Molecular and cellular basis of cancer
• Vascular pathology and immunopathology
• Immune responses to infections
• Pathophysiology of the major human diseases and their clinical correlates

MICROBIOLOGY AND CLINICAL IMMUNOLOGY [3 CFU]
(Prof. Silvia Angeletti, Dr. Roberta Campagna)

Course overview and learning outcomes

The Microbiology and clinical microbiology course will provide the students with strong basis in the essential principles and practices related to the microbic world. Students acquire the skills to identify and categorize microorganisms such as bacteria, viruses, fungi, and protozoa, utilizing both theoretical concepts and hands-on laboratory methods. This understanding is fundamental for understanding the roles these organisms have in health and disease.
One of the core competencies developed in this course is the ability to conduct laboratory experiments with precision and accuracy. Students become proficient in aseptic techniques, cultural methods, and various microbiological assays that are essential for the isolation and identification of pathogens. They gain hands-on

experience with advanced equipment, such as microscopes and spectrophotometers, enhancing their technical skills and fostering critical thinking in experimental design and troubleshooting.
Moreover, the course emphasizes the importance of clinical microbiology in diagnosing infections and informing treatment strategies. Students learn to interpret laboratory results and apply their findings to real-world clinical scenarios. This includes understanding antimicrobial susceptibility testing, which is vital for selecting appropriate therapeutic interventions and managing infectious diseases.
Additionally, knowledge of microbial genetics and biochemistry allows students to appreciate the mechanisms of pathogenicity and resistance. This understanding is crucial for developing novel antimicrobial strategies and public health initiatives aimed at controlling outbreaks and promoting community health.
The course includes a specific focus on the study of human microbiota foundations in clinical microbiology setting. focusing on the specific concept of how the differente array of microorganisms residing within our bodies plays a crucial role in our overall health and well-being. This new area of research highlights the importance for clinical microbiology students to understand the complex connections between humans and their microbes. In addition, the rise of antibiotic resistance is a pressing concern in modern medicine. Through a comprehensive analysis of the microbiota, students can better understand how antibiotics alter microbial communities, promoting resistance and diminishing the effectiveness of these important drugs. This insight is crucial for improving responsible antibiotic use and developing strategies to mitigate resistance.
Furthermore, during the course, insights will be provided to the students about Molecular diagnostic methodologies that play a critical role in the diagnosis of infectious diseases, reshaping the field of medical diagnostics in significant ways. These advanced techniques, which include polymerase chain reaction (PCR), next-generation sequencing (NGS), and various other nucleic acid amplification tests, allow for the rapid and accurate identification of pathogens at the genetic level. The importance of these methodologies will be illustrated along with their ability to detect even trace amounts of microbial DNA or RNA, enabling clinicians to diagnose infections much earlier than traditional culture methods. This early detection is vital, particularly for diseases caused by fast-acting pathogens such as viruses and bacteria, as it allows for timely interventions that can significantly improve patient outcomes and reduce morbidity and mortality rates.

The Virology course will be divided into two parts. The first part will cover topics of general virology, starting with a brief introduction to the structure and classification of animal viruses. This will be followed by an in-depth examination of the stages of the viral replication cycle and the pathogenesis of viral infections. The second part of the course will be dedicated to special virology, focusing on some of the main families of viruses of human interest: Herpesviridae, Orthomyxoviridae, Papillomaviridae, Retroviridae (HIV), viral hepatitis will be discussed, thus the families Hepadnaviridae (HBV), Flaviviridae (HCV) and Picornaviridae (HAV), and finally an overview of the exanthematous diseases associated with viral infections. For each family, topics related to diagnosis, therapy, and prophylaxis will also be addressed.

Expected learning outcomes
At the end of the course, the students will understand how the integration of molecular diagnostic methodologies into clinical practice is indispensable for the effective management of infectious diseases. Their capacity for rapid, accurate, and specific diagnosis not only enhances patient care but also strengthens public health responses, demonstrating their pivotal role in combating infectious diseases worldwide. In summary, the course in microbiology and clinical microbiology not only imparts essential scientific knowledge but also promotes practical laboratory skills, critical thinking, and effective communication, preparing graduates for diverse careers in healthcare, research, and public health.

CLINICAL PATHOLOGY [1 CFU]
(Prof. Silvia Angeletti)

Course overview and learning outcomes

The Clinical Pathology course provides students with a comprehensive understanding of disease mechanisms and their implications in clinical practice. This course equips students with a unique blend of theoretical knowledge and practical skills essential for diagnosing and understanding various health conditions.
Firstly, students gain in-depth knowledge of pathology, including the mechanisms of disease, cellular adaptations, and the impact of pathological processes on human health. This foundation allows them to analyze the underlying causes of illnesses, ranging from infectious diseases to cancers and autoimmune disorders.
Moreover, the program emphasizes diagnostic techniques, where students learn how to interpret laboratory results and correlate them with clinical symptoms.
In addition to technical skills, the Clinical Pathology course encourages the development of critical thinking and problem-solving skills. Students are trained to evaluate complex clinical scenarios, synthesize information from various sources, and make informed decisions regarding patient care. This analytical mindset is crucial in pathology, where precise diagnosis can significantly influence patient treatment.
Furthermore, effective communication is a key competency acquired through clinical pathology training. Students learn to articulate their findings and collaborate with other healthcare professionals, ensuring a multidisciplinary approach to patient management. This promotes collaboration and improves the overall quality of healthcare delivery.
Finally, the ethical dimensions of practicing clinical pathology are emphasized throughout the course. Students learn

the significance of ethics in managing patient information and making diagnostic decisions, improving the sense of responsibility and integrity that is essential in the medical profession.

Expected learning outcomes
The Clinical Pathology course equips students with broad set of skills including comprehensive knowledge of disease processes, technical laboratory skills, analytical thinking, effective communication, and a strong ethical framework. These competencies prepare them for successful careers in various healthcare settings, contributing to improved patient outcomes and advancements in medical science.

ANATOMIC PATHOLOGY [1 CFU]
(Prof. Giuseppe Perrone)

COURSE DESCRIPTION AND OBJECTIVES
The Pathological Anatomy course aims to provide students with the tools to learn the pathological basis of diseases of organs and systems, and to integrate macroscopic, histological, cytological and molecular alterations into the clinical picture. Specifically, this course will cover an introduction to Pathological Anatomy: the module will illustrate the clinical application of the principles of General Pathology (inflammation, neoplasms, degenerative processes) through the activity of Pathological Anatomy. The main diagnostic procedures in surgical pathology, the professional tasks, responsibilities and fields of activity of the pathologist will be described.

EXPECTED LEARNING OBJECTIVES
The course will cover the fundamental aspects of the main procedures and techniques in pathological anatomy, such as cytological and histological examinations; intraoperative fresh examinations; histological, histochemical, immunohistochemical and molecular biology techniques.
At the end of the course, students will be familiar with the main diagnostic tools (exfoliative and aspirative cytology, histology, cytology, intraoperative examinations) and techniques (immunohistochemistry and molecular pathology) of pathological anatomy.

Prerequisiti
Basic Life Science III, Biochemistry.

Contenuti del corso
EXPERIMENTAL MEDICINE AND PATHOPHYSIOLOGY [11 CFU]
(Dr. Andrea Marra, Prof. Mario Cioce, Dr. Veronica Gatti, Prof. Vito Michele Fazio)

Module 1. Molecular and cellular pathology
• Definitions of health, homeostatic equilibrium and disease
• Types of cellular and molecular responses to stress and toxic stimuli: mechanisms of cell and tissue adaptation (hypertrophy, hyperplasia, atrophy. regression, metaplasia and dysplasia), injury and death
• Wound healing: Tissue renewal, repair and regeneration
• Programmed cell death

Module 2. Inflammation
• The acute inflammatory response
• Chronic inflammation (histophlogosis), fibrosis, stem cells and tissue renewal
• Chronic granulomatous reactions
• Inflammation and cancer

Module 3. Vascular pathology
• Hemostasis and coagulation
• Atherosclerosis
• Thrombotic disorders

Module 4. Tumor biology
• The basis of cancer: definition, nomenclature and epidemiology
• Cellular and molecular hallmarks of cancer
• Genetic and non-genetic mechanisms of tumorigenesis
• The tumor micro- and macro-environment
• The cancer-immunity cycle
• Cancer as a systemic disease
• Principles of precision medicine in oncology: applying omics and informatics
• Cancer models: patient avatars, animal models and 3D cultures
• Principles of cancer immunotherapy

Module 5. Pathophysiology
• Disorders of the respiratory system: obstructive and restrictive diseases

• Cardiac diseases (heart failure, acute myocardial infarction, cardiomyopathies, arrythmias) and hypertension
• Disorders of the liver and biliary tract
• Diabetes mellitus and metabolic syndrome
• Acute and chronic kidney disease
• Electrolyte disorders and acid-base disturbances
• Shock: basic pathobiology and types of shock
• Disorders of the hematopoietic and lymphoid system

Module 6. Immunology and immunopathology (Dr. Andrea Marra)
• Introduction to immunology
• Leukocyte circulation and migration into the tissue
• Innate immunity
• Histocompatibility complex and antigen presentation
• Immune receptors
• T cell activation
• Lymphocyte tolerance
• Differentiation and function of T cells
• B cell activation and antibody production
• Humoral immunity
• Mucosal immunology
• Immunopathology: hypersensitivity reactions, primary and secondary immunodeficiencies; autoimmunity

MICROBIOLOGY AND CLINICAL IMMUNOLOGY [3 CFU]
(Prof. Silvia Angeletti, Dr. Roberta Campagna)

Module 1. Cellular microbiology and clinical bacteriology
• General information about prokaryotic cells and bacterial cell wall
• Biosynthesis of the bacterial cell wall, bacterial growth curves, and bacterial culture media
• Bacterial pathogenesis, enzymes (Lecithinase: destroys the phospholipids of cell membranes. Protease: degrades the host's proteins, facilitating invasion), structural components (Capsule: a gelatinous structure that surrounds certain bacteria, helping them evade the host's immune system. The capsule can prevent phagocytosis. Cell wall); bacterial toxins (exotoxins-and endotoxins)
• Pre-analytical, analytical, and post-analytical phases of clinical bacteriology
• Antibacterial agents
• Role of clinical microbiology in antimicrobial stewardship programs
• Systematic bacteriology and main groups of bacterial species of clinical interest: Staphylococci (Staphylococcus aureus, coagulase-negative staphylococci, streptococci, enterococci and pneumococci, Bacillus anthracis and Bacillus cereus, Corynebacterium diphtheriae, Listeria monocytogens, Neisseria (Neisseria meningitidis, Neisseria gonorrhoeae,),Mycobacteria (Mycobacterium tuberculosis,) and non-tuberculous mycobacteria(NTM),Enterobacteriaceae (E. coli, Salmonella, Shigella, Klebsiella, Citrobacter, Enterobacter, Serratia, Proteus, and Yersinia); Vibrio cholerae, Campylobacter, Helicobacter pylori, Brucella, Bordetella (Bordetella pertussis), Pseudomonas aeruginosa, Acinetobacter, Legionella (Legionella pneumophila), Clostridia (Clostridium tetani, Clostridium botulinum, Clostridium perfringens, Clostridioides difficile), Spirochetes (Treponema pallidum, Borrelia, and Leptospira), Chlamydia (Chlamydia trachomatis, Chlamydia psittaci, Chlamydophila pneumoniae), Mycoplasmas (Mycoplasma pneumoniae and genital mycoplasmas)
• Human microbiota, methods and tools for research and diagnostics in microbiology and clinical microbiology
• Serological and molecular diagnostics.

Module 2. Mycology and parasitology
• Antimicrobial susceptibility testing; characteristics of clinically relevant fungi. Yeasts and filamentous fungi (Candida spp.; Dermatophytes Malassezia furfur; Cryptococcus neoformans; Nocardia; Aspergillus)
• General Information on Parasites, Hosts, and Vectors
• Parasites and Parasitism
• Human intestinal parasites (protozoa and metazoa) classification, biological cycle, pathogenesis, epidemiology
• Blood and tissue parasites in humans: classification, biological cycle, pathogenesis, epidemiology
• Zoonosis caused by parasites: classification, biological cycle, pathogenesis, epidemiology

Module 3. Virology (Dr.ssa Roberta Campagna)
• General virology: structure and classification of animal viruses
• Stages of the viral replication cycle and the pathogenesis of viral infections
• Main families of viruses of human interest (pathogenesis, diagnosis, therapy and prophylaxis): Herpesviridae, Orthomyxoviridae, Papillomaviridae, Retroviridae (HIV), viral hepatitis, Hepadnaviridae (HBV), Flaviviridae (HCV) and Picornaviridae (HAV)
• Viruses responsible for recurrent infections: focus on herpes virus type seven
• Infections of the skin and mucous membranes: focus on papillomaviruses
• Exanthematous diseases associated with viral infections
• Virological diagnostics of viral infections: direct and indirect diagnosis, molecular diagnostics of respiratory virus infections: focus on influenza virus and epidemic viruses (SARS, MERS, SARS-CoV-2)

CLINICAL PATHOLOGY [1 CFU]
(Prof. Silvia Angeletti)

• Biological sample collection; transport and storage
• CBC examination: iron deficiency anemia; macrocytic anemia; haemolytic anemia; lymphoproliferative diseases
• Coagulative tests
• Diagnosis of diabetes and other endocrine disorders; hepatic failure; renal failure; dyslipidemics; diagnosis of myocardial infarction
• Hydro-electrolytic imbalances; enzymes and their diagnostic use
• Tumor markers
• Laboratory diagnosis of the most relevant bacterial and viral infections: hepatitis, pneumonia, urinary tract infection and sepsis
• ODDS ratio, ROC curves, laboratory errors
• Quality in the clinical laboratory: introduction to quality systems; clinical laboratory certification and accreditation; internal quality control (Levy-Jennings quality charts); external quality control (VEQ)
• Presentation of clinical cases to practically illustrate the correct use of laboratory tests in terms of appropriate request, accurate reporting, and communication with the clinician
• The ethical use of laboratory testing in diagnosing common diseases: this represents a fundamental topic in medicine, as it involves the responsibility of health professionals in managing information and diagnostic results
• Information and consent: patients are adequately informed about the laboratory tests that will be performed
• Access to tests: it is necessary to ensure that all patients have equitable access to diagnostic tests.
• Interpretation of results: Laboratory professionals must interpret laboratory test results carefully, taking into account the patient's overall clinical picture.
• Privacy and confidentiality: test results must be treated with the utmost confidentiality.
• Management of false positives and negatives:it is important to be aware of the limitations of laboratory tests.

ANATOMIC PATHOLOGY [1 CFU]
(Prof. Giuseppe Perrone)

Module 1. Main procedures and techniques in pathological anatomy
- Method of Pathological Anatomy
- Cytological and histological examinations
- Intraoperative fresh examinations
- Histological, histochemical, immunohistochemical and molecular biology techniques
- Reporting in Pathological Anatomy

Metodi didattici
The course includes frontal lessons and monographic courses. External speakers may be invited to lecture on specific topics.
Lectures supported by visual aids and professional training activities in the Pathological Anatomy Unit of the Hospital.

Modalità di verifica dell'apprendimento
The final assessment will consist of a written test followed by an oral examination. The written test will include 64 questions (multiple choice examination) on:

• Experimental medicine and pathophysiology: 32 questions
• Immunology and immunopathology: 8
• Microbiology and clinical immunology: 12 questions
• Clinical pathology: 6 questions
• Pathology: 6 questions

To pass the exam, the student must correctly answer at least half of the questions in each module.

Each correct answer is worth 0.5 points, no answer yields 0 points, and each incorrect answer deducts 0.2 points.

The oral examination will cover questions from each module, and the final grade will be calculated as a weighted average of the scores from both the written test and the oral examination across all modules.

Testi di riferimento
Powerpoint slides which will be presented during the course will be available in .pdf format through the UCBM e-learning portal. Scientific articles or other teaching materials will be discussed and shared during the lessons.

Recommended textbooks

• Experimental medicine & pathophysiology, and anatomical pathology: Robbins and Cotran Pathologic Basis of Disease, 10th edition. Elsevier 2020.

• Immunology and immunopathology: A.K. Abbas, A.H. Litchman, J.S. Pober, Cellular and molecular immunology, 10th edition. Elsevier 2021.

• Microbiology: Patrick R. Murray, Ken S. Rosenthal, Michael A. Pfaller. Medical Microbiology. 9TH Edition. Elsevier 2020.

• Clinical pathology: Michael Laposata. Laposata's Laboratory Medicine Diagnosis of Disease in Clinical Laboratory Third Edition. McGraw-Hill Education.

Risultati di apprendimento specifici

D1- KNOWLEDGE AND UNDERSTANDING ABILITIES
The student must demonstrate knowledge of the main mechanisms responsible for the development of diseases in humans; the causes of cell/tissue damage and death; molecular and cellular immunology; fundamental pathogenetic mechanisms associated with immunity, inflammation and carcinogenesis.

In addition, the student should be familiar with the biological fundamentals of microbiology, the pathogenesis of the major infectious disorders, and the laboratory methodologies necessary to support the clinical management of the patients.

Further, the clinical pathology course will equipe the student with the knowledge on the basic mechanisms of human diseases, technical laboratory skills, analytical thinking, and rigorous ethical approach.

Furthermore, at the end of the Anatomical Pathology course, the student has to:
· become acquainted with the most important diagnostic tools (exfoliative and aspirative cytology, histology, cytology, frozen section) and techniques (immunohistochemistry and molecular pathology) of the anatomical pathology;
· be aware of the possible applications of such tools in preventive medicine (cytological and molecular screening), in clinical diagnostics and in the evaluation of prognostic and predictive parameters;
· be able to properly interpret and integrate in the clinic the information provided by the pathology report for an appropriate therapeutic decision-making process.

D2-ABILITY TO APPLY KNOWLEDGE
The student should have acquired knowledge enabling him/her to recognize the mechanisms responsible for the development of a disease and to identify specific pathological conditions with applicative possibilities in the prevention, diagnosis and therapy of diseases. The ability to use these tools will be an integral part of the student's future professional life, in health care and/or experimental research. These skills will be assessed through the final examination.

D3-INDEPENDENT JUDGEMENT
The student must demonstrate that he/she has acquired the ability to critically evaluate and connect the topics tested. Capacity for constructive synthesis, ability to contextualize and connect different scientific evidence. These skills will be tested both by means of the written test and through application-oriented oral questions. These skills will be assessed through the final examination.

D4-COMMUNICATION SKILLS
The student should be able to describe the principles and concepts learnt during the course by expressing himself/herself clearly, in appropriate terms and using appropriate examples. This ability will be assessed during the oral interview.

D5-KNOWLEDGE ABILITIES
The student must be aware of his or her own scientific growth in a critical and autonomous manner, be able to make correct use of the study material provided and be able to delve into it independently. These skills, as far as possible, will be stimulated by the lecturer proposing during the lessons.

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale	Laurea Magistrale in Medicine and	comune	17	MED/04, MED/05,

Ciclo Unico 6 anni	Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2025)	MED/07, MED/08

Stampa del 16/10/2026

pharmacology and medical genetics [1210207]

Offerta didattica a.a. 2026/2027

Docenti: FIORELLA GURRIERI, EMANUELA SALVATORELLI

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi
The course brings together two main branches: Pharmacology and Medical Genetics, strictly connected within the modern concept of precision medicine. In essence, the main objective is to start from the foundations of the two fields and move towards the knowledge of the genetic load in human diseases, the potential for tailored treatments and the opportunities for cause-related rather than disease-related therapies. Basic concepts in human genetics and drug metabolism will be included.

Prerequisiti
Biology and Chemistry are prerequisites.

Contenuti del corso
Medical Genetics:
• Basics concepts of genetics: from Mendelian inheritance to complex diseases (FG and CL)
• Human Genome Organization (CL)
• Human chromosomes and their associated diseases (CL)
• Genetic Load in medicine (genetic tests – genetic counselling- clinical genetics) (FG)
• Genetics of fetal diseases (including principles of prenatal diagnosis) (FG)
• Deviations from Mendelian genetics: Imprinting, dynamic mutation diseases (FG and CL)
• Fundamentals of molecular genetics techniques used in medical genetics (CL)
• Bioinformatic tools in Medical genetics: classification of variants (CL)
• Population Genetics (FG)
• Neuropsychiatric diseases and genetics (CL)
• Genetics in oncology (FG and CL)
• Cardiogenetics (FG)
• Genetics and thoracic diseases (FG)
• Genetics and autoinflammatory disease (FG)
• Principles of Medical GenETHICS (FG)
• Precision Medicine (FG)
• The concepts of polygenic risk score for diseases (FG)
• Epigenetic Signatures (CL)

General Pharmacology:
• Clinically oriented principles of pharmacokinetics, pharmacodynamics and drug metabolism
• Drug-drug interactions
• Principles of drug development and clinical trials
• Principles of mutagenesis and teratogenesis
• Genetically-oriented new methodologies in drug development and clinical trials
• Bioequivalent and biosimilar drugs

Metodi didattici
The teaching methodology will consist of a combination of traditional platform lessons, class seminars, interactive discussion on selected topics or on topics of interest for the students, practical activities both in the clinics and in the laboratory. The students will be stimulated to select an article from the medical literature and to briefly expose its contents to the whole class. Because the two disciplines of this Course share interests in preclinical and clinical fields, multidisciplinary seminars will be organized and relevant topics will be jointly discussed.

Modalità di verifica dell'apprendimento
At the end of the course the final exam will take place, in agreement with sessions scheduled in the academic

calendar. For Pharmacology, the knowledge gained and the ability to apply it will be verified by a written test. The text will include 16 multiple choice questions formulated to assess student capability to move around different topics. The evaluation (marks expressed as 30/30, w/wo honours) takes the following points into account:
- to each correct question will be given a score of 2 point
- to each wrong or not-answered question will be given a score of 0 point
- to pass the test the student needs to achieve a score of not less than 18/30
- honours can be awarded only if the student will correctly answer to all 16 questions

For Medical Genetics the exam will also be written with multiple choice questions (16 questions) and short assays/problems (3).
The evaluation (marks expressed as 30/30, w/wo honours) takes the following points into account:
- to each correct multiple choice question will be given a score of 1 point
- no penality for wrong multiple choice question
- for each short assays/problems the maximum score is set to 5 points each with no penality for wrong or not answering
- to pass the test the student needs to achieve a score of not less than 18/30
- honours can be awarded only if the student will correctly answer to all multiple choice questions and short assay/problems

In the event of irregularities during the written test, the teachers can ask students to take an oral exam.

Testi di riferimento
Medical Genetics:
Medical Genetics - Jorde Carey Bamshad, 6th edition, Elsevier
Medical Genetics - G. Bradley Schaefer, James N. Thompson Jr. Mc Graw Hill
Clinical cases will be presented and discussed throughout the course. Attendance of the genetic outpatients clinic is strongly recommended.

General Pharmacology:
- Goodman and Gilman's The Pharmacological Basis of Therapeutics 14th edition. McGraw Hill Publishing Co.

Risultati di apprendimento specifici
Marks of the two modules will be averaged to give a final mark, in proportion to the CFU of each courses.

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2025)	comune	6	BIO/14, MED/03

Stampa del 16/10/2026

Physiological Models [1210205]

Offerta didattica a.a. 2026/2027

Docenti: ALESSANDRO LOPPINI

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi
The course aims at providing basic knowledge of the mathematical tools to model physiological processes, from the cell scale up to the organ and system scale. The eventual objective is to provide students with a quantitative approach to physiology which would allow them better understanding of body functions, exploitable for both descriptive and predictive scenarios.

Prerequisiti
Basic knowledge of Mathematics (Calculus), Physics, and human Physiology.

Contenuti del corso
- Models of neurons: Hodgkin-Huxley model, cable equation and applications. Synapses and plasticity. Integrate-and-fire. Firing rate models.
- Models of muscles: Cross-bridge model. Extra- and intra-fusal fibers models. Motor control.
- Electrophysiological models of cardiac tissue: sinoatrial node cells, ventricular cells. Cardiac tissue modeling: 1D and 2D models of ventricular tissue. Heart dipole vector and ECG.
- Circulatory system modelling. Blood flow and Poiseuille's law. Vessel resistance and compliance. Cardiac pump and cardiac output. Simple models of circulatory system. Windkessel effect.
- Models of gas exchange in the respiratory system. Capillary-alveoli gas exchange. Carbon Dioxide removal model. Oxygen uptake model. Ventilation-perfusion.
- Models of renal physiology. Glomerular filter model. Urinary concentration: countercurrent mechanism.

Metodi didattici
Theoretical and practical lectures addressing the topics of the course. Teaching methods involve frontal lectures with slides and whiteboard, computer simulations of simple models, work in groups for in-depth study of selected models.

Modalità di verifica dell'apprendimento
Learning evaluation criteria and methods
Learning is assessed through a written exam and an oral examination, aimed at verifying the student's preparation on the topics presented during the course. In particular, the written test is designed to assess knowledge and understanding of the modeling topics covered during the course. The oral interview focuses on the discussion of the written test and on the presentation of a group project consisting of an in-depth study of a selected model, chosen from a list provided by the lecturers. This oral presentation is intended to evaluate the students' ability to apply the concepts addressed in the course.

Criteria for learning assessment and final score
The written test lasts 2 hours and includes 2 open questions (worth 8 points each, for a total of 16 points) and 8 multiple-choice questions (worth 1 point each, for a total of 8 points) on the models presented in the class. The oral presentation related to the group work on the selected modeling application is assessed with a mark ranging from 1 up to 6 points. A minimum score of 18 is required to pass the exam. The maximum achievable score is 30, with the possible award of honors (cum laude).

Testi di riferimento
- Slides and material produced by lecturers and uploaded on the e-learning platform.
- Suggested textbooks: Mathematical Physiology, James Keener and James Sneyd. Mathematical Foundations of Neuroscience, G. Bard Ermentrout , David H. Terman. Quantitative Human Physiology, Joseph Feher.

Risultati di apprendimento specifici
Knowledge and understanding
Students will achieve an adequate knowledge of the main mathematical models used in physiology, including applications to:

- neurons electrophysiology
- muscles contraction
- cardiac electrophysiology
- respiration
- blood circulation
- renal filtration

Applying knowledge and understanding
At the end of the course, students will be able to formulate coherent conceptual models of physiological processes, and identify the correct mathematical framework able to describe them quantitatively, at the desired level of detail. Further, students will be able to interpret the assumptions behind the specific models used in physiology, understanding their domain of applicability, descriptive and predictive power, and limits.

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2025)	comune	5	FIS/07

Stampa del 16/10/2026

Probability and Statistics [1210201]

Offerta didattica a.a. 2026/2027

Docenti: MASSIMO CICCOZZI, MARCO PAPI

Periodo: Primo Ciclo Semestrale

Obiettivi formativi
The course aims to provide students with fundamental knowledge in probability and statistics necessary for understanding and analyzing experimental data and random phenomena in the field of biomedical engineering. Particular emphasis will be placed on applications of descriptive statistics, probability theory, and statistical inference to biomedical contexts, with examples and case studies based on real data.

Prerequisiti
Students are expected to be familiar with basic concepts of linear algebra (vectors, matrices, systems of linear equations) and calculus (functions, limits, derivatives, integrals), as covered in the Mathematics I course.

Contenuti del corso
Descriptive Statistics:
- Types of data. Graphical representations. Frequency tables.
- Mean, median, mode, variance, standard deviation.
- Percentiles, interquartile range.
- Covariance and correlation. Simple and multiple linear regression.

Probability:
- Probability spaces. Classical, frequentist, and axiomatic definitions.
- Operations on events. Law of total probability. Bayes' theorem.
- Independence.

Random Variables:
- Discrete variables: binomial, geometric, Poisson distributions.
- Continuous variables: uniform, exponential, normal distributions.
- Cumulative distribution function. Expectation and variance.
- Bivariate random variables. Covariance and correlation. Marginal and conditional distributions.

Statistical Inference:
- Sampling. Sampling distributions. Central limit theorem.
- Point estimation: estimators and desirable properties.
- Confidence intervals for mean and proportion.
- Hypothesis testing: tests on means and proportions, type I and II errors, p-values.
- Applications to hypothesis validation in biomedical contexts.

Metodi didattici
-Lectures (40 hours): theoretical exposition and discussion of examples from biomedical applications.
-Exercise sessions (22.5 hours): problem-solving and case studies using real or simulated data, including the use of statistical software (e.g., MatLab, Excel).

Modalità di verifica dell'apprendimento
Knowledge and skills will be assessed through a written exam, which includes:
- 2 open-ended exercises (on probabilistic modeling, probability computation, and statistical inference)
- 2 multiple-choice questions on theoretical topics.
The maximum score for the written exam is 32 points.
Duration of the exam: 2 hours.
The final grade is expressed in thirtieths. The exam is passed if the score is at least 18/32. If the score is above 30/32, the final grade is 30 cum laude.

Testi di riferimento
[1] S.M. Ross – Introduction to Probability and Statistics for Engineers and Scientists Academic Press (Elsevier), 6th

edition, 2021, ISBN: 978-0-12-824346-6.
[2] Dimitri P. Bertsekas and John N. Tsitsiklis - Introduction to Probability, Athena Scientific, 2nd edition, 2008, ISBN: 978-1-886529-23-6.
[3] A. Agresti & C. Franklin – Statistics: The Art and Science of Learning from Data, Pearson, 5th edition, 2022, ISBN: 978-0-13-530688-2.
[4] Sheldon M. Ross – Student Solutions Manual for Introduction to Probability and Statistics for Engineers and Scientists, Academic Press (Elsevier), 6th edition, 2021, ISBN: 978-0-12-824351-0.
[5] Teaching materials provided by the instructor through the e-learning platform

Risultati di apprendimento specifici

Knowledge and understanding
The course will provide students with knowledge and understanding in the following areas:
- Descriptive statistics: measures of central tendency and variability, graphical representations.
- Probability: definitions, axioms, conditional probability, independence.
- Random variables: discrete and continuous, relevant probability distributions.
- Statistical inference: point and interval estimation, hypothesis testing.

Applying knowledge and understanding
By the end of the course, students will be able to:
- describe and represent real-world datasets using descriptive and graphical tools;
- build probabilistic models of observable phenomena;
- apply common distributions to practical problems;
- conduct inferential analysis on samples from biomedical populations;
- understand statistical results in clinical and experimental studies.

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2025)	comune	6	MAT/06, MED/01

Stampa del 16/10/2026

Respiratory Diseases [1210307]

Offerta didattica a.a. 2026/2027

Docenti: SIMONE SCARLATA, PANAIOTIS FINAMORE, PIERFILIPPO CRUCITTI, FILIPPO LONGO, BIANCA ROCCA, LORENZO NIBID, GIUSEPPINA PACELLA

Periodo: Secondo Ciclo Semestrale

Obiettivi formativi
The course aims to provide students with a comprehensive and integrated preparation on respiratory diseases, covering medical, surgical, pharmacological, imaging, and pathological aspects. Students will acquire theoretical and practical knowledge required for the diagnosis, treatment, and follow-up of patients with respiratory conditions, with special focus on the multidisciplinary approach.

Prerequisiti
Organs Anatomy and Physiology, Biochemistry, (Pathology, Immunology and Microbiology strongly suggested)

Contenuti del corso
a) Respiratory Diseases

Obstructive diseases: asthma, COPD, bronchiectasis.

Restrictive and interstitial lung diseases.

Respiratory infections: pneumonia, tuberculosis, opportunistic infections.

Pulmonary neoplasms.

Sleep-related breathing disorders.

Acute and chronic respiratory failure.

b) Thoracic Surgery

Principles and indications of thoracic surgery.

Surgery of lung carcinoma.

Surgery of pulmonary metastases.

Surgery of pleural and mediastinal diseases.

Minimally invasive techniques (VATS, robotic surgery).

c) Pharmacology of Respiratory Diseases

Bronchodilator drugs: β2-agonists, anticholinergics.

Inhaled and systemic corticosteroids.

Biological and immunomodulatory therapies.

Antitubercular and antimicrobial agents for respiratory infections.

Therapy of pulmonary hypertension.

d) Imaging of Thoracic Diseases

Chest X-ray: principles and interpretation.

Chest CT: protocols and indications.

Thoracic MRI and PET/CT.

Functional and interventional imaging.

Imaging diagnosis of major thoracic diseases.

e) Pathology of Respiratory Diseases

Inflammatory and infectious lung pathology.

Neoplastic pathology: benign and malignant lung tumors.

Interstitial lung diseases: pathological features.

Pleural and mediastinal pathology.

Clinico-pathological correlations.

Metodi didattici
Interactive lectures.

Multidisciplinary clinical case discussions.

Laboratory activities and seminars.

Clinical rotations and operating room observation.

Guided self-study.

Modalità di verifica dell'apprendimento
Written exam with multiple-choice questions.

Oral exam for integrated knowledge assessment.

Discussion of clinical cases.

Innovative teaching sessions (e.g., Flipped Classroom).

Assessment of practical skills during rotations.

Testi di riferimento
J. Larry Jameson, Anthony S. Fauci, Dennis L. Kasper, Stephen L. Hauser, Dan L. Longo, Joseph Loscalzo
Harrison's Principles of Internal Medicine, 20th edition – Publisher: Mc Graw-Hill

Stephen G. Spiro & Gerard A Silvestri & Alvar Agustí. Clinical Respiratory Medicine, 4th Edition
.
West JB. West's Pulmonary Pathophysiology, ninth edition - Publisher: Lippincott Williams and Wilkins

Online references:
Here listed are some web links to useful synopsis on the respiratory system anatomy and physiology. They can be viewed as a revising tool for basic notions required for the course.
1) https://youtu.be/toCAui5OIhQ
2) https://youtu.be/w642INBo2LU
3) https://youtu.be/QmoxmIgQwj0
4) https://youtu.be/xcumNVISO4Q
5) https://youtu.be/IbhrII-LbA0

Risultati di apprendimento specifici
At the end of the course, the student will be able to:

Recognize, describe, and classify the main respiratory diseases.

Integrate clinical, instrumental, radiological, and pathological data to establish accurate diagnoses.

Define an appropriate diagnostic and therapeutic pathway according to the specific disease.

Understand the main surgical indications in thoracic diseases and the principles of minimally invasive techniques.

Comprehend the pharmacological rationale of respiratory therapies, including biological and innovative treatments.

Correctly interpret thoracic imaging examinations.

Analyze histological and cytological specimens, correlating findings with the clinical scenario.

Apply a multidisciplinary approach to the management of respiratory patients.

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2025)	comune	9	BIO/14, MED/08, MED/10, MED/21, MED/36, MED/08, MED/10, MED/21

Stampa del 16/10/2026

Signal and Imaging Processing [1210304]

Offerta didattica a.a. 2026/2027

Docenti: ROSARIO FRANCESCO GRASSO, LEANDRO PECCHIA, PAOLO SODA, LAURA OLIVIERI

Periodo: Ciclo Annuale Unico

Obiettivi formativi

Module of Processing of Biomedical Signals I:
The aim of this integrated module is to provide MedTech students with a solid foundation in the principles, methods, and tools of signal processing as applied to physiological signals. The focus is on engineering and physics-based approaches to extract relevant information from biomedical signals to support diagnosis, monitoring, and clinical evaluation. It introduces theoretical concepts applicable to all biomedical signals, including fundamentals of signal theory, biostatistics, acquisition systems, and basic signal processing techniques. These concepts are then applied to real-world examples, with particular focus on voltage signals such as electrocardiograms (ECG) and electroencephalograms (EEG). Starting from signal acquisition, students will learn how to process and analyze data through filtering, spectral analysis, and feature extraction techniques.
By the end of the module, students will have developed both theoretical knowledge and practical skills needed to understand, handle, and interpret biomedical signals in clinical and technological contexts.

Module of Image Processing:

Prerequisiti

Module of Processing of Biomedical Signals I:
The module builds upon the first- and second-year courses in Mathematics, General Physics, Computer Science, Physiology and Anatomy, Probability and Statistics, Mathematics II, Electronics, Electrotechnics, and Advanced Physics. Students are strongly encouraged to have passed the Computer Science course and to be familiar with programming languages.

Module of Image Processing:
It is recommended that students pass the final examination in Computer Science.

Contenuti del corso

Module of Processing of Biomedical Signals I:
Introduction to Biomedical Signals and Signal Processing (5 ECTS, Semester I)
1.1 Statistics and Biomedical Data Analysis
• Descriptive statistics: mean, median, mode, variance, standard deviation, percentiles, and distributions
• Parametric and non-parametric statistics: selection criteria and principal methods (t-test, ANOVA, signed-rank test, ranksum test, Kruskal-Wallis test)
• Introduction to MATLAB for biomedical data analysis: basic syntax, data import, graphical visualization, and fundamental numerical processing tools

1.2 Introduction to Signals and Systems
• Definition and classification of signals: continuous and discrete, periodic and aperiodic, deterministic and random
• Biomedical signal acquisition chain: (1) transduction, (2) analog conditioning, (3) ADC conversion, (4) digital processing and artifact removal, (5) feature extraction and pattern identification
• Introduction to signal analysis in the time and frequency domains and basic concepts of the Fourier Transform
• Qualitative approach to linear time-invariant (LTI) systems

1.3 Signal Acquisition and Preprocessing Fundamentals
• Signal digitization: sampling theorem, sampling frequency, aliasing and prevention techniques, analog-to-digital conversion
• Fundamentals of filtering: rationale for filtering biomedical signals, FIR vs IIR filters, filtering in MATLAB
• Artifacts and signal cleaning: common artifacts (ocular, muscular, motion, power-line interference) and computational techniques for isolation and removal

1.4 Applications to Biomedical Signals
• Electrocardiography (ECG): ECG generation and structure, lead systems, preprocessing for respiratory and power-line artifact removal, QRS detection methods
• Heart rate (HR) and heart rate variability (HRV): derived signals and RR series, HR and HRV definitions, time- and

frequency-domain features, basic nonlinear measures
• Electroencephalography (EEG) and multichannel signals: overview and physiological origin of EEG signals, junction boxes and montages, international 10–20 system, use of open-source software (e.g., EEGLAB, Brainstorm)
• Electromyography (EMG): signal origin, surface acquisition, noise and motion artifacts, envelope extraction, time- and frequency-domain analysis, applications to muscle fatigue and motor control
• Photoplethysmography (PPG): optical principles, relationship with cardiac pulsation, HR and SpO2 estimation, motion artifacts, wearable sensors
• Respiratory signals: pneumography, respiratory flow, thoracic belts, respiratory rate, cardiorespiratory synchronization
• Electrooculography (EOG): eye movements and blink detection, artifact removal in EEG
• Galvanic skin response (GSR/EDA): sympathetic activity, tonic/phasic analysis, applications in stress and affective computing

1.5 Feature Extraction and Introduction to Machine Learning
• Feature extraction pipelines: extraction of time-domain (amplitudes, intervals), frequency-domain (PSD, power bands), and time-frequency features
• Introduction to supervised machine learning: classification vs regression, general training and testing workflows
• Basic algorithms: theoretical introduction and practical implementation of classification and regression algorithms
• Validation and metrics: overfitting and generalization, stratified k-fold cross-validation and hyperparameter optimization, evaluation metrics (sensitivity, specificity, F1-score, AUC-ROC, R^2)

Final Project and Practical Work (2–3 weeks)
Students will work in small groups on a hands-on final project. They will design a simple biomedical experiment, acquire real or simulated signals, preprocess the data, extract relevant features, and perform statistical analysis. The goal is to apply all key concepts from the module in a practical setting. Each group will define their own experimental question, carry out the signal processing steps, compare groups or conditions statistically, and present their findings in a final written report and oral presentation. During this phase, class sessions will be used for support, guidance, and feedback.

Module of Image Processing:
- Introduction, The light and the electromagnetic spectrum, Human vision, Computer and Digital Radiology, An historical overview, Main application areas, Components and processes for digital image processing
- Image sampling and quantization: Signals and systems, The sampling system (Fourier theorem, Sampling theorem, Aliasing), Quantization system, Image representation: Resolution and contrast, A few information on colour models
- Compression Models, Basic Methods for Compression
- Image File Formats: DICOM and NIfTI
- Affine Transformations: Translation, Rotation, Scaling, Reflection, Shearing
Interpolation: Zoom, Shrinking
- Image Enhancement: linear operators. Pixel relations, Histograms, Point and local transformations, Basic Transformations: Look-Up-Table (LUT), Linear: identity and negative, Logarithmic Polynomials (γ), Sensitometry curve and Sigmoid
- Non linear operations: contrast stretching, windowing, grey level slicing
- 3D visualization
- Histogram processing, image subtraction, logical operations
- Image statistics - histograms, first and second order features
- Image Enhancement- spatial filtering
- Artificial Intelligence and Deep Learning, Perceptron, MLP, Convolutional Neural Networks
- Autoencoders
- MedSam
- XRay generation
- Interventional Radiology procedures
- Basics on XRay, CT, MRI and Interventional Radiology

Metodi didattici
Module of Processing of Biomedical Signals I:
The module includes lectures covering core topics, accompanied by exercises that illustrate their application to real-world problems. Laboratory sessions are dedicated to the use of software tools for biomedical signal processing, with a mix of guided activities and practical examples. Additional time is allocated to group projects and individual study, involving the design of simple experiments, signal acquisition, data processing, and interpretation of physiological signals.

Module of Image Processing:
Teaching is based on lectures and computer exercises, using open-source or proprietary software packages. The ratio between lectures and computer exercises is 70% to 30%, respectively, unless specific needs arise during teaching.

Modalità di verifica dell'apprendimento

Module of Processing of Biomedical Signals I:
Assessment Methods and Evaluation Criteria
Knowledge and competencies related to biomedical signal preprocessing and analysis methods and tools will be assessed through a final group project and a final examination consisting of both a written and an oral component. The exercises proposed during the examination will be similar to those covered during lectures and made available on the e-learning platform. The oral examination will assess students' understanding of theoretical concepts, their ability to apply the methodologies covered during the module, and their capacity to justify the selection of the most appropriate techniques for specific biomedical signal analysis problems.
The final group project will be evaluated based on the quality of the experimental protocol, the signal acquisition and processing procedures, the analysis and interpretation of the results, the clarity of the final presentation, and the individual contribution of each student to the project activities.

Learning Assessment and Final Grade Assignment
Each assessment component is graded on a 30-point scale and is considered passed with a minimum score of 18/30.
The final grade is determined as the weighted average of the following components:
• written and oral final examination: two thirds (2/3) of the final grade;
• final group project: one third (1/3) of the final grade.

Module of Image Processing:
Knowledge and skills related to the course are assessed through an oral examination, which aims to verify that students have acquired an adequate level of knowledge of the theoretical foundations. During the oral exam, the following elements are taken into consideration: the logic followed by the student in formulating the answer to the question, the correctness of the procedure identified for solving the question, the adequacy of the proposed solution in relation to the skills that the student is expected to have acquired at the end of the course, and the use of appropriate language. During the interview, questions relating to the practical part may also be asked, using a computer available in the classroom.
An example of a question could be: "explain the methods of spatial filtering of images". During the oral exam, the applications developed during the laboratory activities will also be discussed.

Testi di riferimento

Module of Processing of Biomedical Signals I:
Handouts of Processing of Biomedical Signals, powerpoint presentations, exercises (including exemplary exam tests), freely distributed in electronic document at http://elearning.unicampus.it/.
– Semmlow, J. Circuits, signals, and systems for bioengineers: a MatLab-based introduction (2024, Elsevier)
– Abood S. Digital Signal Processing A primer with MATLAB (2020, CRC Press)
– Hu L. & Zhang Z. EEG Signal Processing and Feature Extraction (2019, Springer)

Module of Image Processing:
- Slides of the lectures
- Notebooks in Python of the lectures
- R.C. Gonzalez, R.E. Woods, "Digital Image Processing"
- Thomas Martin Deserno, "Biomedical image processing", Springer
- M. Uffmann, C. Schaefer-Prokop, Digital radiography: The balance between image quality and required radiation dose, European Journal of Radiology 72 (2009) 202-208

con OpenCV, scikit-image e librerie MedTech-specifiche

Risultati di apprendimento specifici

Module of Processing of Biomedical Signals I:
KNOWLEDGE AND UNDERSTANDING
Students will acquire a clear understanding of the basic principles behind the generation, acquisition, and analysis of biomedical signals. The module covers relevant physiological, physical, and mathematical foundations, along with essential engineering and statistical tools. Emphasis is placed on how these signals are used in clinical and research settings for monitoring physiological activity and supporting medical decision-making.

APPLIED KNOWLEDGE AND UNDERSTANDING
Students will learn how to apply key techniques for working with biomedical signals, including acquisition, filtering, spectral analysis, and feature extraction. Special focus is given to practical examples involving voltage signals such as ECG and EEG. Programming languages like MATLAB or Python will be used to implement and test processing methods introduced in class.

JUDGEMENT AND CRITICAL THINKING
The module develops students' ability to assess which processing methods are most appropriate depending on the signal type and clinical context. Students will learn to evaluate the strengths and limitations of various techniques and to support their methodological choices with reasoned arguments. Project work will further support the development of critical and independent thinking.

COMMUNICATION SKILLS
Students will practice communicating signal analysis procedures and results in a clear and structured way, using appropriate technical language. They will present their work both in writing and orally, gaining experience in explaining technical content to peers and professionals in healthcare and engineering environments.

LEARNING SKILLS
The module encourages active learning through lectures, practical sessions, and group work. Students will develop an effective approach to studying and applying signal processing concepts, building a foundation that supports further study and professional growth in medical technologies.

Module of Image Processing:
Ability to apply knowledge and understanding
Students must be able to:
- Apply the main image processing algorithms;
- Use software tools for processing biomedical images;
- Critically analyse the results obtained.

Autonomy of judgement
Students must:
- Be able to assess the quality and suitability of the techniques applied;
- Be able to choose the most suitable methodologies depending on the problem.

Communication skills
Students must be able to present the results of analyses and projects, and use technical language appropriate to the medical-technological field.

Learning skills
Students must develop the learning skills necessary to undertake further studies with a high degree of autonomy. In particular, students must:
- Acquire an adequate level of knowledge of the theoretical basis of the main image processing techniques;
- Understand the fundamentals for constructing procedural sequences for the processing and recognition of visual information in the images under observation;
- Understand the potential of image processing for the development of image analysis and autonomous and semi-autonomous classification systems;

L'attività didattica è offerta in:

Faculty of Medicine, Surgery and Dentistry

Tipo corso	Corso di studio (Ordinamento)	Percorso	Crediti	S.S.D.
Laurea Magistrale Ciclo Unico 6 anni	Laurea Magistrale in Medicine and Surgery-MedTech (official title: Laurea Magistrale in Medicine and Surgery-MedTech) (2025)	comune	12	ING-INF/05, ING-INF/06, MED/36, MED/36

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