Course unit English denomination	Regenerative medicine, state of the art and innovative applications in head and neck
SS	MEDS-18/A (ex. MED/31, ENT)
Teacher in charge	Professor Laura Astolfi
Teaching Hours	5
Number of ECTS credits allocated	1
Course period	05/2025
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	Italian/English
Mandatory attendance	☒ Yes (Compulsory for PhD students of CTN curriculum) (80%) ☐ No
Course unit contents	This lecture covers the latest advancements and innovative applications of regenerative medicine in head and neck surgery. Topics include laryngeal transplantation, stem cell therapies, 3D-printed implants, bioengineered constructs, cell-based therapies, and scaffold generation
Learning goals	Understand the current state of regenerative medicine in head and neck surgery. Identify key innovations such as laryngeal transplantation and 3D-printed implants. Explore the potential of stem cell and cell-based therapies in treating head and neck conditions. Examine the role of bioengineered constructs and scaffolds in tissue regeneration.
Teaching methods	The course will be delivered through two face-to-face lectures in Italian or English. Interactive teaching methods will be employed, incorporating research application examples and utilizing tools such as Wooclap to enhance engagement.
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	Knowledge equivalent to a master's degree in STEM disciplines (Science, Technology, Engineering, Mathematics, and Medicine).

Examination methods (in applicable)	Not applicable
Suggested readings	Materials provided by the instructor during lectures, including slides and scientific articles.
Additional information	The lecture provides an overview of cutting-edge regenerative techniques and their applications in head and neck surgery, highlighting the potential to improve patient outcomes through personalized and advanced treatments. For a neuroscience PhD student, understanding these techniques is crucial, as innovations in regenerative medicine can open new avenues for research and treatment of neurological disorders, significantly enhancing patient quality of life.

Course unit English denomination	Machine Learning: Overview of machine learning techniques, algorithms, and applications
SS	MEDS-24/A – Statistica medica
Teacher in charge (if defined)	Ileana Baldi Corrado Lanera
Teaching Hours	10
Number of ECTS credits allocated	1
Course period	I year, II semester
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (80%) ☐ No
Course unit contents	The course begins with an introduction to machine learning, covering its definition, history, and applications in various sectors, with a particular focus on the importance of Big Data in healthcare and how it can improve patient care. Next, it explores different types of learning with practical application examples. The course continues with a discussion on the bias-variance tradeoff, explaining the concepts of bias and variance, their importance, and how to balance these aspects to reduce overfitting and underfitting. Finally, it addresses performance metrics, including metrics for regression models such as MAE, MSE, and R-squared, and for classification models such as accuracy, precision, recall, F1-score, and confusion matrix. It concludes with a section on model evaluation and validation, explaining techniques such as cross-validation. The course ends with a summary of key concepts and a discussion of case studies.
Learning goals	The course objectives are to understand the fundamental concepts of machine learning and the importance of Big Data in healthcare, distinguish between different types of learning, comprehend the bias-variance tradeoff, evaluate model performance, apply validation techniques such as cross-validation, and critically interpret the results.
Teaching methods	Lectures
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No

Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	
Examination methods (in applicable)	Moodle quiz
Suggested readings	An Introduction to Statistical Learning 2nd edition - Springer
Additional information	

Course unit English denomination	Design and analysis of clinical trials and observational clinical studies
SS	MEDS-24/A – Statistica medica
Teacher in charge (if defined)	Baldi D, Gregori D, Lorenzoni G
Teaching Hours	10
Number of ECTS credits allocated	1
Course period	First Year, Second Semester
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (80%) ☐ No

Course unit contents	• Methodology of Clinical Trials and Observational Studies: Introduction to the most relevant study designs for addressing clinical research questions, including randomized clinical trials and observational studies (cohort, case-control, and cross-sectional), with a comparison of their respective strengths and limitations.
	• Strategies to Minimize Bias and Manage Confounding: Approaches at both the design and analysis levels for managing bias and confounding in clinical trials and observational studies.
	• Statistical Analysis:
	  ▪ For Clinical Trials: Intention-to-treat (ITT) and per-protocol analyses to evaluate treatment efficacy.
	  ▪ For Observational Studies: Multivariable analysis and propensity score techniques for managing confounding and accurately interpreting the results.

Learning goals	• Understand the Differences in Approach Between Clinical Trials and Observational Studies: Develop skills to identify the most appropriate study designs for specific clinical questions, considering the unique characteristics and limitations of each methodological approach. • Apply Bias Reduction and Confounding Control Strategies in Study Designs: Build competencies in the use of randomization, blinding, and confounding control techniques tailored to clinical trials and observational studies. • Interpret Clinical Data Through Appropriate Statistical Analyses: Use specific statistical approaches to assess outcomes of interest, applying methods such as intention-to-treat analysis for

	clinical trials and propensity score analysis for observational studies, with attention to binary, continuous, and time-to-event outcomes.
Teaching methods	• Lectures: Introduction to key concepts and application techniques for the design and analysis of clinical trials and observational studies, with theoretical insights supported by practical examples. • Practical Exercises: Simulations and case studies to strengthen methodological and analytical skills, including the use of statistical software for data analysis. Students will apply confounding control techniques, such as multivariable analysis and propensity score methods, to accurately interpret study outcomes. • Critical Discussions: Interactive analysis of real-world scenarios, with critical review of published studies and use of software to explore clinical datasets. Discussions will include result evaluation, identification of bias and confounding, and selection of the most suitable analytical techniques for each study type.
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	Basic knowledge of statistics, including concepts such as data distribution, statistical inference, and interpretation of statistical tests. A basic knowledge of clinical research methodology is useful, though not essential.
Examination methods (in applicable)	
Suggested readings	• Reference Texts and Articles: A selection of specialized texts on study design methodologies and statistical analysis, including techniques for bias and confounding management. Recent articles from epidemiology and statistics journals for practical applications. • Guidelines and Operational Manuals: Key documents for conducting and reporting clinical trials and observational studies, including ICH-GCP guidelines for clinical trials and EQUATOR network reporting guidelines (e.g., CONSORT, STROBE) to ensure transparency and rigor in result presentation.
Additional information	Course for doctoral students interested in clinical trial and observational study design and analysis, featuring real examples and case studies for practical preparation.

Course unit English denomination	Longitudinal Data Analysis: Methods for analyzing repeated measurements and time-to-event data in clinical settings
SS	MEDS-24/A – Statistica medica
Teacher in charge (if defined)	Ileana Baldi
Teaching Hours	10
Number of ECTS credits allocated	1
Course period	II year, I semester
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (80%) ☐ No
Course unit contents	The course begins with an introduction to longitudinal data, covering its definition, examples, and importance in clinical research. It distinguishes between continuous and categorical data, as well as time-to-event data. Next, the course deals with exploratory data analysis, focusing on descriptive statistics for longitudinal data, visualization techniques, and identifying patterns and trends using time plots and correlation structures. The core of the course is dedicated to statistical models for longitudinal data, including linear mixed models, generalized estimating equations (GEE), and survival analysis for time-to-event data. This includes basic tools for survival analysis such as the Kaplan-Meier estimator and the Cox proportional hazards model, as well as transition models for analyzing health state changes over time.
Learning goals	The course objectives are to understand the fundamental concepts of longitudinal data analysis and its importance in clinical research, distinguish between continuous, categorical, and time-to-event data, and acquire skills in data analysis and critical interpretation of results in clinical contexts.
Teaching methods	Lectures
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No

Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	
Examination methods (in applicable)	Moodle quiz
Suggested readings	
Additional information	

Course unit English denomination	Transcriptomics, Genomics, Proteomics, and Metabolomics data analysis in R
SS	MEDS-24/A – Statistica medica
Teacher in charge (if defined)	I. Baldi, L. Vedovelli, D. Sabbatini
Teaching Hours	10
Number of ECTS credits allocated	1
Course period	First semester
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (100% minimum of presence) ☐ No
Course unit contents	• Introduction to transcriptomics, genomics, proteomics, and metabolomics. • Data analysis in R. • Practical applications and case studies. • Advanced tools and techniques for omics data analysis. • Interpretation and visualization of results.
Learning goals	• Understand the fundamental principles of omics sciences. • Acquire practical skills in using R for omics data analysis. • Apply advanced analysis techniques to real data. • Interpret and communicate analysis results.
Teaching methods	• Lectures. • Practical laboratory exercises. • Case study analysis. • Group discussions and presentations.
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	
Examination methods	

(in applicable)	
Suggested readings	R for data Science - R for Data Science (2e)
Additional information	

Course unit English denomination	Advanced biomedical technologies: focus on the bronchial epithelium
SS	MEDS-26/D – Advanced Medical Technical Sciences
Teacher in charge (if defined)	Simonetta Baraldo
Teaching Hours	5
Number of ECTS credits allocated	1
Course period	January 2025
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	Italian (available in English upon request by students)
Mandatory attendance	☒ Yes (75% minimum of presence) ☐ No
Course unit contents	This course explores the application of contemporary biomedical techniques to the study of epithelial integrity/ airway remodelling. Classes will cover study of the molecular organization of bronchial epithelium and the different techniques used in laboratory medicine to study epithelial abnormalities.
Learning goals	The course provides an overview of current biomedical technology applied to the epithelium. Students will have to acquire awareness of the principal biomedical techniques used to investigate the epithelium and of their application to selected aspects of therapy (biologics).
Teaching methods	The course consists in a combination of lectures and discussion of specific cases, with the main purpose of creating a direct interaction with students
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☐ Yes ☒ No
Prerequisites (not mandatory)	
Examination methods (in applicable)	n.a.

Suggested readings	Teaching material provided by the lecturer and suggested articles: Russell et al, The airway epithelium: an orchestrator of inflammation, a key structural barrier and a therapeutic target in severe asthma [DOI: 10.1183/13993003.01397-2023]. Varricchi G,et al. Airway remodelling in asthma and the epithelium: on the edge of a new era. Eur Respir J 2024; 63: 2301619 [DOI: 10.1183/13993003.01619-2023].
Additional information	

Course unit English denomination	Study of Cell Communication in Lung Diseases: Cytofluorometric Approach
SS	MEDS-26/A
Teacher in charge (if defined)	Prof.ssa Erica Bazzan
Teaching Hours	10
Number of ECTS credits allocated	2
Course period	January 2024
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	Italian/English
Mandatory attendance	☒ Yes (80%) ☐ No
Course unit contents	• Introduction to Flow Cytometry: Fundamental Principles and Functioning. • Mechanisms of Cell Communication: The Role of Extracellular Vesicles (EVs) in Lung Diseases. • Types of EVs: Release Mechanisms, Isolation Techniques, and Labeling of EVs for Cytometric Characterization. • Characterization of Lung Cells: Using Cytometry to Analyze and Distinguish EVs in Pulmonary Fluids.
Learning goals	The goals of the course are to provide students with a comprehensive understanding of the application of flow cytometry in studying cell communication and extracellular vesicles (EVs) in lung diseases. The course will explore how flow cytometry can be utilized to analyze cellular interactions mediated by EVs, significantly enhancing our understanding of the pathogenesis of respiratory conditions such as asthma, COPD, pulmonary fibrosis, and lung cancers. It will emphasize the characterization of EVs, the mechanisms of their biogenesis and release, and the isolation and labeling techniques necessary for precise cytometric analysis. Ultimately, the course aims to evaluate the potential of EVs as biomarkers in lung diseases.
Teaching methods	To achieve the learning objectives of the course, a blend of traditional and innovative teaching methods will be employed. Lectures will provide a comprehensive overview of flow cytometry and cell communication in lung diseases, with an emphasis on essential components such as lasers, filters, and detectors. The course will

	also focus on the isolation and characterization of EVs. Through simulations, students will engage with real-world scenarios related to diseases such as asthma, COPD, and pulmonary fibrosis, deepening their practical application of the concepts learned.
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☐ Yes ☒ No
Prerequisites (not mandatory)	No
Examination methods (in applicable)	No
Suggested readings	Educational materials provided by the teacher
Additional information	

Course unit English denomination	Bayesian Biostatistics: Introduction to Bayesian methods for modeling uncertainty and incorporating prior information
SS	MEDS-24/A
Teacher in charge (if defined)	Paola Berchialla
Teaching Hours	10
Number of ECTS credits allocated	1
Course period	2nd year, 2nd semester
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (80%) ☐ No
Course unit contents	Introduction to Bayesian Statistics Overview of Bayesian vs. Frequentist perspectives, History and philosophy of Bayesian inference, Basic concepts: Prior, likelihood, posterior, and Bayes' theorem Bayes' Theorem and Simple Bayesian Models Bayes' theorem in detail, Conjugate priors, Common distributions (e.g., Bernoulli, Beta, Gaussian, Gamma), Bayesian Inference in Practice Posterior distribution and credible intervals, Prior selection: informative vs. non-informative priors, Likelihood function, MAP (Maximum A Posteriori) estimation Markov Chain Monte Carlo (MCMC) Methods Introduction to MCMC for Bayesian inference, Gibbs Sampling, Metropolis-Hastings algorithm, Hamiltonian Monte Carlo (HMC), No-U-Turn Sampler (NUTS) Practical challenges in MCMC (e.g., convergence, mixing), Practical implementation using Stan, R (BRMS) Hierarchical Bayesian Models Hierarchical modeling for nested data, Application in multi-level models, Implementation and practical examples, Model interpretation and visualization of posterior distributions, Model comparison: Bayes factors, Deviance Information Criterion (DIC), Watanabe-Akaike Information Criterion (WAIC)
Learning goals	Define and explain Bayesian concepts: Articulate the principles of Bayesian inference, including the roles of prior distributions, likelihood functions, and posterior distributions.

	Distinguish Bayesian and Frequentist approaches: Compare and contrast Bayesian and frequentist methods, understanding the implications and advantages of each for various types of inference. Construct Bayesian models: Formulate Bayesian models for different data types and scenarios, choosing appropriate priors and likelihoods to reflect problem-specific knowledge. Implement MCMC algorithms: Apply Markov Chain Monte Carlo (MCMC) methods (e.g., Gibbs sampling, Metropolis-Hastings, and Hamiltonian Monte Carlo) to estimate posterior distributions, demonstrating proficiency in using software tools like Stan, or BRMS. Evaluate Bayesian models: Use model selection criteria such as Bayes factors, Deviance Information Criterion (DIC), and Watanabe-Akaike Information Criterion (WAIC) to evaluate and compare Bayesian models. Communicate Bayesian analysis results: Present Bayesian analysis results clearly, including explanations of prior selection, posterior inference, and model validation, using visualizations to enhance interpretation.
Teaching methods	Frontal class
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	
Examination methods (in applicable)	Moodle quiz
Suggested readings	Bayesian Data Analysis, A. Gelman, J. B, Carlin, H. Sterne Doing Bayesian Data Analysis, J. Kruschke
Additional information	

Course unit English denomination	Epidemiological methods in clinical and etiological research
SS	MEDS-24/A – Statistica medica
Teacher in charge (if defined)	Annibale Biggeri, Catelan Dolores
Teaching Hours	10
Number of ECTS credits allocated	1
Course period	Second semester first year
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (100% minimum of presence) ☐ No
Course unit contents	Fundamental epidemiological methods used in clinical and etiological research are introduced, with an emphasis on study design, data collection, and data analysis. Topics covered include the main study types (cohort and case-control studies, cross-sectional studies), biases, confounding, and effect modification.
Learning goals	🎬 Understand key epidemiological concepts and their application in clinical and etiological research. 🎬 Develop skills in selecting appropriate methods and data analysis. 🎬 Learn to identify and control for biases, confounders, and effect modifiers in epidemiological research. 🎬 Interpret and critically evaluate epidemiological literature.
Teaching methods	🎬 Theoretical lectures and discussions. 🎬 Case studies. 🎬 Practical sessions.
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	
Examination methods	

(in applicable)	
Suggested readings	Rothman, K (2012) Epidemiology: An Introduction. Oxfrod University Press. Rothman, K. J., Greenland, S., & Lash, T. L. (2008). *Modern Epidemiology*. Lippincott Williams & Wilkins. Handouts and articles used during the course
Additional information	

Course unit English denomination	Citizen Science in Biological Research
SS	MEDS-24/A – Statistica medica
Teacher in charge (if defined)	Annibale Biggeri
Teaching Hours	10
Number of ECTS credits allocated	1
Course period	Second semester second year
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (100% minimum of presence) ☐ No
Course unit contents	This course explores the concept of citizen science, its methodologies, and its applications in biological research. Topics include the history and philosophy of citizen science, with a particular focus on the design and implementation of participatory research. Real-world case studies will be examined to highlight the impact of citizen science on scientific research and the value of citizen involvement in public health research.
Learning goals	🍫 Understand the fundamental principles of citizen science and its importance in scientific research. 🍫 Develop skills in the design, implementation, and management of citizen science projects. 🍫 Explore ethical considerations and challenges of involving citizens in scientific research. 🍫 Analyze case studies to understand the role of citizen science in the design and conduct of scientific studies.
Teaching methods	🍫 Interactive lectures and discussions 🍫 Group activities 🍫 Real-world case studies
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No

Prerequisites (not mandatory)	
Examination methods (in applicable)	
Suggested readings	Muki Haklay, Citizen Science and Policy: A European Perspective. Washington, DC:Woodrow Wilson International Center for Scholars, 2015. Froeling F, Gignac F, Toran R, Ortiz R, Ficorilli A, De Marchi B, Biggeri A, Kocman D, Ftičar J, Tratnik JS, Andrusaityte S, Grazuleviciene R, Errandonea L, Vermeulen R, Hoek G, Basagaña X. Implementing co-created citizen science in five environmental epidemiological studies in the CitieS-Health project. Environ Res. 2024 Jan 1;240(Pt 2):117469.
Additional information	

Course unit English denomination	Riproducibilità della ricerca scientifica e open-data/open publishing
SS	MEDS-24/A – Statistica medica
Teacher in charge (if defined)	Annibale Biggeri
Teaching Hours	10
Number of ECTS credits allocated	1
Course period	First semester fisrt year
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (100% minimum of presence) ☐ No
Course unit contents	This course addresses the critical issues of reproducibility, uncertainty, and transparency in scientific research, with a focus on open data and open publishing practices. Students will explore the concepts of reproducibility and replicability, the factors that influence them, and the so-called "replicability crisis" affecting various fields, particularly applied sciences such as medicine. The course will cover practices to ensure transparency in research, understand and communicate uncertainty, and adopt open-access and data-sharing approaches to promote reliable and accessible research outcomes.
Learning goals	🎬 Understand the importance of reproducibility and transparency in scientific research, identifying factors that affect replicability across studies. 🎬 Apply best practices to enhance the reproducibility of their research, including rigorous data management and transparency in data sharing. 🎬 Explore the role of open data and open publishing in promoting scientific integrity and accessibility. 🎬 Develop strategies for managing and communicating uncertainty in scientific conclusions, contributing to more robust and transparent research.
Teaching methods	🎬 Interactive lectures and group discussions 🎬 Case studies to illustrate challenges in reproducibility and open publishing

Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	none
Examination methods (in applicable)	
Suggested readings	Articles and handouts provided during the course.
Additional information	

Course unit English denomination	Soft Skills
SS	MEDS-24/A – Statistica medica
Teacher in charge (if defined)	Annibale Biggeri
Teaching Hours	10
Number of ECTS credits allocated	1
Course period	First semester first year
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (100% minimum of presence) ☐ No
Course unit contents	This course is designed to develop essential soft skills for PhD students, with a focus on scientific communication, effective writing, team building, and the use of AI tools to enhance research productivity. Through interactive sessions and practical exercises, students will learn how to communicate their research, draft scientific articles, collaborate in interdisciplinary teams, and leverage AI tools like Copilot and ChatGPT to improve research workflows.
Learning goals	▪ Communicate scientific concepts clearly to specialized and general audiences, adapting their language to the context. ▪ Draft and structure a scientific article effectively, using AI tools to assist with writing, summarization, and refinement. ▪ Develop team-building skills for productive collaboration in interdisciplinary research teams. ▪ Integrate AI tools such as Copilot and ChatGPT into research processes, enhancing efficiency in tasks like coding, data management, and document drafting.
Teaching methods	▪ Interactive lectures and discussions ▪ Hands-on writing and presentation workshops ▪ Group activities to develop team-building skills
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No

Prerequisites (not mandatory)	none
Examination methods (in applicable)	
Suggested readings	Articles and handouts provided during the course.
Additional information	

Course unit English denomination	Amyloid and paraproteinemic neuropathies
SS	MEDS-12/A
Teacher in charge (if defined)	Chiara Briani
Teaching Hours	5
Number of ECTS credits allocated	1
Course period	April-May 2025
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	Italian/English
Mandatory attendance	☒ Yes (80%) ☐ No
Course unit contents	Amyloidotic and paraproteinemic neuropathies
Learning goals	The most important clinical characteristics of systemic amyloidosis (both acquired, AL, and hereditary due to mutation of the transthyretin gene) will be presented with the problems of differential diagnosis and systemic involvement. Paraproteinemic neuropathies will be extensively treated with attention to the pathogenesis, neurophysiology and the most recent therapeutic innovations.
Teaching methods	The course will be delivered through two frontal lessons in Italian or English. The translationality of the diseases in question will be highlighted and, in addition to updated lectures (including new diagnostic and therapeutic advances), interactive clinical cases will be presented.
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	
Examination methods (in applicable)	

Suggested readings	Material provided by the teacher in class, including slides and scientific references
Additional information	

Course unit English denomination	Morphological and molecular analysis in non-neoplastic thoracic diseases: prognostic and predictive biomarkers
SS	MEDS-04/A
Teacher in charge (if defined)	Prof.ssa Fiorella Calabrese
Teaching Hours	6
Number of ECTS credits allocated	1
Course period	II Year, II Semester
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (80%) ☐ No
Course unit contents	The course will provide students with an in-depth overview of the latest discoveries and developments in non-neoplastic molecular pathology of the thorax, with a particular focus on biomarkers and targeted therapies. Through a combination of theoretical lectures and practical activities, students will engage in the analysis of biomarkers and the interpretation of molecular data, acquiring essential skills for the personalized treatment of patients with thoracic diseases.
Learning goals	By the end of the course, students should have acquired: a) Knowledge on how to preserve tissue and cytological samples for molecular studies; b) Understanding of the main diseases that require molecular insights for both diagnostic and research purposes; c) Ability to understand and apply liquid biopsy as an innovative technique in the context of oncology and transplantation; d) Skills to actively participate in the diagnostic process, including the integration of clinical/pathological data with molecular findings using machine learning approach.
Teaching methods	The course will be divided into a theoretical and a practical component. THEORETICAL PART: ● Overview of the main methods for collecting and preserving tissue samples for molecular studies. ● Information on the organizational aspects of a frozen tissue bank. ● Identification of the primary diseases that require molecular investigations for accurate diagnostic characterization.

	• Key molecular applications in the field of anatomical pathology research. • In-depth exploration of liquid biopsy as an innovative technique in oncology and transplantation. PRACTICAL PART: • Interpretation of results and integration with clinical and morphological data.
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	/
Examination methods (in applicable)	/
Suggested readings	Slides and articles
Additional information	/

Course unit English denomination	Advanced Epidemiological Methods: Complex study designs, confounding, effect modification, and meta-analysis
SS	Medical statistics
Teacher in charge (if defined)	Cristina Canova, Honoria Ocagli
Teaching Hours	10
Number of ECTS credits allocated	1
Course period	1 semester (second year)
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (80%) ☐ No
Course unit contents	The course provides an advanced overview of epidemiological methods for addressing and interpreting complex data. The main topics include: Epidemiological Bias: An introduction to different types of bias, with a focus on confounding, selection, and misclassification. Methods to identify and control these systematic errors will be presented, both in study design and data analysis. Additive and multiplicative approaches for effect modification will also be explored. Advanced Study Designs: Examination of various study designs, including nested case-control, case-only, and case-crossover, with emphasis on their advantages and applicability in specific scenarios. Meta-analysis: Principles and application of meta-analysis, including a discussion of fixed-effect and random-effect models. Topics will also cover managing heterogeneity, assessing the risk of publication bias, and interpreting results.
Learning goals	Identify and classify the different types of epidemiological bias, including confounding, selection, and misclassification, and apply appropriate techniques to control and mitigate these biases during study design and data analysis. Distinguish between effect modification and confounding and apply additive and multiplicative approaches to accurately interpret effect modification in epidemiological data.

	Evaluate and select advanced study designs, such as nested case-control, case-only, and case-crossover, and effectively implement them according to specific research objectives and epidemiological contexts. Conduct and interpret a meta-analysis, with the ability to assess and manage heterogeneity across studies, identify the risk of publication bias, and critically analyze results to formulate reliable conclusions.
Teaching methods	Lectures and discussions Case studies from the scientific literature Practical exercises with statistical software
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	Principles of epidemiology
Examination methods (in applicable)	
Suggested readings	Material provided by the teacher. Per approfondimenti: TL Lash, TJ VanderWeele, S Haneuse, KJ Rothman. Modern Epidemiology, 4th edition. Wolters Kluwer, 2021 https://training.cochrane.org/handbook/current
Additional information	

Course unit English denomination	Research Project Management
SS	MEDS-26/A *Scienze tecniche di medicina di laboratorio* MEDS-26/D *Scienze tecniche mediche e chirurgiche avanzate*
Teacher in charge (if defined)	Castellani Chiara e Iop Laura
Teaching Hours	20
Number of ECTS credits allocated	2
Course period	January - September
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	Italian
Mandatory attendance	☒ Yes (80%) ☐ No
Course unit contents	The project management course provides comprehensive training on how to successfully plan, manage, and conclude a research project. Participants will learn to set clear objectives using the SMART model, break down work with the Work Breakdown Structure (WBS), and manage resources and timelines through tools such as Gantt charts. Techniques for identifying and mitigating risks will also be explored, ensuring the project stays on schedule and within budget. In addition to planning, the course places great emphasis on communication management and performance monitoring. Participants will learn to track progress using Key Performance Indicators (KPIs) and project management software. Finally, project closure and documentation of lessons learned will be addressed as crucial phases for ensuring continuous improvement in future project initiatives
Learning goals	By the end of the course, students will be able to manage a project in all its phases, from initial planning to closure. They will know how to define clear and achievable objectives for the project, organize the work into manageable tasks, and plan and optimize the use of available time and resources. They will be capable of developing a well-defined project structure, ensuring that each phase is coordinated to achieve the established goals. Additionally, students will be prepared to manage the risks associated with a project by identifying them and developing strategies to mitigate them, while maintaining effective communication with all stakeholders. They will acquire skills to monitor the project's

	progress, evaluate performance through key indicators, and correct any deviations, effectively concluding the project
Teaching methods	Lectures, workshops and practical exercises, case studies, group work
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	
Examination methods (in applicable)	
Suggested readings	
Additional information	

Course unit English denomination	Causal Inference: Techniques for Establishing Causal Relationships in Observational Studies and Clinical Research
SS	MEDS-24/A – Statistica medica
Teacher in charge (if defined)	Annibale Biggeri/Dolores Catelan
Teaching Hours	10
Number of ECTS credits allocated	1
Course period	1 semestre 2 anno
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (100% minimum of presence) ☐ No
Course unit contents	This course provides an introduction to causal inference with a focus on methods applicable to observational studies and clinical research. Key topics include the identification of causal relationships, understanding confounding variables, and techniques such as propensity score matching, instrumental variables, and difference-in-differences. The course emphasizes practical applications in medical research, showcasing how these techniques are used to infer causality in non-randomized settings.
Learning goals	■ Develop an understanding of causal inference principles in observational and clinical research contexts. ■ Gain proficiency in various statistical techniques used for causal inference, including propensity score methods, instrumental variables, and others. ■ Apply causal inference methodologies to real-world medical and clinical datasets. ■ Critically evaluate the validity of causal claims in published observational studies.
Teaching methods	■ Lectures and discussions ■ Case studies and practical examples ■ Hands-on exercises and analysis with statistical software
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No

Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	Basic knowledge of statistics and familiarity with statistical software (e.g., R or STATA) are recommended.
Examination methods (in applicable)	
Suggested readings	Hernán, M. A., & Robins, J. M. (2020). *Causal Inference: What If*. CRC Press. Imbens, G. W., & Rubin, D. B. (2015). *Causal Inference for Statistics, Social, and Biomedical Sciences: An Introduction*. Cambridge University Press. Rosenbaum, P. R. (2017). *Observation and Experiment: An Introduction to Causal Inference*. Harvard University Press
Additional information	

Course unit English denomination	Diagnostic work-up in athletes with suspected heart disease
SS	MEDS-07/B
Teacher in charge (if defined)	Domenico Corrado
Teaching Hours	10
Number of ECTS credits allocated	1
Course period	December 2024 – May 2025 (2 seminars)
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	Italian
Mandatory attendance	☐ Yes (% minimum of presence) ☒ No
Course unit contents	The module focuses on analyzing real clinical cases of athletes with suspected cardiomyopathy, exploring the most appropriate diagnostic pathways and comparing them to the COCIS 2023 guidelines.
Learning goals	Students will develop the ability to critically assess clinical cases, apply current guidelines for diagnosing cardiomyopathies in athletes, and select the most appropriate tests in a clinical setting.
Teaching methods	Interactive lessons based on case discussions, supported by up-to-date materials and direct comparison with the guidelines, promoting a practical and analytical approach.
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	
Examination methods (in applicable)	Multiple choice quiz
Suggested readings	

Additional information

Course unit English denomination	Transplantation immunology
SS	MEDS-26/D
Teacher in charge (if defined)	Prof Emanuele Cozzi
Teaching Hours	6
Number of ECTS credits allocated	1
Course period	II semester
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	Italian
Mandatory attendance	☒ Yes (75% minimum of presence) ☐ No
Course unit contents	• The immune system and transplantation immunology • Immunology of cellular and humoral rejection • Test to evaluate the donor-recipient immunological compatibility • Latest advancements in xenotransplantation
Learning goals	The course is aimed at providing the immunological knowledge that is necessary to allow the best possible allocation of the limited number of human organs available and enable the ideal clinical management of patients following transplantation. In particular, students are expected to acquire the following knowledge: 1. Basic knowledge of the immune system and of the mechanisms underlying cellular and humoral immunity 2. Knowledge specifically regarding transplant immunology and rejection
Teaching methods	The course will include formal lectures with powerpoint presentations.
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No

Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	This course is aimed at students with background knowledge in immunology.
Examination methods (in applicable)	*The verification of knowledge will take place through an oral exam.*
Suggested readings	The powerpoint files with the slides presented at each lesson will be available through the Moodle platform.
Additional information	

Course unit English denomination	Pathophysiology of diabetes mellitus and its complications
SS	MEDS-08/A
Teacher in charge (if defined)	G. P. Fadini, G. Sartore
Teaching Hours	10
Number of ECTS credits allocated	1
Course period	1st and 2nd semester
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	Italian
Mandatory attendance	☒ Yes (75% minimum of presence) ☐ No
Course unit contents	Pathogenesis of chronic complications. Acute and chronic complications of diabetes mellitus Micro and macrovascular complications Innovative therapies for diabetes complications Therapeutic algorithm
Learning goals	Learn the most recent acquisitions on the pathophysiology of diabetes and its complications, as well as the diagnostic and therapeutic approaches to be used
Teaching methods	Lectures and clinical cases
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	
Examination methods (in applicable)	
Suggested readings	The lesson material
Additional information	

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Course unit English denomination	Omics data analysis
SS	MEDS-22/B
Teacher in charge (if defined)	Dott.ssa Chiara Giraudo
Teaching Hours	20
Number of ECTS credits allocated	2
Course period	I Year, I Semester
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (80%) ☐ No
Course unit contents	The course will provide a comprehensive overview about the role of radiomics. Then the different aspects of radiomics will be addressed taking into account the various areas of medicine and with a special focus on oncological imaging of the thoracic, abdominal and musculoskeletal fields. The students will learn the importance of multidisciplinary and integrated models with radiomic and clinical variables, aiming to develop radiological biomarker of disease.
Learning goals	At the end of the course the students are expected to: a) Gain knowledge about radiomics b) Gain knowledge about how to develop a radiomic project c) Gain knowledge about the segmentation and analyses techniques d) Gain knowledge about integrated models of advanced imaging and clinical variables aiming to develop new biomarkers.
Teaching methods	Theory: ● Show the various radiological techniques that can be used for radiomic models ● Show the software for the analyses ● Show the various field of application ● Integrate radiomic and clinical models Practice:

	• simulate a radiomic project with potential prediction of results and applicability.
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	/
Examination methods (in applicable)	/
Suggested readings	Slides and articles
Additional information	/

Course unit English denomination	Advanced Biostatistical Methods: In-depth exploration of linear and nonlinear regression, generalized linear models, and survival analysis
SS	MEDS-24/A – Statistica medica
Teacher in charge (if defined)	Dario Gregori
Teaching Hours	10
Number of ECTS credits allocated	1
Course period	II semester, I year
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (100% minimum of presence) ☐ No
Course unit contents	This course will cover advanced biostatistical methods, focusing on: • Linear and nonlinear regression: fundamental concepts and applications in biostatistics. • Generalized Linear Models (GLM): introduction and analysis of logistic and Poisson models. • Survival analysis: Kaplan-Meier methods, Cox regression, and handling censored data.
Learning goals	This course introduces students to generalized linear models to analyze binary, discrete, ordinal, count, survival outcomes. The primary emphasis will be interpretation, inference and hands-on data analyses. We will use R and Jamovi to analyze public health datasets, evaluate regression assumptions, and assess model fit.
Teaching methods	Lectures Hands-on labs using statistical software (R and Jamovi) Group discussions and case studies
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites	Basic knowledge of statistics and data analysis software.

(not mandatory)	
Examination methods (in applicable)	There is no exam, hence there is also no definition of the evaluation criteria.
Suggested readings	Maindonald JH, Braun WJ, Andrews JL. A Practical Guide to Data Analysis Using R: An Example-Based Approach. Cambridge University Press; 2024. Moore DF. Applied survival analysis using R. Cham, Switzerland: Springer Nature. 2016; p. 101–12. Course handouts and selected articles
Additional information	The course includes a practical component with real data analysis, supported by dedicated software.

Course unit English denomination	Biostatistics
SS	MEDS-24/A – Statistica medica
Teacher in charge (if defined)	Lorenzoni G.
Teaching Hours	10
Number of ECTS credits allocated	1
Course period	First Year, Second Semester
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (80%) ☐ No
Course unit contents	The course is divided into two main sections. The first section covers introductory concepts in exploratory data analysis, statistical inference (including confidence intervals and hypothesis testing), and an introduction to regression. The second section focuses on applying biostatistics in scientific publishing, providing students with skills to interpret, analyze, and present data in academic research contexts.
Learning goals	• Understand and apply fundamental principles of data analysis. • Interpret and construct confidence intervals and conduct hypothesis testing. • Use regression models for data analysis. • Apply biostatistical concepts in preparing scientific articles, including result interpretation and drafting statistical sections.
Teaching methods	The course includes lectures integrated with practical exercises on realistic datasets and group discussions on scientific articles.
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	Basic knowledge of descriptive statistics and experience with data analysis software are recommended.

Examination methods (in applicable)	
Suggested readings	Selected materials will be provided by the teacher throughout the course, along with references to additional readings for further exploration of the topics.
Additional information	This course is designed for PhD students interested in acquiring biostatistical skills applicable to clinical and biomedical research. Concrete examples and case studies will be used to illustrate the discussed techniques, with particular emphasis on both theoretical and practical aspects of statistical analysis and data preparation for scientific publication.

Course unit English denomination	Practical Artificial Intelligence for Medical Data Analyses with R - Advanced
SS	MEDS-24/A – Statistica medica
Teacher in charge (if defined)	Corrado Lanera, Luca Vedovelli, Giulia Lorenzoni
Teaching Hours	10
Number of ECTS credits allocated	1
Course period	1° semester
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (80%) ☐ No
Course unit contents	Advanced study of machine learning models for clinical data analysis. Techniques for model validation and tuning, with a focus on advanced models (ensemble methods, random forest, gradient boosting). Introduction to unsupervised learning techniques for pattern discovery in clinical data. ● Deep dive into advanced ML models: decision trees, random forests, gradient boosting. ● Feature engineering and selection techniques. ● Model evaluation metrics for classification and regression in a healthcare context. ● Practical application using R: tidymodels.
Learning goals	Students will develop advanced skills in using R for the modeling and validation of machine learning models applied to healthcare data. By the end of the course, students will be able to select, implement, and evaluate appropriate models for different types of data analysis. ● Gain an in-depth understanding of advanced ML models and their applications in medical research. ● Develop skills in feature engineering and model optimization.
Teaching methods	Lectures, hands-on exercises, and case study discussions.
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No

Prerequisites (not mandatory)	Basic knowledge of R and machine learning (have attended the basic course)
Examination methods (in applicable)	
Suggested readings	Lecture notes, R documentation, research articles.
Additional information	

Course unit English denomination	Practical Artificial Intelligence for Medical Data Analyses with R - Basic
SS	MEDS-24/A – Statistica medica
Teacher in charge (if defined)	Corrado Lanera, Luca Vedovelli, Giulia Lorenzoni
Teaching Hours	10
Number of ECTS credits allocated	1
Course period	1° semester
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (80%) ☐ No
Course unit contents	Introduction to the basics of AI applied to clinical data. Introduction to R and the Tidyverse. Overview of the complete analysis pipeline, from preprocessing clinical data to simple supervised machine learning algorithms (such as logistic regression and decision trees). The course focuses on real-world use cases and the use of R libraries to analyze healthcare datasets. ● Introduction to AI in medical research: motivations, applications, ethical considerations. ● Overview of R for medical data analysis. ● Basic data management using dplyr and tidyr. ● Introduction to Machine Learning (ML): supervised vs. unsupervised learning. ● Practical examples of basic ML models (linear regression, classification) using caret. ● Introduction to cross-validation and model evaluation.
Learning goals	Participants will acquire knowledge of basic AI concepts applied to clinical data and will be able to use R to conduct data analysis and apply simple machine learning models. By the end of the course, students will understand and implement an AI-based analysis pipeline for clinical data. ● Understand the fundamental concepts of AI and its application in the medical domain. ● Develop skills in using R for data management and visualization in a medical context. ● Gain a basic understanding of ML models and their practical implementation in R.

Teaching methods	Lectures, hands-on exercises, and case study discussions.
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	Basic knowledge of statistics and programming.
Examination methods (in applicable)	
Suggested readings	Lecture notes, R documentation, research articles.
Additional information	

Course unit English denomination	Practical Artificial Intelligence for Medical Data Analyses with R - Advanced
SS	MEDS-24/A – Statistica medica
Teacher in charge (if defined)	Corrado Lanera, Luca Vedovelli, Giulia Lorenzoni
Teaching Hours	10
Number of ECTS credits allocated	1
Course period	1° semester
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (80%) ☐ No
Course unit contents	Specialized AI applications for clinical data analysis, including neural networks and deep learning techniques. Use of Keras and TensorFlow to develop deep learning models in R. In-depth study of convolutional and recurrent neural networks for clinical data analysis. ● Handling unstructured medical data, including text and images. ● Introduction to large language models (LLMs) and their applications in healthcare. ● Text analysis using LLMs: extracting insights from medical texts and notes. ● Working with medical images: basic techniques for image preprocessing and analysis. ● Introduction to neural networks and deep learning with Keras in R. ● Using APIs for GPT, with a focus on gpteasyr in R for accessing OpenAI models. ● Case studies demonstrating the practical use of LLMs, neural networks, and image analysis in healthcare settings.
Learning goals	Students will gain skills in using R and Keras/TensorFlow to build deep learning models for clinical data. By the end of the course, they will be able to implement neural networks to analyze different types of data, such as images or clinical time series. ● Learn to implement simple neural networks using Keras in R. ● Develop the ability to handle and analyze unstructured medical data such as text and images.

	• Understand the potential and limitations of large language models and neural networks in healthcare. • Gain hands-on experience with API-based interaction with LLMs for medical research and deep learning techniques.
Teaching methods	Lectures, hands-on exercises, and case study discussions.
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	Knowledge of R and machine learning (have attended the basic and advanced courses)
Examination methods (in applicable)	
Suggested readings	Lecture notes, R documentation, research articles.
Additional information	

Course unit English denomination	Clinical Trial Design: Study design and analysis techniques for clinical trials, including randomization and blinding
SS	MEDS-24/A – Statistica medica
Teacher in charge (if defined)	Lorenzoni G.
Teaching Hours	10
Number of ECTS credits allocated	1
Course period	First Year, Second Semester
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (80%) ☐ No
Course unit contents	• Clinical Trial Methodology: Introduction to methodological principles for designing clinical trials, covering key trial types (superiority, equivalence, non-inferiority) and their applications. • Randomization and Randomization List: Techniques for generating and managing the randomization list, focusing on stratified and blocked randomization to maintain group balance. • Blinding and Bias Minimization: Strategies for blinding to reduce bias risk, with discussions on varying levels of blinding. • Data Analysis in Clinical Trials: Analytical techniques for binary, continuous, and time-to-event outcomes, with emphasis on intention-to-treat and per-protocol analyses.
Learning goals	• Understand Core Principles of Clinical Trials: Gain competence in key methodological aspects of clinical trials and understand the importance of randomization and blinding. • Implement Randomization and Blinding: Be able to generate and manage randomization lists and develop effective blinding strategies. • Conduct Appropriate Statistical Analyses: Apply analytical techniques to accurately interpret clinical data, adhering to validity and reliability criteria.
Teaching methods	• Lectures: Theoretical sessions on principles and techniques in clinical trial design, with practical examples to contextualize learned concepts. • Practical Exercises: Group and individual activities on randomization list generation, blinding strategies, and data analysis simulations.

	• Group Discussions and Critical Review: Interactive analysis of real-life case studies.
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	Students should have a basic understanding of clinical research methodology, inferential statistics, and key data analysis techniques. A general awareness of the regulatory context for clinical trials is helpful but not essential.
Examination methods (in applicable)	
Suggested readings	• Textbooks and Selected Articles: Reference texts on study design, randomization techniques, and clinical data analysis. • International Guidelines: ICH-GCP guidelines and other relevant regulatory documents for clinical trial design.
Additional information	This course is designed for doctoral students interested or involved in the design and analysis of clinical studies, particularly those who aim to conduct or are already involved in the conduction of clinical trials. Real-life examples and case studies will illustrate the techniques covered, with a strong emphasis on both theoretical and practical aspects of experimental design.

Course unit English denomination	The use of biomarkers in clinics. State of the art and innovative aspects in diagnostics and prognostics
SS	MEDS-18/B - AUDIOLOGIA E FONIATRIA
Teacher in charge (if defined)	Prof. G. Marioni
Teaching Hours	5
Number of ECTS credits allocated	1
Course period	11/2025
Course delivery method	☒ In presence ☐Remotely ☐Blended
Language of instruction	Italian/English
Mandatory attendance	☒ Yes (Compulsory for PhD students of CTN curriculum) ☐No
Course unit contents	Definition and roles of diagnostic and prognostic biomarkers in oto-rhino-laryngology; Laboratory, histopathological, immunohistochemical biomarkers in chronic sinonasal inflammatory diseases; Role of inflammatory biomarkers in sudden sensorineural hearing loss diagnosis and prognosis; Diagnostic, prognostic, and therapeutic role for biomarkers in head and neck squamous cell carcinoma.
Learning goals	The aim of the course is to critically provide information on the current knowledge regarding the role of biomarkers in head and neck and audiological diseases.
Teaching methods	The course will be delivered through two in presence lessons in Italian or English.
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐No
Available for PhD students from other courses	☒ Yes ☐No
Prerequisites (not mandatory)	-

Examination methods (in applicable)	-
Suggested readings	The material will be provided in the form of slides discussed during the lessons or appropriate scientific articles.
Additional information	-

Course unit English denomination	Ethics applied to clinical research involving human subjects: an introduction to bioethics and how to navigate to an ethic approval considering data protection and regulatory direction.
SS	MEDS-26D - Advanced Medical and Surgical Technology and Methodology
Teacher in charge (if defined)	Matteo Martinato
Teaching Hours	10
Number of ECTS credits allocated	1
Course period	II year I semester
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (80% minimum of presence) ☐ No
Course unit contents	• Definition of bioethics • Directions in bioethics • The classical principles of bioethics • Non-classical principles of bioethics • Informed consent • Main bioethical issues • Clinical research in minors • Clinical research in emergencies/emergencies • Information, consent, dissent • The use of placebos in trials • The problem of conflict of interest • How non-classical principles of bioethics (e.g. ethics of care or patient-centred approach) influence the design of clinical trials • The European data protection regulation in the context of research • The Declaration of Helsinki • The Oviedo Convention • The Good Clinical Practice guidelines • The SPIRIT standard of research protocols, bioethical and regulatory aspects
Learning goals	• Understand bioethics applied to clinical research

	• Acquire the competence to integrate bioethics into clinical research • Conduct a bioethical analysis of standard elements of a research protocol • Set up data collection to protect participants' privacy
Teaching methods	• Lectures • Film presentations of clinical cases • Small group work • Practical examples or case studies on how to ensure GDPR compliance • Discussion sessions or a short project
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	Knowledge of the Good Clinical Practice guidelines, the Declaration of Helsinki, the Oviedo Convention and the SPIRIT guidelines is preferred, but not necessary.
Examination methods (in applicable)	Closed-ended test (multiple choice, one correct answer out of 5 possible answers, one minute available for each question)
Suggested readings	Handout prepared by the lecturer and reference texts including the cited documents. Online supplementary reading materials or recent studies will be provided during the lessons.
Additional information	This course is designed for PhD students interested or involved in the design and conduct of clinical trials, particularly those who wish to conduct or are already involved at various levels in clinical trials. Real-world examples and case studies will be used to illustrate the content discussed in class, with emphasis on both theoretical and practical aspects of trial design and conduct.

Course unit English denomination	Science Communication. How to communicate effectively with various audiences in different contexts
SS	GSPS-06/A
Teacher in charge (if defined)	Mutto Accordi Elisabetta
Teaching Hours	20
Number of ECTS credits allocated	2
Course period	First semester
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	Italian or English
Mandatory attendance	☒ Yes (80%) ☐ No
Course unit contents	The learning program focuses on simulations and exercises in the classroom and on the direct involvement of participants. On this basis, PhD students will practice changing their communicative approach, using diverse range of media. They will develop the basic skills to convey the content of their work to various audiences, being able to stress the value and the impact of their projects.
Learning goals	Students will experiment how to effectively communicate scientific and technical information in various contexts and situations, such as public or professional interactions, intersectoral and multisectoral collaborations. They will learn to select the suitable language, appropriate content and messages, avoiding discipline-specific jargon and terminology.
Teaching methods	To guarantee the quality of the learning program, only 20 PhD students will be admitted and during the practical lessons the class will be split into two different groups.
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☐ Yes ☒ No
Prerequisites (not mandatory)	No

Examination methods (in applicable)	Final oral examination
Suggested readings	
Additional information	

Course unit English denomination	Neuromuscular diseases and personalized medicine
SS	NEUROLOGY MEDS-12/A
Teacher in charge (if defined)	Prof.ssa Elena Pegoraro
Teaching Hours	16
Number of ECTS credits allocated	2
Course period	December 2024- March 2025
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	Italiano
Mandatory attendance	☐ Yes (% minimum of presence) ☒ No
Course unit contents	Neuromuscular diseases are rare disorders for which numerous personalized therapies and various strategies to slow the progression of certain symptoms have recently emerged. Understanding the pathophysiological basis of these diseases is essential for developing innovative therapeutic approaches.
Learning goals	Understanding the concept of neuromuscular disease and knowledge of the main neuromuscular disorders, including their etiopathogenic basis: an overview of muscular dystrophies, spinal muscular atrophies, and myasthenia gravis. Principles of pathophysiology and treatment approaches.
Teaching methods	Lectures. Viewing of histopathological muscle biopsy samples.
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	None
Examination methods (in applicable)	
Suggested readings	Lecture notes. Bibliographic references.

Additional information	
Course unit English denomination	LUNG TRANSPLANTATION
SS	06/MEDS-13A
Teacher in charge (if defined)	MARCO SCHIAVON
Teaching Hours	6
Number of ECTS credits allocated	1
Course period	MARCH 2025
Course delivery method	☐ In presence ☒ Remotely ☐ Blended
Language of instruction	ITALIAN
Mandatory attendance	☒ Yes (minimum % attendance) ☐ No
Course unit contents	- TRANSPLANT CANDIDATE DISEASES AND SELECTION OF RECIPIENTS, - PATHOPHYSIOLOGY OF ORGAN DONATION AND HARVESTING TECHNIQUES - USE OF EX VIVO PERFUSION MACHINES - LUNG TRANSPLANTATION TECHNIQUE - PERI- AND POST-OPERATIVE COMPLICATIONS - RESULTS AND TREATMENT OF COMPLICATIONS
Learning goals	KNOWLEDGE OF SURGICAL TECHNIQUES AND SELECTION OF RECIPIENT PATIENTS AND LUNG DONORS TRANSPLANT RESULTS
Teaching methods	LECTURES AND INSTRUCTIONAL VIDEOS
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	
Examination methods	NOT AVAILABLE

(in applicable)	
Suggested readings	LECTURE SLIDES AND ICONOGRAPHIC MATERIAL, SUPPORTING LITERATURE ON MOODLE
Additional information	

Course unit English denomination	Peripheral Hearing and Central Auditory Processing: state of the art and new perspective
SS	MEDS-18/B AUDIOLOGIA E FONIATRIA
Teacher in charge (if defined)	Prof. Pietro Scimemi Department of Neurosciences-DNS University of Padova School of Medicine and Surgery
Teaching Hours	5
Number of ECTS credits allocated	1
Course period	05/2025
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	Italian
Mandatory attendance	☐ Yes (% minimum of presence) ☒ No
Course unit contents	1. Anatomy and function of Peripheral Auditory System Outer Ear, Middle Ear, Inner Ear (Cochlea) • Anatomy of the Cochlea. Mechano-transduction. Tonotopic Organization. Cochlear Function (Frequency analysis, cochlear amplification and role of outer hair cells, and basilar membrane mechanics) Auditory Nerve (VIII Cranial Nerve) • Structure of the Auditory Nerve: Pathway from cochlea to brainstem, synapses with hair cells. Neural Coding of Sound: How the auditory nerve encodes frequency, intensity, and timing information. • Auditory Nerve Pathologies: Cochlear nerve damage, auditory neuropathy. 2. Central Auditory Pathway 2.1. Brainstem: Cochlear Nuclei to Superior Olivary Complex • Cochlear Nuclei: The first synaptic relay in the brainstem; its role in sound processing and localization. • Superior Olivary Complex (SOC): Key structure for binaural processing and sound localization (e.g., interaural time differences, interaural level differences).

- Decussation and Pathway to Contralateral Brainstem: The crossing of auditory pathways and implications for sound localization.

2.2. Lateral Lemniscus and Inferior Colliculus

- Lateral Lemniscus: role in the integration of frequency and timing cues.
- Inferior Colliculus: auditory processing, sound localization, and integrating auditory information with other sensory modalities (e.g., vision).

2.3. Medial Geniculate Body (MGB)

- Role of the MGB and Thalamocortical Connections: How the MGB serves as a filter for auditory information before it reaches higher cortical centers.

3. Auditory Cortex and Higher-Level Processing

3.1. Primary Auditory Cortex (A1)

- Anatomy and Function Basic processing of pitch, loudness, and temporal aspects of sound.
- Tonotopic Mapping in A1: How different frequencies are represented in different areas of the auditory cortex.

3.2. Association areas of Auditory Cortex

- Higher-Level Processing: Understanding speech, music, and complex sounds (e.g., speech recognition, music perception, environmental sound analysis).
- Bilateral Processing: Role of both hemispheres in processing complex auditory stimuli like language.
- Cortical Plasticity: How the brain adapts to changes in auditory input (e.g., after hearing loss or cochlear implantation).

3.3. Auditory-Visual Integration

- Cross-modal Processing: How auditory information is integrated with visual and motor information, such as in speech perception (McGurk effect) and sound localization.

4. Auditory Perception

4.1. Pitch Perception

- Frequency Analysis: How the auditory system perceives pitch, including the role of cochlear mechanics, neural coding in the auditory nerve, and cortical processing.
- Pitch Perception Theories: Place theory vs. temporal theory of pitch perception.

4.2. Loudness Perception

- Intensity Encoding: How the brain processes loudness through the firing rate of auditory neurons and the recruitment of additional neurons.
- Perceived Loudness: How loudness is perceived subjectively and how it relates to intensity and frequency.

4.3. Temporal Processing

- Timing of Auditory Events: How the auditory system processes sound timing for events like speech rhythm and sound localization.
- Auditory Temporal Resolution: The ability to detect rapid changes in sound (important in speech perception and music).

4.4. Sound Localization

- Binaural Cues: Use of interaural time differences (ITD) and interaural level differences (ILD) for sound localization.
- Monaural Cues: How the shape of the ear can provide additional cues for localizing sounds (e.g., spectral cues).

5. Disorders of the Auditory System

5.1. Peripheral Disorders

- Hearing Loss Types: Conductive vs. sensorineural vs. mixed hearing loss.
- Common Pathologies: Otitis media, presbycusis, noise-induced hearing loss, cochlear implants.

5.2. Central Auditory Processing Disorders

- Cortical and Subcortical Auditory Processing: Understanding how disorders at the brainstem or cortical levels affect hearing.
- Auditory Processing Disorder (APD): Difficulty in processing auditory information despite normal peripheral hearing.
- Tinnitus: Auditory hallucinations and the neurophysiological mechanisms involved.

6. Emerging Topics in Hearing Science

- Auditory Neuroscience Research: Recent advances in auditory neuroscience, such as plasticity in the auditory cortex, cochlear implant research, and gene therapy for hearing loss.
- Hearing Restoration Technologies: New approaches like gene therapy, stem cell treatments, and advancements in cochlear implants and hearing aids.

7. Future Directions

- Emerging fields in auditory neuroscience, such as auditory brain-computer interfaces, neuromodulation techniques, and advances in hearing restoration.

Learning goals	Knowledge and Understanding Students will be able to: 1. Explain Core Concepts in Auditory Neuroscience 2. Identify Mechanisms of Auditory Perception 3. Describe Neuroplasticity in Hearing 4. Summarize the Role of Auditory Processing: Outline how perceptual processes influence auditory experiences, such as speech processing, music perception, and environmental sound recognition. 5. Understand the Impact of Disorders: Discuss common auditory disorders (e.g., tinnitus, presbycusis, auditory processing disorder) and the neuroscience underlying these conditions. Applying Knowledge and Understanding Students will be able to: 1. Analyze Case Studies 2. Evaluate Experimental Studies 3. Interpret Audiological Data 4. Engage in Cross-Disciplinary Problem-Solving
Teaching methods	1. Active Learning and Engagement ● Interactive Polls/Quizzes: before starting the lesson, quick poll or quiz to gauge students' prior knowledge. Quick feedback and to engage students right from the start using platforms like Kahoot. ● 2. Multimedia Integration ● Animations/Visual Aids: animated videos are used to show complex auditory processes, such as sound transduction in the cochlea, neural signal transmission in the auditory pathway, or the tonotopic organization of the auditory cortex. ● Sound Examples: students are provided with examples of different sound frequencies, pitch, or auditory illusions (e.g., the Shepard Tone or McGurk effect) ● Neuroimaging/Brain Activity Visuals: ● 3. Conceptual Mapping ● Flowcharts or Diagrams: flowcharts are used to show the progression of auditory signals from the ear to the brain (e.g., cochlea → auditory nerve → brainstem → thalamus → auditory cortex). ● Anatomical Models. ● 4. Case Studies and Real-Life Applications ● Clinical Case Studies: clinical scenarios are introduced, such as hearing loss, auditory processing disorders, or tinnitus. Case studies explain how the auditory system can be disrupted and what that reveals about its normal function. ● Technological Applications: Discuss how advances in auditory neuroscience are applied in real-world technology like cochlear implants, hearing aids. ● 5. Problem-Based Learning ● Group Work: Have students break into small groups to tackle specific problems related to auditory neuroscience (e.g., how auditory information is integrated with other sensory systems in the brain).

Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	Knowledge equivalent to a master's degree in STEM disciplines (Science, Technology, Engineering, Mathematics, and Medicine
Examination methods (in applicable)	Not applicable
Suggested readings	Oxford Handbook of Auditory Science (3 volume pack) Oxford University Press, 2010 Volume 1: The Ear (edited by Paul Fuchs) Volume 2: The Auditory Brain (edited by Alan Palmer and Adrian Rees) Volume 3: Hearing (edited by Chris Plack)
Additional information	

Course unit English denomination	Motor neuron diseases: from neurodegeneration to clinical phneotypes
SS	MEDS-12/A
Teacher in charge (if defined)	Gianni Sorarù
Teaching Hours	10
Number of ECTS credits allocated	2
Course period	May 2025- November 2025
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	Italian
Mandatory attendance	☐ Yes (% minimum of presence) ☒ No
Course unit contents	This course covers the mechanisms of neurodegeneration, exploring the underlying biological processes leading to various neurodegenerative diseases.
Learning goals	The learning objectives of the course are to understand the cellular and molecular mechanisms of neurodegeneration, analyze major neurodegenerative diseases, explore emerging diagnostic and therapeutic techniques, and develop a critical perspective on the challenges in research and treatment.
Teaching methods	Lectures
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	Knowledge of Neurobiology
Examination methods (in applicable)	Oral exam
Suggested readings	Lecture notes

Additional information	

Course unit English denomination	Bioethics
SS	MEDS-02/C
Teacher in charge (if defined)	Fabio Zampieri
Teaching Hours	10
Number of ECTS credits allocated	2
Course period	Summer semester
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	Italian
Mandatory attendance	☒ Yes (75% minimum of presence) ☐ No
Course unit contents	The Bioethics course consists of lectures covering the following topics. • Ethics and evolution in the animal world • Ethics and science • Ethics and medicine • Milestones of ethics in medicine • Ethical aspects in the history of vaccinations • Principles of "permission" and "person" • Clinical bioethics • Code of Medical Ethics • Ethics Committee in Italy This is a transversal teaching on the origin, nature and main issues of ethics, deontology and bioethics. Recently, following the COVID-19 pandemic, the topic of vaccinations from a historical, ethical and legislative point of view has also been included.
Learning goals	The student will be able to understand why medicine, as well as science and techniques in general, need to develop ethical principles to follow for the proper functioning of medicine itself and the well-being not only of the individual patient, but also of the entire social community.
Teaching methods	The methodology will be based mainly on frontal teaching, but the teacher will stimulate discussion on each topic addressed during the lessons, also asking for the personal opinion of the students.

Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	No particular prerequisites are necessary, other than a personal sensitivity to ethical issues, relating, therefore, to values such as good-bad, just-unjust, legal-illegal, beautiful-ugly and so on.
Examination methods (in applicable)	Thesis on a topic of your choice
Suggested readings	The study material will consist of the slides shown during the course and some articles that explore some topics in depth
Additional information	