Course unit English denomination	A journey with the cytotoxic lymphocytes
SS	MEDS-02/A
Teacher in charge (if defined)	Prof. Denis Martinvalet
Teaching Hours	10
Number of ECTS credits allocated	2
Course period	To be defined
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (80% minimum of presence) ☐ No
Course unit contents	The course includes the following lessons: 1. Self / non-self for the cytotoxic lymphocytes: A general introduction to basic immunology. 2. Cytotoxic lymphocytes in the body: Histology of the lymphoid tissues. 3. Development, function and pathology of cytotoxic lymphocytes. 4. Mechanisms of lymphocyte cytotoxicity. 5. Cytotoxic lymphocytes in the clinic.
Learning goals	The goal of this course is to familiarize the attendees to the fundamental principles of the physiology of the immune system. We will follow the life cycle of the cytotoxic lymphocytes to instil these fundamental principles of immunology. 1. Self / non-self for the cytotoxic lymphocytes: A general introduction to basic immunology. This first lecture offers a definition of the immune system doted with interoception monitoring the integrity of the entire organism. We will develop the self/non-self concept.

	2. Cytotoxic lymphocytes in the body: Histology of the lymphoid tissues. This lecture offers an exploration of the organ of the immune system and their specific role in the development differentiation and activation of the immune cells. 3. Development, function and pathology of cytotoxic lymphocytes. This lecture explores the different pathology affecting the immune system but also the consequence of the dysregulation of the immune system. 4. Mechanisms of lymphocyte cytotoxicity. This lecture gives an in-depth exploration of the mechanism of lymphocyte mediated cytotoxicity. 5. Cytotoxic lymphocytes in the clinic. This lecture explores the usage of cytotoxic lymphocytes in clinical setting.
Teaching methods	Lecture and case studies
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes Classes are open to doctoral students only in the following courses: Biosciences ☐ No
Prerequisites (not mandatory)	Basic knowledge in biology, cellular and molecular biology, biochemistry.
Examination methods (if applicable)	A case study to be solved in small groups or 5 Multiple choice questions, depending on the size of the class.
Suggested readings	Peter Parham: The Immune System, Fourth Edition
Additional information	

Course unit English denomination	Genomics & Bioinformatics hands-on
SS	BIOS-07/A
Teacher in charge	Marco Giorgio
Teaching Hours	10
Number of ECTS credits allocated	2
Course period	To be defined
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (80% minimum of presence) ☐ No
Course unit contents	This course explores the conceptual framework behind how genomic functions impact disease. It covers technologies used to examine cell identity and genomic alterations. It also explains how to prepare samples for single-cell and spatial epigenetic/transcriptomic studies. Moreover, it offers introductory training in sequencing data analysis, including hands-on work with real datasets. Lesson Plan: 1) Cell identity and plasticity, epigenetic errors, transcriptional noise and cellular heterogeneity. 2) Exposome-genome crosstalk, long term imprinting and maladaptation. 3) NGS devices, theory and practice. 4) Chromatin and RNA tools, at single cell and spatial levels. 5. RNAseq data set analysis - pipeline description - be part of the galaxy "community". 6 – 10) Hands-on from fastq to bam files, quality check, alignment to ref genome, samples clustering, stat tricks, differential analysis, gene onthology, upstream regulators.
Learning goals	This course aims to provide: i) training with state of the art technologies and experimental procedures used to study genomic adaptation; ii) the skill to understand complicated genomic data and relate them to information from different biological areas; iii) the ability to incorporate methods for exploring and analyzing genomic behavior into research programs focused on understanding disease mechanisms.

Teaching methods	Lectures with case discussions, working groups and interactive computational analysis sessions.
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes Classes are open to doctoral students only in the following courses: Biosciences ☐ No
Prerequisites	Understanding the terminology and the main molecular processes of genetics, epigenetics and gene expression control.
Examination methods (if applicable)	Checking the outcomes from the exercise completed during the lessons.
Suggested readings	Teaching material and applications exchanged during the course.
Additional information	An up-to-date personal notebook is required

Course unit English denomination	Grant Writing
SS	BIOS-08/A - BIOLOGIA MOLECOLARE
Teacher in charge (if defined)	Maria Pennuto
Teaching Hours	10
Number of ECTS credits allocated	2
Course period	To be defined
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (80% minimum of presence) ☐ No
Course unit contents	1. Overview of a successful grant application. 2. The core of the application in 1 page: Specific Aims and Significance 3. Background and Preliminary data 4. Experimental plan, Gantt chart, Future perspectives, Collaboration letters, Graphical Abstract. 5. Practical part for evaluation.
Learning goals	Provide the tools that take the PhD student from developing an idea to creating a scientific hypothesis (central hypothesis of the grant application) to convert it into a competitive research project that the PhD student can present to a funding agency. Provide the tools that the PhD can use during the course or in the future to obtain funding to continue their research with a view to developing a competitive research program.
Teaching methods	• promote critical thinking in the classroom • lead discussions in plenary and in working groups in the classroom • use group work in the classroom • teach interactively
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes Classes are open to doctoral students only in the following courses: Biosciences

	☐ No
Prerequisites (not mandatory)	
Examination methods (if applicable)	written: exercise in preparing the core page of the applications “specific aims and significance”
Suggested readings	grants
Additional information	Information material, grants as examples, links to texts for further information will be provided.

Course unit English denomination	Intrinsically Disordered Proteins: structural and functional characterization and their key role in human diseases
SS	05/BIOS-07 - BIOCHEMISTRY
Teacher in charge (if defined)	Maria Cristina Aspromonte
Teaching Hours	10
Number of ECTS credits allocated	2
Course period	To be defined
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (80% minimum of presence) ☐ No
Course unit contents	This course will cover both theoretical and practical aspects of Intrinsically Disordered Proteins (IDPs) and Intrinsically Disordered Regions (IDRs), with a focus on their biological significance and computational analysis. The main topics include: 1) Introduction to IDPs and IDRs. Definition and characteristics of IDPs and IDRs; structural and functional properties. 2) IDPs and IDRs in Biological Processes and Diseases 3) Role of IDPs/IDRs in phase separation and biomolecular condensates. 4) IDPs/IDRs and their implications in neurodegenerative diseases, cancer, and other disorders.

5) Computational Approaches for IDP/IDR Analysis.

    a) Databases and bioinformatics tools for IDP/IDR prediction and annotation.

    b) Identification of disorder-related features and molecular interaction.

    c) Practical Training and Hands-on Sessions

6) Using in silico tools and databases to retrieve and analyze IDP/IDR-related data.

7) Case studies on IDP/IDR function, regulation, and disease involvement.

Learning goals	Participants will receive training in a multidisciplinary environment and acquire knowledge of integrative methodologies required to study Intrinsically Disordered Proteins (IDPs) and Intrinsically Disordered Regions (IDRs), emphasizing their crucial role in human diseases.The goal of this course is to provide participants with: 1. Fundamental knowledge to understand the key aspects of IDPs and IDRs. 2. Insight into IDPs/IDRs involvement in key biological phenomena such as phase separation, other cellular processes, and disease mechanisms. 3. An overview of computational resources available for studying IDPs/IDRs. 4. Hands-on experience in applying databases, *in silico* resources, and computational tools to: a) Analyze relevant biological data in context. b) Using integrative methodologies for studying intrinsically disordered proteins c) Investigate the IDPs of wild-type and mutant proteins in physiology and disease.
Teaching methods	This course will combine theoretical knowledge with practical applications, equipping participants with essential skills for studying IDPs/IDRs in biomedical research.

Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes Classes are open to doctoral students only in the following courses: Biosciences ☐ No
Prerequisites (not mandatory)	
Examination methods (if applicable)	Final multiple-choice exam to assess knowledge acquisition.
Suggested readings	Scientific Article and Slides shared by the teacher
Additional information	

Course unit English denomination	Learning, memory and actions: from neural circuits to complex behaviours
SS	BIOS-09 Fisiologia
Teacher in charge (if defined)	Manuela Allegra Letizia Mariotti
Teaching Hours	10
Number of ECTS credits allocated	2
Course period	To be defined
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (80% minimum of presence) ☐ No
Course unit contents	• Role of hippocampus in learning and memory (spatial memory and navigation) • Role of superior colliculus in actions (goal-oriented actions and adaptive behaviours) • Learning, memory and actions impairment in neurodegeneration: focus on stroke and Alzheimer's disease • Fundamentals of in vivo electrophysiology and its application in freely moving animals. • Fundamentals of in vivo imaging in freely moving animals. • Fundamentals of in vivo optogenetics in freely moving animals.
Learning goals	By the end of the course, PhD students will have acquired: • The fundamentals of functional and structural neurobiology of learning and memory, with a particular focus on spatial navigation and goal-oriented actions. • Essential knowledge of the neurobiology of neurodegeneration (e.g., stroke, Alzheimer's disease). • The skills to apply major techniques for studying learning and memory in murine models, including in vivo electrophysiology, imaging, and optogenetics.
Teaching methods	• Facilitate plenary discussions • Teach using interactive methods

	• Foster critical reflection in the classroom • Utilize the critical incident technique • Encourage effective feedback • Establish authentic relationships in the classroom
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes Classes are open to doctoral students only in the following courses: Biosciences ☐ No
Prerequisites (not mandatory)	Basic knowledge of cell biology
Examination methods (if applicable)	True/false or multiple-choice
Suggested readings	• Course's slides • Scientific articles related to the topics covered, available on PubMed • Reference text: Principles of Neuroscience, E. Kandel
Additional information	N/A

Course unit English denomination	Nanomedicine: from dream to applications?
SSD	MEDS-02/A; BIOS-07/A
Teacher in charge (if defined)	Regina Tavano, Emanuele Papini Giulio Fracasso Laura Fusco
Teaching Hours	10
Number of ECTS credits allocated	2
Course period	To be defined
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (80% minimum of presence) ☐ No
Course unit contents	The course includes the following lessons: 1. Introduction to Nanotechnology: why is something so small so big? Differences between bulk and nano materials; physical (size and shape), chemical (lipid-based, polymeric, and inorganic nanoparticles), and biological (biocompatibility, bioavailability, pharmacokinetics) properties of different types of nanoparticles. Examples of FDA-approved Nanomedicines. The challenging journey of nanoparticles in the body: biological barriers (protein corona, secretion, blood flow, immune system cells and proteins, tumor microenvironment). Examples of nanotoxicological tests conducted in vitro. 2. Surface masking, protein corona, biodistribution. Opsonins and dysopsonins: how corona proteins modify nanoparticle biodistribution and clearance by macrophages; collectins, C1q, ficolins, and apolipoproteins and the effects of their association with nanoparticle surfaces; the effects of the RES (reticuloendothelial system) on nanoparticle biodistribution. How to integrate preclinical and human models: species-specific differences in biomolecular corona composition, molecular mechanisms of innate recognition of nanoparticles, specific anatomical-organic structural characteristics, which lead to different responses to nanoparticles in preclinical models compared to humans." 3.Therapeutic and Theranostic Applications of Nanosystems. How we can improve tumor accumulation of drugs by exploiting nanomedicine: enhancing half-life and stability; avoiding phagocytosis by the reticuloendothelial system; protecting the drug during its pathway to the target tissue;modifying accumulation by targeting the tumor microenvironment. How nanomedicine can improve tumor accumulation:

	the EPR effect versus specific targeting. The Vascular targeting. How we can overcome the blood-brain barrier. Which molecules can be used to guide a nanosystem to the tumor: advantages and disadvantages. Overview of the use of the modular nanoplatform based on human ferritin for drug delivery. Brief overview of potential organelle targeting. Brief mention of macrophage targeting, a cell population that accumulates in the tumor microenvironment. 4. Biocompatibility and biomedical applications of new two-dimensional nanomaterials: MXenes. The development and discovery path of new 2D nanomaterials will be traced, from graphene to the discovery of MXenes, describing their main characteristics and chemical composition. Special attention will be given to the physical, chemical, and biological properties of MXenes and their correlation with applications in various sectors, focusing on biomedical uses. The main toxicity mechanisms of nanomaterials and methodologies for biosafety evaluation will also be examined. In the final part, some emerging applications of MXenes in the biomedical field will be explored, including: i) the interaction of MXenes with human immune cells and the use of single-cell mass cytometry to study their effects, and ii) potential applications of two-dimensional materials in space biology.
Learning goals	1. Understand the fundamental principles of nanotechnology and the impact of nanoscale dimensions on properties and applications in medicine. 2. Delve into the concept of the protein corona, the biodistribution of nanomaterials, and strategies for integrating preclinical and human models. 3. Explore the key therapeutic applications of nanosystems, such as drug carriers, photodynamic therapy, and photothermal ablation. 4. Analyze the biocompatibility and potential biomedical applications of new two-dimensional nanomaterials, with a particular focus on MXenes.
Teaching methods	Lectures, classroom discussion, feed-back forms
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes Classes are open to doctoral students only in the following courses: Biosciences ☐ No
Prerequisites (not mandatory)	
Examination methods (if applicable)	Final quiz consisting of 20 questions of various types (multiple choice, true/false, fill-in-the-blank)
Suggested readings	Scientific articles in the field, lecturer's slides

Additional information

Course unit English denomination	Neurodegeneration
SS	MEDS-02/B
Teacher in charge (if defined)	Emanuela Zuccaro, Elisa Greggio, Elena Ziviani
Teaching Hours	13
Number of ECTS credits allocated	2
Course period	To be determined
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (80% minimum of presence) ☐ No
Course unit contents	The course provides a comprehensive exploration of both the molecular and clinical aspects of neurodegenerative diseases, offering in-depth insights into the clinical features and pathogenesis of a broad range of neurodegenerative diseases, including Alzheimer's disease, Parkinson's disease, repeat expansion disorders, and prion diseases. Key topics will include: • The accumulation of misfolded and aberrant proteins, the inflammatory response, and the cellular and molecular mechanisms underlying neurodegeneration, as well as disease propagation. • The initiation, genetic contributions, and pathomechanisms of neurodegenerative diseases. • Diagnostic methods and potential strategies for therapeutic intervention. • Animal and cell culture models pivotal to research on neurodegenerative diseases.

	• Practical experience: The practical part of the course consists of **3 hours**, structured as follows: - **Theoretical session** (1 hr) covering microscopy techniques used in the subsequent rotations (TEM, confocal, and high-content imaging). - **TEM visualization** (40 mins), focusing on mitophagy defects and other proteostasis impairments in Parkinson's disease models. - **Confocal microscopy** (40 mins), using mouse brain sections with Alzheimer's and Parkinson's pathology. - **High-content imaging (Operetta)** (40 mins), demonstrating high-throughput screening approaches to identify/evaluate potential druggable molecules based on cellular readouts (e.g., protein aggregation, increased target phosphorylation, etc.).
Learning goals	By the conclusion of the course, students should be able to: 1. Describe the pathophysiology of the most prevalent neurodegenerative disorders, including the clinical symptoms, the affected cells and regions, as well as the potential mechanisms underlying disease progression. 2. Describe and analyze potential mechanisms of disease spread. 3. Explain and interpret the role of genetics in the development of neurodegenerative diseases. 4. Demonstrate a thorough understanding of investigative methods and diagnostic approaches. 5. Describe and evaluate in vivo and in vitro disease models available. 6. Engage in a critical discussion of the potential future disease-modifying treatment options. 7. Evaluate the scientific literature on both the clinical and research aspects of neurodegenerative diseases.
Teaching methods	The course will be divided into 10 hours of lectures supported by slides and 3 hours of practical experience. The course involves active student participation through both questions and the use of interactive teaching tools. The supporting slides will be made available to students via upload on the Moodle platform.
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes Classes are open to doctoral students only in the following courses: Biosciences ☐ No
Prerequisites (not mandatory)	Basic knowledge of Neurobiology, Cellular and Molecular Biology. Basic knowledge of Microscopy.

Examination methods (if applicable)	Multiple-choice Quiz
Suggested readings	Slides, scientific articles, and supplementary materials will be made available to students on the Moodle platform.
Additional information	

Course unit English denomination	Neuromuscular Plasticity
SS	BIOS-06/A
Teacher in charge	Marco Narici
Teaching Hours	10
Number of ECTS credits allocated	2
Course period	To be defined
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (80% minimum of presence) ☐ No
Course unit contents	1) Skeletal muscle, structural and functional characteristics 2) Motor units, histological, biochemical and contractile properties, nervous control 3) Neuromuscular adaptations to chronic inactivity 4) Neuromuscular adaptations to exercise 5) Neuromuscular plasticity in ageing1) Skeletal muscle, structural and functional characteristics
Learning goals	The course aims to provide students with fundamental knowledge on skeletal muscle physiology, analysing its morphological, biochemical and functional characteristics, as well as its nervous control during muscle activity and under fatigue conditions. A special focus will be devoted to neuromuscular plasticity, examining muscle responses to conditions of chronic disuse, such as exposure to hypogravity, physical training and ageing. The neurodegenerative processes associated with disuse and ageing will be explored, with a detailed analysis of the molecular and cellular mechanisms involved and their impact on neuromuscular function. Finally, the course will address the exercise-induced neuromuscular adaptations, highlighting their neuroprotective role in maintaining the integrity of the neuromuscular system.
Teaching methods	Frontal lectures

Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes Classes are open to doctoral students only in the following courses: Biosciences ☐ No
Prerequisites (not mandatory)	
Examination methods (if applicable)	Multiple choice test
Suggested readings	1) Narici M, Franchi M, Maganaris C. Muscle structural assembly and functional consequences. J Exp Biol. 2016 Jan;219(Pt 2):276-84. doi: 10.1242/jeb.128017. 2) Motanova E, Sarto F, Negro S, Pirazzini M, Rossetto O, Rigoni M, Stashuk DW, Gasparini M, Šimunic B, Pišot R, Narici MV. Neuromuscular junction instability with inactivity: morphological and functional changes after 10 days of bed rest in older adults. J Physiol. 2025 Mar 17. doi: 10.1113/JP288448. 3) Motanova E, Pirazzini M, Negro S, Rossetto O, Narici M. Impact of ageing and disuse on neuromuscular junction and mitochondrial function and morphology: Current evidence and controversies. Ageing Res Rev. 2024 Dec;102:102586. doi: 10.1016/j.arr.2024.102586. 4) Murgia M, Rittweger J, Reggiani C, Bottinelli R, Mann M, Schiaffino S, Narici MV. Spaceflight on the ISS changed the skeletal muscle proteome of two astronauts. NPJ Microgravity. 2024 Jun 5;10(1):60. doi: 10.1038/s41526-024-00406-3. 5) Sirago G, Pellegrino MA, Bottinelli R, Franchi MV, Narici MV. Loss of neuromuscular junction integrity and muscle atrophy in skeletal muscle disuse. Ageing Res Rev. 2023 Jan;83:101810. doi: 10.1016/j.arr.2022.101810. 6) Franchi MV, Badiali F, Sarto F, Müller P, Müller NG, Rehfeld K, Monti E, Rankin D, Longo S, Lund J, Hökelmann A, Narici M. Neuromuscular Aging: A Case for the Neuroprotective Effects of Dancing. Gerontology. 2023;69(1):73-81. doi: 10.1159/000524843. 7) Sarto F, Franchi MV, McPhee JS, Stashuk DW, Paganini M, Monti E, Rossi M, Sirago G, Zampieri S, Motanova ES, Valli G, Moro T, Paoli A, Bottinelli R, Pellegrino MA, De Vito G, Blau HM, Narici MV. Neuromuscular impairment at different stages of human sarcopenia. J Cachexia Sarcopenia Muscle. 2024 Oct;15(5):1797-1810. doi: 10.1002/jcsm.13531. 8) Mitchell WK, Williams J, Atherton P, Larvin M, Lund J, Narici M. Sarcopenia, dynapenia, and the impact of advancing age on human skeletal muscle size and strength; a quantitative review.

Front Physiol. 2012 Jul 11;3:260. doi: 10.3389/fphys.2012.00260.

9) Franchi MV, Reeves ND, Narici MV. Skeletal Muscle Remodeling in Response to Eccentric vs. Concentric Loading: Morphological, Molecular, and Metabolic Adaptations. Front Physiol. 2017 Jul 4;8:447. doi: 10.3389/fphys.2017.00447.

Additional information

Course unit English denomination	Science Communication
SS	
Teacher in charge (if defined)	Elisabetta Mutto-Accordi
Teaching Hours	13
Number of ECTS credits allocated	2
Course period	To be defined
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (80% minimum of presence) ☐ No
Course unit contents	Science communication is the practice of sharing scientific knowledge, research findings and technical information to non-expert audiences. This programme introduces the fundamental information that can bring a deep understanding of why Science Communication is important and how it can have an impact at a professional and social level. Starting from the needs, the expectations and the understanding levels of the audiences, the students will learn how to create a relation with the target based on clarity, precision and simplicity. The course will cover strategies to develop empathy and to build trust and credibility. The programme: Science communication - Communication process - Content selection - Storytelling - Persona Branding - Written communication - Public speaking - PowerPoint presentations
Learning goals	PhD students will learn how to effectively communicate scientific and technical information to different audiences, in various contexts. They will practice selecting the suitable language, appropriate content and messages. They will learn to stress the value and the impact of their scientific projects, avoiding discipline-specific jargon, terminology and unnecessary complexity. Students will learn how to break down complex topics and present them in engaging and understandable formats, without losing accuracy and ensuring that information is not distorted or oversimplified. They will practice to tailor content using storytelling, framing scientific concepts in compelling and narrative-driven ways, using metaphors and analogies to simplify. They will become skilled at changing their communicative approach, using diverse range of media to meet the needs of the target.

	They will learn evaluating the effectiveness of their communication by understanding audience feedback. The program focuses on simulations and exercises in the classroom and on the direct involvement of participants. Students will exchange feedback on their work and refine their communication skills.
Teaching methods	Non-direct teaching method. Direct involvement of participants through simulations and exercises.
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes (Classes are open to doctoral students only in the following courses: Biosciences) ☐ No
Prerequisites (not mandatory)	
Examination methods (if applicable)	Evaluation of final presentations
Suggested readings	
Additional information	The course is held for PhD Students of the 2nd and 3rd year only

Course unit English denomination	The world of RNA: from cell biology to personalized medicine
SS	06/MEDS-02
Teacher in charge (if defined)	Prof. Rosario Rizzuto, Dott.ssa Annamaria Lia
Teaching Hours	10
Number of ECTS credits allocated	2
Course period	To be defined
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (80% minimum of presence) ☐ No
Course unit contents	1. Introduction to the world of RNA 2. RNA Delivery: strategies and limitations 3. mRNA: applications 4. RNA interference and ASOs 5. siRNA: advantages and examples
Learning goal	This course aims to provide students with basic knowledge of the world of RNA and the concept of personalized medicine. The course will cover RNA drug delivery challenges (stability, degradation and immune response) and strategies (lipid nanoparticles, viral vectors, and polymer-based systems). Covid-19 mRNA vaccine delivery will be presented as an example. In addition, basic knowledge of the various types of RNA will be provided. As for mRNA both vaccines and proteins replacement therapy will be discussed. Gene silencing approaches mediated by RNA interference and ASOs will be presented. Some examples of FDA-approved RNAi or ASO-based therapies will be discussed, such as the case of Inclisiran for hypercholesterolemia and Eteplirsen for Duchenne muscular dystrophy. Finally, also the advantages of siRNA with respect to other strategies will be examined. As a case-study will be presented the case of Patisiran for hereditary transthyretin amyloidosis. At the end of the course, students will be able to: • Understand the structural and functional properties of RNA. • Analyze various RNA delivery strategies and their limitations.

	• Evaluate the therapeutic applications of mRNA and its role in modern medicine. • Examine RNA interference (RNAi) and antisense oligonucleotides (ASOs) as gene-silencing tools. • Understand the advantages and applications of siRNA therapeutics.
Teaching methods	The course is divided into 5 frontal lessons.
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes Classes are open to doctoral students only in the following courses: Biosciences ☐ No
Prerequisites (not mandatory)	
Examination methods (if applicable)	Test multiple choice.
Suggested readings	Bibliographical references for further study will be provided during the course.
Additional information	

Course unit English denomination	Protein Structure Analysis: Databases, Visualization, and Functional Insights
SS	BIO10, BIOS-07/A - Biochimica
Teacher in charge (if defined)	Emanuela Leonardi
Teaching Hours	10
Number of ECTS credits allocated	2
Course period	To be defined
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (80% minimum of presence) ☐ No
Course unit contents	Throughout the course, students will explore the intricate relationships between protein structure, function, and interactions. Participants will learn to navigate and retrieve protein structures from primary databases like the Protein Data Bank (PDB) and AlphaFoldDB and visualize them using tools such as PyMOL. The course covers essential structural elements—such as binding sites, secondary structure motifs, and active sites—and examines their roles in protein function and interactions. Additionally, advanced methods based on residue interaction networks (RINs) will be introduced for analyzing structure-function relationships and predicting residue interactions relevant to drug design and biotechnology. The course consists of five two-hour lessons structured as follows: Lesson 1: Introduction to protein structure and databases Lesson 2: Visualization tools and structural analysis Lesson 3: Structural prediction and homology modeling Lesson 4: Function, interactions, and biotechnological implications Lesson 5: Residue Interaction Networks (RIN) and their applications
Learning goals	At the end of the course, students will have acquired knowledge on: • The fundamental principles of protein structure and their functional implications. • Structural prediction methodologies, including homology modeling and AI-based approaches (AlphaFold). • Residue Interaction Networks (RIN), their role in structural analysis, and the tools for their construction and interpretation. Students will be able to:

	• Consult and use structural databases to extract and analyze protein-related information. • Use molecular visualization software to explore protein structures and identify key structural elements. • Generate structural models through homology modeling and assess their reliability. • Build and analyze Residue Interaction Networks (RIN) to identify functional residues and evaluate the effects of mutations. By the end of the course, students will have developed the ability to: • Apply a critical approach to protein structure analysis, integrating data from various bioinformatics sources. • Effectively communicate the results of structural analysis using graphical representations and accurate descriptions.
Teaching methods	Lectures, practical exercises, group work
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	
Examination methods (if applicable)	Multiple-choice test
Suggested readings	
Additional information	