A.D. 1308 unipg

DIPARTIMENTO DI SCIENZE FARMACEUTICHE

DOCTORAL PROGRAM IN PHARMACEUTICAL SCIENCES

Frontal teaching provided by the doctoral course

a.a. 2025-26

Prof. Giuseppe Manfroni - University of Perugia	**2 CFU, 12h**	**CC**	**February 2026**

Surface plasmon resonance: principles and applications.

Biophysical methods for studying biomolecular interactions play a central role in characterizing affinity, kinetics, and recognition mechanisms between proteins, nucleic acids, and small molecules. Surface Plasmon Resonance (SPR) is one of the most established label-free, real-time techniques, thanks to its high sensitivity and ability to provide accurate kinetic parameters. In recent years, a number of SPR-like techniques have emerged, based on similar optical principles but optimized to enhance robustness, throughput, and compatibility with complex matrices. Among these, Grating-Coupling Interferometry (GCI) has gained particular prominence. GCI uses diffraction gratings to couple light to the sensing surface and generate highly stable interferometric signals. Overall, the integration of SPR and SPR-like techniques, with a special focus on GCI, provides an advanced analytical framework for structural biology, drug discovery, and the functional characterization of biomolecular complexes.

This course provides a comprehensive introduction to biophysical methodologies for the characterization of biomolecular interactions, with a particular focus on SPR and on GCI. A special focus will be on ligand immobilization strategies, examining how different surface chemistries influence sensitivity, specificity, and data quality. Throughout the course, students will explore the principles and applications of these optical biosensing techniques through a series of thematic lectures (4 hs) and a laboratory section (8 hs). By integrating theoretical foundations with practical considerations, students can acquire the fundamentals to carry out a SPR/GCI experiment.

Dr. Francesco Casuscelli- Nerviano Medical Sciences	**1 CFU, 6h**	**EPDD**	**March 2026**

Leveraging Covalent Inhibitors as new Modality for Drug Discovery.

Targeting intractable proteins remains a key challenge in drug discovery, often demanding mechanisms of inhibition that are more efficient than those offered by traditional non-covalent drugs. The irreversible and reversible covalent inhibition approach provides a powerful strategy to access challenging binding pockets or allosteric sites, expanding the scope of protein druggability and establishing a novel therapeutic modality. Advances in rational ligand- and structure-based drug design enable the highly selective targeting of specific nucleophilic residues, including the common cysteine and the less-utilized lysine, serine, and tyrosine.

This seminar will explore the biochemical principles governing covalent interactions and analyze the medicinal chemistry optimization process. A core focus will be the fine-tuning of the electrophilic warhead's reactivity to achieve the optimal balance of target potency and selectivity. We will present case studies demonstrating superior drug efficacy through this approach, highlighting new treatment options for diseases with high unmet medical need. Finally, we will detail the complete drug discovery process for covalent inhibitors, from initial identification to progression towards preclinical studies.

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Dr. Tiziano Bandiera – Istituto Italiano di Tecnologia	**1 CFU, 6h**	**EPDD**	**March 2026**

Drug Discovery: an introduction to the process leading to new small-molecule drugs.
The course will provide an overview of the process that leads to a new chemical entity as a drug. This process develops through three main phases: the discovery phase, the preclinical development, and the clinical development. In turn, each phase consists of a number of subsequent steps where different activities are performed. After a general introduction on the drug discovery process, the main focus of the course will be on the discovery phase, which consists of four steps: target identification and validation, hit identification, hit to lead, and lead optimization. Each of the four steps will be described: activities that are typically carried out and technologies that are used will be presented. Several topics will be addressed, including assays for compounds screening, chemical libraries, medicinal chemistry approaches for hit to lead and lead optimization, assessment and improvement of the drug-like properties of compounds, and the intellectual property protection of new chemical classes.

Prof. Antimo Gioiello - University of Perugia **Prof. Mariateresa Giustiniano - University of Naples Federico II**	**1 CFU, 6h**	**EPDD**	**April 2026**

Integrated technology platforms for medicinal chemistry and organic synthesis.
In recent years, innovations in synthesis have significantly advanced the discovery and development of life-changing medicines. Enabling chemical technologies are accelerating research pipelines and expanding the accessible chemical space. These developments are not only increasing the pace of synthetic chemistry but are also reshaping the way medicinal chemistry and drug discovery are practiced.
These seminal lessons will showcase some of the most impactful recent advances in synthetic chemistry and related technologies, illustrating how they are expected to transform drug discovery and development in the coming years. Particular emphasis will be placed on merging complexity-generating transformations, such as multicomponent reactions, with chemical technologies, including photochemistry and flow systems, and on how these tools can be effectively integrated into modern research programs, providing PhD students with both concepts, approaches, and practical insights.

Dr. Alexandros Patsilinakos - Sibylla Biotech	**1 CFU, 6h**	**EPDD**	**April 2026**

Rational design of small molecule degraders: from PROTAC to IFDs.
Targeted protein degradation (TPD) has emerged as a promising therapeutic strategy for treating a wide range of diseases, including cancer, neurodegenerative diseases, and genetic disorders. TPD enables tackling undruggable targets, and some small molecules inducing protein degradation have shown promise in preclinical and clinical trials. However, the rational design of small molecules that effectively induce target degradation is a complex task that requires a deep understanding of the molecular mechanisms involved. This seminar will provide a comprehensive overview of the rational design of small molecules that induce protein degradation, from PROTAC to folding interfering degraders (FIDs), and medicinal chemistry strategies for optimizing their potency, selectivity, and pharmacokinetic properties.

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Prof. Adam Paclawski - University Medical College Medyczna	**1 CFU, 6h**	**PTN**	**May 2026**

Applied ML/AI in biopharmaceutics: build your own oral bioavailability prediction system.
Artificial Intelligence is transforming drug discovery and development process, but applying it requires more than just code - it requires domain expertise. This short 6-hour course in form of interactive seminars is tailored specifically for PhD candidates in pharmaceutical technology field.
This course is designed for absolute beginners. No prior knowledge of programming (Python/R) or data science is required. We have structured the material to be accessible to everyone, regardless of their technical background. We will move beyond theory to build a functional AI system from scratch using the human oral bioavailability database. You will be guided through the entire data science lifecycle: from understanding the raw data and the importance of expert curation, through building and training your own models, to validating results and interpreting them with explainable AI (xAI).

Prof. Anna Donnadio - University of Perugia **Prof. Riccardo Vivani - University of Perugia**	**2 CFU, 12h**	**CC**	**May 2026**

Solid state characterization of pharmaceuticals.
The course will be addressed to introduce some of the solid-state characterization techniques (X-ray diffraction, thermogravimetric analysis and differential scanning calorimetry) routinely utilized in the pharmaceutical field, together with examples of the information provided by each. The aim is to provide the basic principles and typical applications of these commonly employed analytical tools for characterization of pharmaceutical solids for understanding the physical properties and ensure optimal physical form.

Prof. Alessandro Fatica - Sapienza University of Rome **Prof. Mariangela Morlando - Sapienza University of Rome**	**2 CFU, 12h**	**CC**	**June 2026**

Emerging Approaches using Nucleic Acids as target or therapeutic molecules for the treatment of complex diseases.
Small-molecules and proteins/antibodies have represented for long time the major form of drugs for medical use and the preferred modes in drug development, mainly acting on protein targets such as enzymes, receptors and ion channels. However, there are number of proteins, RNAs and genes that cannot be targeted by these conventional approaches, while they can be selectively targeted by RNA molecules. Moreover, a growing number of evidences have highlighted the contribution of altered RNA and DNA metabolism in the pathogenesis of many complex diseases, thus expanding the repertoire of suitable targets for therapeutic purposes. This course aims to provide students with knowledge of the most advanced methodologies employing RNA and DNA as novel drugs and of the most promising therapeutic strategies targeting the pathological alteration of the RNA and DNA metabolism occurring in complex diseases such as neurological disorders and cancer.

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Prof. Francesco Galli - University of Perugia	**2 CFU, 12h**	**CC**	**September 2026**

Multiomic techniques and applications in biomedical, nutrigenomics and drug discovery studies.
Genomics and its subdisciplines - including transcriptomics, proteomics and metabolomics - are increasingly used to study the molecular networks underlying the different aspects of human pathophysiology. Their potency in describing the complexity of biological processes and the dynamics of their alterations during aging and disease is huge and can be magnified by the integration of targeted and untargeted omics methods in multiomics protocols of investigation. Accordingly, these techniques hold great potential in precision medicine allowing personalized investigation and treatment of virtually all human ailments. Genome-wide association studies – investigation of the genome and its levels of expression in large cohorts of subjects presenting different biological and clinical features - are required to rise the genomic "big data" of our species, thus increasing the translational potential of omics sciences in human biology and medicine.
The course will present omics sciences from their origin to our days, their main technological aspects and biomedical applications with a focus in disease modeling, biomarkers and therapeutic target exploration, early drug discovery studies and nutrigenomics, a second-generation discipline specialized in studying the interaction between food or specific nutrients and the genome in all its components and multiple manifestations. Such discipline is now offering unprecedent opportunities in characterizing the complexity of human nutrition. Specific purposes include precision diagnostics and treatment of unhealthy diets, sedentary lifestyles and their metabolic correlates, as well as specific nutritional defects (i.e. vitamin deficiencies), protein-caloric undernutrition and defects of the microbiome-host interaction (dysbiosis, intestinal inflammation and alterations of the multiple gut-organ axes). Nutrigenomics is also utilized in defining nutrient physiology and their important role in organ metabolism and function, including liver, muscle, adipose and brain; emerging applications are drug discovery and development of nutraceuticals and functional food products, also encompassing studies of their positive (health-promoting) interactions with physical activity programs. Examples of these nutrigenomics applications will be provided during the course together with practical sessions of bioinformatics for "big data" handling (analysis and interpretation) and use in preparing charts, technical reports and scientific articles.

Prof. Andrea Capotorti - University of Perugia	**2 CFU, 12h**	**CC**	**To be defined**

Elements of Statistics – Introductory Course.
This course offers an overview of the key concepts in descriptive and inferential statistics. Topics include data collection and organization, measures of central tendency and variability, graphical representations, and an introduction to probability and statistical inference. It is designed for learners who wish to develop essential tools for critically and effectively analyzing data, even without an advanced mathematical background.