Admission to the PhD program in Pharmaceutical Sciences XLI cycle, A.A. 2025/2026– Research Projects.

Thematic 1
Curriculum: Pharmaceutical Technology and Nutraceuticals
Title: New Technologies for the development of promising therapeutic platforms in nanomedicine
Project referents: Prof. Maurizio Ricci and Prof Cinzia Pagano
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Abstract. Among the technologies applied in nanomedicine, the three-dimensional printing (3DP) and microfluidics are worthy of investigation.
3DP is an additive and sustainable manufacturing technique allowing the fabrication of personalized formulations that could contain micro- and nano-systems useful to obtain integrated versatile devices for broad therapeutic applications.
Microfluidic is a technology enabling the formation of reproducible micro- and nano-systems with customized sizes, shapes and morphologies.
The aim of the project is to exploit 3DP for the fabrication of formulations for topical application and microfluidics for nose to brain application.
The work will be divided as follows:
i) selection of the raw materials in the perspective to produce safe and eco-sustainable products, according to EU Regulation 2023/2055 restrictions.
ii) The planned formulations will be prepared and characterized by official and standardized procedures and the efficacy will be evaluated by in vitro/in vivo studies as well.

Thematic 2
Curriculum: Early Phase Drug Discovery
Title: Natural compounds for the synthesis of functionalized arenes and saturated heterocyclic compounds for applications in biomaterials and medicine
Project referents: Prof. Andrea Temperini and Prof Daniela Lanari
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Abstract. The structural and functional modification of natural products has represented and continues to represent a key opportunity of modern research for the synthesis of new chemical entities for use in medicine, agriculture, chemical technologies, and advanced materials. Accordingly, we plan to design new synthetic approaches that, by employing natural substrates or biomass-derived intermediates, enable the efficient preparation of variously functionalized benzene derivatives in a regio-defined manner via the Diels–Alder reaction. Alternative routes for the synthesis of saturated oxygen-containing heterocycles, such as tetrahydrofurans and oxetanes, will also be explored. The resulting compounds, thoroughly characterized from a physicochemical standpoint, will subsequently undergo biological activity testing to assess their potential pharmaceutical applications.

Thematic 3
Curriculum: Pharmaceutical Technology and Nutraceuticals
Title: Synthetic Pesticides vs.Biopesticides: From Pest Management to Toxicity andImpacts on Essential Oils
Project referents: Prof. Claudia Zadra and Prof Mariacarla Marcotullio
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Abstract. Essential oils have been shown to have multiple health benefits, primarily due to their antimicrobial and anti-inflammatory effects. The increasing demand for medicinal herbs used for essential oils (EO)production implies their large-scale cultivation, which is not possible without the use of pesticides. The growth of the plants, in particular the flower production, and the qualitative and quantitative composition of the EO are strongly

influenced by pesticide treatments. This negative effect is evident for some cultivated medicinal plants after the application of herbicides. The aim of the project is to compare the effect of some synthetic pesticides with respect to biopesticides on the yield and composition of EO obtained with different sustainable green methodologies.

Scholarship reserved for student of Palestinian nationality

Thematic 4
Curriculum: Early Phase Drug Discovery
Title: Identification of small heterocycles to tackle emerging infectious threats
Project referents: Prof. Stefano Sabatini, Prof Giuseppe Manfroni
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Abstract. The rise of antimicrobial resistance (AMR) is a critical global health problem, making once-treatable infections increasingly difficult to manage. In myco/bacteria, resistance often arises through genetic mutations or horizontal gene transfer, leading to various resistance mechanisms exploited by the microbes to make the antibiotics ineffective. Regarding viruses, there are no therapeutic options for several classes of RNA viruses. This is the case for flavivirus infections and emerging viruses such as the Rift Valley and Marburg viruses.
The PhD project will be pursued in two directions:
- discovering both potent bacterial efflux pump inhibitors (EPIs) able of synergizing with known antibiotics restoring their efficacy as well as the discovery of new compounds endowed of activity against non-tubercular mycobacteria.
- design and synthesis of anti-flavivirus compounds endowed with innovative mechanism of action possibly having also a broad-spectrum antiviral profile covering other emerging viruses. The ligand-target interaction will be also studied by using SPR-like techniques.

Thematic 5
Curriculum: Pharmaceutical Technology and Nutraceuticals
Title: In vitro and in vivo evaluation of the neuroprotective effect of nanoparticle-based formulations containing garcinoic acid targeting nuclear receptor pathways administered via the nose-to-brain delivery system
Project referent: Prof. Desirè Bartolini
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Abstract. Delivering neuroprotective agents to the brain is hindered by the blood-brain barrier (BBB). Intranasal administration offers a promising route by bypassing the BBB via the olfactory region, enabling direct brain access. However, challenges like mucociliary clearance and enzymatic degradation remain. To overcome these, nanoparticle carriers are being developed to enhance intranasal delivery of neuroprotective compounds.
This research aims to test nanoparticle-based formulations for intranasal delivery of garcinoic acid (GA) to overcome the challenges posed by the BBB. Intranasal administration offers a non-invasive route to the brain, though it faces barriers. GA, selected for its interaction with the pregnane X receptor (PXR), will be tested in two in vitro co-culture models simulating the BBB (endothelial cells/neuronal/glial cells) and nasal mucosa (nasal cells/neuronal/glial cells). Both free GA and GA-loaded nanoparticles will also be evaluated in vivo in mice via intranasal and intraperitoneal routes using an Experimental Autoimmune Encephalomyelitis (EAE) model.

Thematic 6
Curriculum: Early Phase Drug Discovery
Title: In vitro and in vivo evaluation of the neuroprotective effect of nanoparticle-based formulations containing garcinoic acid targeting nuclear receptor pathways administered via the nose-to-brain delivery system.

Project referent: Prof. Massimo Moretti
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Abstract. Olive mill wastewater (OMWW) is a waste product from the olive oil-production industry. Its produced quantity is relevant, constituting an environmental burden. Its chemical properties are under study to detect any useful way to re-use it in various fields. From OMWW, a by-product extract (E1) very rich in bioactive molecules was gained showing positive effects on human health (anti-inflammatory and antioxidant effects). The aim of the study will be the detection in vitro of eventual anti-cancer activities of E1 on several tumor cell lines (i.e., Hep G2, MCF-7, HT-29) used as cell models of liver, breast, and colon cancer, respectively. Cultured/treated cells will be tested for: (i) cytotoxicity, by applying tests showing different endpoints; (ii) cell cycle analysis; (iii) genotoxicity; (iv) early and late apoptosis.

Thematic 7 (riservata ai dipendenti ITEL Telecomunicazioni Srl)
Curriculum: Pharmaceutical Technology and Nutraceuticals
Title: Implementation and Validation of an Aseptic Manufacturing Process for the Radiopharmaceutical based on 18F-Flotufolastat for PET Imaging
Project referent: Prof. Luana Perioli (academic), Dr. Anna Tolomeo (industrial)
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Abstract. Itel Telecommunicazioni Srl – ItelPharma Division proposes, within the framework of the Industrial Ph.D. in Pharmaceutical Sciences (XLI Cycle) at the University of Perugia, a research project focused on the implementation and validation of an aseptic preparation process, compliant with Good Manufacturing Practice (GMP), for the radiopharmaceutical [^{18}F]rhPSMA-7.3—also known as 18F-Flotufolastat—for use in PET (Positron Emission Tomography) diagnostics.
18F-Flotufolastat is a fluorine-18 labelled analogue of PSMA (Prostate-Specific Membrane Antigen), a protein highly overexpressed on the surface of prostate cancer cells. Due to its strong affinity and specificity for this biomarker, the radiopharmaceutical represents an advanced diagnostic tool for staging prostate cancer. It enables the detection of hard-to-identify micro-metastatic lesions, localization of tumor foci responsible for biochemical recurrence, and evaluation of treatment response.
The project involves the design, implementation and validation of a dedicated GMP production line for the sterile manufacture of the radiopharmaceutical. This includes the development of standardized operating procedures (SOPs), validation of aseptic processes and compliance with current regulatory requirements to support clinical use.

Thematic 8 (riservata ai dipendenti Magi's Lab S.r.l.)
Curriculum: Early Phase Drug Discovery
Title: Development of Machine Learning-Based Methods for Polygenic Risk Score Analysis in Complex and Rare Diseases
Project referents: Prof. Michela Codini (academic), Dr. Matteo Bertelli (industrial)
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Abstract. This project aims to develop and evaluate computational methods based on machine learning for the calculation of polygenic risk scores (PRS), with the goal of improving the estimation of genetic predisposition in complex and rare diseases, such as anorexia nervosa, lipedema, and lymphedema.
Innovative approaches will be compared with standard methods, assessing the impact of different strategies for genetic marker selection, population structure correction, and statistical modeling.
The analysis will be conducted on genotypic and phenotypic data from case-control cohorts, with attention to possible sex-related differences or other stratifying variables.
As part of the project, a reproducible and user-friendly pipeline will be developed to implement the proposed models and enable efficient analysis and visualization of PRS results.

The objective is to identify robust and generalizable tools, potentially applicable in clinical or translational research settings, contributing to the development of more accurate instruments for individual genetic risk assessment and to a better understanding of the genetic basis of complex diseases.

Thematic 9 (riservata ai dipendenti Sterling S.p.A)
Curriculum: Early Phase Drug Discovery
Title: Optimization of ethynylation reaction on steroidal compounds from laboratory to industrial scale
Project referents: Prof. Oriana Tabarrini (academic), Dr. Antonella Marcucci (industrial) oriana.tabarrini@unipg.it; amarcucci@sterling.it
Abstract. During the PhD period, the ethynylation reaction of steroidal compounds will be studied through bibliographic research. Following the assessment of the bibliographic data, the process for producing ethynylated steroids will be developed.
The focus of these activities will be to scale up the process from laboratory to industrial scale. To achieve this goal, each step will be optimized, with critical parameters being defined to maximize the yield and purity of each intermediate.
The aim of the work is to optimize the ethynylation reaction and apply it to different starting materials to obtain various steroidal APIs.

Thematic 10 (riservata ai dipendenti Janssen)

Curriculum: Pharmaceutical Technology and Nutraceuticals
Title: Real Time Release Testing Strategy in Oral Solid Dosages: Accelerating Quality Control and Patient Delivery
Project referents: Prof. Luana Perioli (academic), Dr. Domenico Annese (industrial), luana.perioli@unipg.it; DANNESE@ITS.JNJ.com

Abstract. Real-Time Release Testing (RTRT) is an innovative release strategy employed in the production of oral solid dosages, applicable in both in Continuous Manufacturing and Batch Mode processes, aimed at enhancing product quality and efficiency. This approach integrates process analytical technology (PAT) and quality by design (QbD) principles to facilitate the continuous monitoring of critical quality attributes during manufacturing. By utilizing in-process measurements, such as near-infrared spectroscopy, it is possible to assess the quality of the product in real-time, enabling immediate decision-making. RTRT reduces the analysis executed in Quality Control laboratory, leading to a reduction in analytical lead time and consequently inventory costs. Additionally, this strategy enhances process understanding, leading to improved control and reduced variability in the final product.