European School of Molecular Medicine

2025 summer call PhD selections

AVAILABLE POSITIONS

Principal Investigator	Antonio Marra
Affiliation	European Institute of Oncology, Milan
Title of the proposed project:	Multimodal Characterization of Homologous Recombination Deficiency in Hormone Receptor-Positive Early Breast Cancer
Short description of the project	Hormone receptor-positive, HER2-negative early breast cancer (HR+/HER2- eBC) is the most prevalent breast cancer subtype globally. Despite its high incidence, current tools for predicting homologous recombination deficiency (HRD) and recurrence risk in this subgroup remain limited. Existing deep learning models are often trained on pan-cancer datasets and rely primarily on genetic definitions of HRD, failing to capture critical transcriptomic changes and tumor microenvironmental features. Moreover, these models are not tailored to the unique biology of HR+/HER2- tumors, restricting their clinical utility. This research project aims to address these gaps by developing a deep learning model specifically designed to detect HRD and predict recurrence risk in HR+/HER2- eBC. The central hypothesis is that HRD induces distinct genetic, transcriptomic, and phenotypic alterations, including disruptions in estrogen signaling and therapeutic response, that can be effectively captured through integrated multiomic and histopathological data. The project is structured around three main components: i) comprehensive multiomic profiling of HR+/HER2- tumors using whole-exome sequencing, RNA sequencing, functional HRD assays, and multiplex immunofluorescence to establish a robust molecular "ground truth"; ii) development of a multiple-instance learning model capable of predicting HRD status and clinical outcomes from H&E-stained pathology slides, trained and validated on large internal and external datasets; iii) prospective clinical validation in newly diagnosed patients, assessing the model's ability to inform prognosis and guide adjuvant treatment decisions in real-world settings. By integrating cutting-edge artificial intelligence with rich biological data, this work aims to deliver a clinically actionable tool that enhances precision oncology in HR+/HER2- eBC, ultimately expanding treatment options and improving patient outcomes. The PhD student involved in this project should have a background in bioinformatics, computational biology, or a closely related field. They will play a central role in the curation, processing, and analysis of multiomic data, including genomic and transcriptomic datasets, as well as in the development and application of state-of-the-art deep learning models for digital pathology. Under the supervision of the principal investigator (Dr. Antonio Marra) and in collaboration with experienced bioinformaticians at the host institution, the student will gain advanced skills in computational oncology, machine learning, and translational cancer research. This training will provide a strong foundation for a career at the interface of biomedical data science and precision medicine.
Main research area for the project	Computational biology

Second research area for the project	Genomic medicine
3 key words for project:	artificial intelligence, homologous recombination deficiency, genomics
Main topic/s of the lab	Precision medicine, translational research
Short description of the lab activity	The Early Drug Development for Innovative Therapies Department at the European Institute of Oncology (IEO), under the leadership of Professor Giuseppe Curigliano, is dedicated to bridging the gap between scientific discovery and clinical impact. Our mission is to accelerate the translation of breakthrough research into innovative diagnostics and therapeutics, ultimately improving outcomes for cancer patients. The department has strong partnerships between medical oncologists, basic scientists, computational biologists, bioinformaticians, chemists, and clinical trialists, ensuring that discoveries in the laboratory are rapidly and effectively translated into real-world clinical applications. A central research theme of the department involves linking insights into cancer genomics with the development of novel therapeutic strategies. This includes the discovery and testing of both small-molecule drugs and immune-based treatments, targeting the molecular drivers of cancer. Through innovative clinical trials and early-phase drug development programs, we are advancing personalized medicine approaches that tailor treatments to the genetic and molecular profiles of individual patients. In this context, a major focus is on identifying and validating new biomarkers that inform therapy selection and predict patient outcomes. Dr. Antonio Marra leads the department's translational research in this area, with a particular emphasis on integrating artificial intelligence and genomic data to uncover clinically actionable biomarkers, especially in breast cancer. Dr. Marra's team is at the forefront of computational oncology, focusing on the intersection of artificial intelligence, digital pathology, and multiomic science to drive precision oncology forward. By harnessing the power of computational pathology and artificial intelligence, the lab aims to develop clinically applicable tools for personalized risk assessment, recurrence prediction, and therapeutic decision-making. This work contributes directly to the department's broader mission of developing individualized treatment strategies based on a patient's unique molecular and biological tumor profile. Together, the Early Drug Development Department represents a unique and agile environment where innovation thrives. Our work is guided by a dual commitment to scientific excellence and patient-centered care, ensuring that our discoveries not only push the boundaries of oncology research but also bring tangible benefits to patients. Through interdisciplinary collaboration and cutting-edge translational research, we strive to redefine the future of cancer treatment—one patient, and one discovery, at a time.
Recent bibliography	• Gupta A, Gazzo A, …, Marra A*, Chandarlapaty S*. APOBEC3 mutagenesis drives therapy resistance in

	breast cancer. Nat Genet. 2025 Jun;57(6):1452-1462. doi: 10.1038/s41588-025-02187-1. (*co-corresponding) • Boehm KM*, El Nahhas OSM*, Marra A* et al. Multimodal histopathologic models stratify hormone receptor-positive early breast cancer. Nat Commun. 2025 Mar 2;16(1):2106. doi: 10.1038/s41467-025-57283-x. (*co-authorship) • Marra A, Morganti S, Pareja F et al. Artificial intelligence entering the pathology arena in oncology: current applications and future perspectives. Ann Oncol. 2025 Jul;36(7):712-725. doi: 10.1016/j.annonc.2025.03.006. • Boscolo Bielo L, Guerini Rocco E, …, Marra A*, Curigliano G*. Genomic and clinical landscape of metastatic hormone receptors-positive breast cancers carrying ESR1 alterations. ESMO Open. 2024 Oct;9(10):103731. doi: 10.1016/j.esmoop.2024.103731. (*co-last autorship) • Morganti S*, Marra A*, De Angelis C et al. PARP Inhibitors for Breast Cancer Treatment: A Review. JAMA Oncol. 2024 May 1;10(5):658-670. doi: 10.1001/jamaoncol.2023.7322. (*co-authorship)
Group composition	The Early Drug Development for Innovative Therapies group is a multidisciplinary team that reflects our commitment to both scientific advancement and patient-centered care. Our team brings together a diverse blend of clinical and research expertise, creating an environment where translational oncology thrives. The group includes eight physicians, who are actively involved in designing and conducting early-phase clinical trials, as well as driving the clinical aspects of translational research. They are supported by a physician-scientist who bridges the gap between bedside and bench, ensuring that clinical observations inform laboratory investigations and vice versa. A core strength of the group is its fifteen clinical fellows, who contribute across all stages of patient management and research execution, from trial recruitment and protocol implementation to data interpretation and dissemination. Their hands-on involvement ensures a continuous flow between clinical practice and research innovation. On the academic and scientific side, two PhD students are engaged in research projects focused on integrating genomics, artificial intelligence, and digital pathology to identify novel biomarkers and develop predictive models for cancer treatment. To support the growing clinical research portfolio, the group is bolstered by three research nurses, who play a critical role in coordinating patient care within clinical trials, and three study coordinators, responsible for managing regulatory documentation, trial logistics, and day-to-day operations. Together, this tightly integrated team embodies the collaborative spirit of the department—where clinicians, scientists, and support staff work side by side to translate cutting-edge discoveries into tangible benefits for patients.
Institutional page link	www.ieo.it

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Lab website link	https://www.ieo.it/en/About-Us-old/Our-Organization/Clinical-Divisions/New-Drugs-and-Early-Drug-Development-for-Innovative-Therapies-OMNDV/