UNIVERSITÀ DEGLI STUDI DI MILANO-BICOCCA

DOTTORATO DI RICERCA IN Tecnologie Convergenti per i Sistemi Biomolecolari – XLII CICLO

Research Topic ID: XLII – 1.13

Project Tutor: Francesco Peri

Project Supervisors: Simone Guglielmetti; Monsoor Shaik

Project Title: Impact of Micro- and Nanoplastics (MNPs) on Human Gut Microbiota: Community Dynamics, Functional Responses, and Volatilome Signatures.

Scientific background & Objectives

Micro- and nanoplastics (MNPs) are increasingly detected in food, water, and human biological samples, raising concerns regarding their potential impact on human health. The gut microbiota represents one of the primary biological interfaces exposed to ingested MNPs, yet the mechanisms underlying microbiota–MNP interactions remain poorly understood. In F. Peri lab new methods have been developed to produce MNP standards from food packaging polymers (PET, PLA) for biological studies.
This PhD project will investigate how diverse classes of MNPs standards produced in lab, influence gut microbial community composition, functional pathways, and metabolic outputs. Using anaerobic fecal incubation models, high-throughput 16S rRNA sequencing, targeted functional gene analysis, and volatilome profiling (SPME–GC–MS), the project aims to identify microbiota shifts, resilience patterns, and dysbiosis-associated metabolic signatures induced by MNP exposure.
The study will integrate preparative chemistry, microbial taxonomic, functional, and metabolomic datasets to establish a comprehensive framework describing the biological impact of MNPs on gut ecosystems.

Project's Networks, Sustainability & Mobility

a) Coherence with hosting lab competences/tools

The project will be developed through the collaboration of several UNIMIB research units: F. Peri chemistry lab, S. Guglielmetti microbiology lab and F. Saliu analytical chemistry/instrument lab.
The F. Peri lab has expertise in the preparation of MNPs standards starting from raw polymers and food packages.
The S. Gulgielmetti team has expertise in microbiota experimental models, anaerobic culture systems, 16S sequencing workflows, and volatilome/metabolomics analysis. The analytical chemistry laboratory of F. Saliu provides mass spectrometers to evaluate microbiota responses to environmental stressors through metabolomic analysis.

b) Collaborations / co-tutoring

The project will involve collaborations with different groups around the university. The fully characterized MNPs will be outsourced from Prof. F. Peri's and Dr. F. Saliu's Labs. The collaborations with industrial partners for microbiota sequencing, while the bioinformatics analysis will be performed in-house. The analytical chemistry support for SPME–GC–MS volatilome profiling, and integrative multi-omics data analysis will be performed with

interdepartmental collaborations. The interdisciplinary nature of the project fosters connections between chemistry, microbiology, environmental health, and biomolecular technologies, ensuring long-term sustainability while integrating within national and international research networks.

c) Pertinent research articles published by the proposer/s

1. Shaik, M. M., Ami, D., Romerio, A., Gagliano, C., Palmer, C., Aladailleh, Z., ... & Peri, F. (2026). Representative secondary PET micro and nanoplastics via ethylene glycol fragmentation (EGF): Physicochemical and immuno-toxicological properties. Chemical Engineering Journal Advances, 101053.
2. Duncan, R., Mantegazza, G., Gargari, G., Pierallini, E., Russo, R., & Guglielmetti, S. (2025). Heyndrickxia coagulans LMG S-24828 Is a Safe Probiotic Strain Capable of Germinating in the Human Gut. *Probiotics and Antimicrobial Proteins*, *17*(6), 4465-4479.

d) Putative foreign institution(s) for mobility (6 months)

Potential mobility period at an international institution with expertise in microbiome research, host–microbiota interactions, with Anglia Ruskin University, UK or Reading University, UK.