III International Conference on Emerging Technologies in Computational Science for Industry, Sustainability and Innovation, M2P 2027
25-28 May, 2027, Terrasini (Palermo), Italy

MULTIPHYSICS MODELLING AND DIGITAL TWINS FOR BIOMEDICAL DEVICES AND ORGAN-ON-CHIP SYSTEMS

NICOLA FERRO* AND LORENZO SALA†

* Department of Molecular Sciences and Nanosystems, Ca' Foscari University of Venice, Campus Scientifico, Via Torino 155, Venezia Mestre, 30170, Italy
nicola.ferro@unive.it

† INRAE, MaIAGE, Université Paris-Saclay
78350 Jouy-en-Josas, France
lorenzo.sala@inrae.fr - https://lsala.github.io

ABSTRACT

Biomedical devices and organ-on-chip systems are evolving rapidly, thanks in large part to computational models that integrate aspects such as geometry, materials, fluid dynamics, and biological functions. However, translating these complex models into practical tools for design and decision-making is still a challenging endeavor. This is largely due to the need to tackle multiple spatial and temporal scales, to limited experimental data, uncertainties in parameters and boundary conditions, and the high computational costs of running detailed simulations.

This Invited Session aims to gather researchers in applied mathematics, computational science, and engineering who are developing models for biomedical devices and organ-on-chip technologies. In this regard, challenging application scenarios include, but are not limited to, the development of reliable digital twins for cardiac and brain function, the design of vascular stents, orthopedic implants, microfluidic devices, and organ-on-chip systems.

Topics of interest span the entire modelling pipeline, from initial formulation and discretization to calibration, validation, and predictive analysis. We welcome contributions on partial differential equation-based modelling, e.g., for fluid dynamics and continuum solid mechanics, and design optimization approaches. From the computational viewpoint, particular interest is devoted to adaptive discretization techniques, reduced-order modelling, uncertainty quantification, as well as hybrid approaches that merge physics-based and data-driven strategies. In addition, throughout the session, we will address common challenges, such as integrating patient-specific data and improving prediction reliability, while aiming to strengthen cross-disciplinary collaboration.

By connecting device mechanics with engineered biological systems, the session aims to stimulate valuable exchange among academics, clinical researchers, and industry professionals, with the goal of enhancing reproducibility, validation, and the translation of research outcomes into real-world applications.