

RESEARCH TOPIC PRIME3

Development of Advanced Microfluidic Platforms for Cardiac Tissue Monitoring and Mechanotherapy

Thematic field of the project

Bioengineering

Research Supervisor

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Main facility

Politecnico di Milano

Department of Electronics, Information and Bioengineering

Other facility

Hunimed

Laboratorio di Ricerca Immunopatologia Epatobiliare

Main field of interest

Organ-on-Chip (OoC) technology combines the use of microfluidics, biomaterials, and advanced cell cultures in order to generate and monitor miniaturized replicas of human tissues and organs in vitro. It is an enabling technology involving interdisciplinary expertise from the fields of engineering, physics, and cell/molecular biology. Application areas include environmental assessment, toxicological evaluation of chemical agents, drug screening and disease modeling, among others.

Abstract

The PhD project aims to develop an advanced microfluidic platform to model cardiac tissue evolution in vitro, within the ERC project EVOOC. The candidate will contribute to the design, fabrication and validation of next-generation heart-on-chip systems integrating sensing and actuation technologies to monitor and control the mechanical behavior of 3D cardiac microtissues. The platform will include AI-based algorithms to adapt mechanical stimulation in real-time, based on the physiological response of the tissue. The goal is to reproduce healthy and pathological cardiac states in vitro, and to investigate mechanical reprogramming strategies to guide tissue recovery. Periods of secondment in research or industrial partner labs may be foreseen.

Main technical approaches

Experience in the design of microfluidic devices and microfabrication techniques; skills in numerical modeling (e.g., COMSOL); familiarity with 3D cell cultures, imaging techniques, and functional analysis; interest in the integration of control algorithms and artificial intelligence.

Scientific references

1. Ballerini M, Galiè S, Tyagi P... Occhetta P, et al. A gut-on-a-chip incorporating human faecal samples and peristalsis predicts responses to immune checkpoint inhibitors for melanoma. Nat. Biomed. Eng (2025). <https://doi.org/10.1038/s41551-024-01318-z>
2. Visone R, Paoletti C, Cordiale A, Nicoletti L, Divieto C, Rasponi M, Chiono V, Occhetta P, In vitro mechanical stimulation to reproduce the pathological Hallmarks of human cardiac fibrosis on a beating chip and predict the efficacy of drugs and advanced therapies. Advanced Healthcare Materials (2023). <https://doi.org/10.1002/adhm.202301481>
3. Visone R, Lozano F, Marzorati S, Rivolta MW, Pesenti E, Redaelli A, Sassi R, Rasponi M, Occhetta P, Predicting human cardiac QT alterations and pro-arrhythmic effects of compounds with a 3D beating heart-on-chip platform. Toxicological Sciences (2022) <https://doi.org/10.1093/toxsci/kfac108>
4. Visone R, Ugolini GS, Cruz-Moreira D, Marzorati S, Piazza S, Pesenti E, Redaelli A, Moretti M, Occhetta P*, Rasponi M*. Micro-electrode channel guide (μ ECG) technology: an online method for continuous electrical recording in a human beating heart-on-chip. Biofabrication (2021). doi: 10.1088/1758-5090/abe4c4
5. MA Polidoro, E Ferrari, ..., M Rasponi, A Lleo, Cholangiocarcinoma-on-a-chip: A human 3D platform for personalised medicine, JHEP Reports, Volume 6, Issue 1, 100910. <https://doi.org/10.1016/j.jhepr.2023.100910>

Type of contract

PhD scholarship of € 21.000 gross per year awarded by Humanitas University, with Funding from Politecnico di Milano. This sum is exempt from IRPEF income tax according to the provisions of art. 4 of Law no. 476 of 13th August 1984 and is subject to social security contributions according to the provisions of art. 2, section 26 and subsequent sections, of Law no. 335 of 8th August 1995 and subsequent modifications.

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