ELECTRICAL, ELECTRONICS AND COMMUNICATIONS ENGINEERING

DM 118-Design, fabrication and characterization of microfluidics as new tools for biological twin development to target disease monitoring and therapy

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Context of the research activity	This subject focus on the fabrication and characterization of microfluidics for the developmente of barrier model and the integration of biosensors and detectors within microfluidic devices for real-time monitoring and feedback. Standard cleanrooms processes as well as 3D printing and rapid prototyping methods will be exploited to proper fabricate the devices and the testing and development of the barrier models will be properly approached. Progetto finanziato nell'ambito del PNRR – DM 118/2023 - CUP E14D23001730006

	The field of microfluidics has emerged as a powerful platform for the design, fabrication, and characterization of innovative devices with diverse applications in various scientific and technological domains. In recent years, there has been a growing focus on leveraging microfluidics to enhance our understanding of new therapy approaches. Microfluidics offers several unique advantages over conventional approaches in the study of new therapy approaches. The ability to manipulate small volumes of fluids within micron-sized channels enables precise control over experimental conditions, leading to improved reproducibility and accuracy. Additionally, microfluidic devices provide high throughput capabilities, allowing for rapid screening of different therapeutic agents and dosage combinations. This technology also facilitates the integration of multiple functionalities within a single platform, enabling the development of complex and versatile systems for therapy understanding.

Objectives	The design of microfluidic systems for therapy understanding involves careful consideration of various factors, such as fluid flow dynamics, surface properties, and biocompatibility. Fabrication techniques for microfluidic devices have also evolved to meet the demands of therapy understanding. Traditional methods, such as soft lithography, have been widely employed for the fabrication of microchannels and structures. However, recent advancements in additive manufacturing technologies, such as 3D printing and rapid prototyping, have enabled the fabrication of more complex and intricate microfluidic architectures. These techniques provide greater flexibility in design, allowing for the integration of additional features such as valves, sensors, and actuators to enhance the functionality of the device. Characterization of microfluidic devices is crucial to ensure their proper functioning and reliability. Various analytical techniques, including optical microscopy, fluorescence imaging, and flow cytometry, have been employed to assess fluid flow patterns, cell behavior, and the efficacy of therapeutic interventions within the microfluidic system. Additionally, the integration of biosensors and detectors within the microfluidic device allows for real-time monitoring and feedback, enabling researchers to dynamically adjust experimental parameters and optimize therapy understanding.

Skills and competencies for the development of the activity	In summary, working on the design, fabrication, and characterization of microfluidics as new tools for biological twin development to target innovation in disease monitoring and therapy requires a multidisciplinary skill set. The key competencies include a strong foundation in microfluidics, knowledge of biomedical engineering, cell and molecular biology, disease pathophysiology, microfabrication techniques and biosensors. Proficiency in bioanalytical techniques, fluid dynamics, and transport phenomena is crucial, along with expertise in data analysis and interpretation. Familiarity with biomaterials, surface chemistry, and problem-solving is necessary. Collaboration and communication skills are important for interdisciplinary collaborations, while understanding ethical considerations ensures responsible research practices.