ELECTRICAL, ELECTRONICS AND COMMUNICATIONS ENGINEERING

PNRR/PNC Salute - New approaches in micro-nanotechnology for biological twin development and testing

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Context of the research activity	This subject focuses on the design, fabrication and characterization of microfluidics for in vitro biological twin development, understanding and new therapy testing. Strategies in micro-nanotechnologies, which include Microelectromechanical systems (MEMS) technologies and high-resolution 3D printing, should be properly investigated and supported by tools for the design, simulations and testing to obtain optimized models for biological twin development. Progetto finanziato nell'ambito del PNRR - Progetto D3-4Health PNRR Complementare Salute - CUP B53C22005980001
	Microfluidic systems have demonstrated their potential in a wide range of cell biology applications to improve the understanding of cells mechanisms and therapies testing. For example, they have been utilized for studying drug delivery mechanisms, investigating cell behavior in response to therapeutic agents, and evaluating the efficacy of personalized treatment strategies. By providing a controlled and dynamic microenvironment, microfluidics offer a more accurate representation of in vivo conditions, enabling researchers to gain insights into complex therapeutic interactions that are otherwise challenging to study using traditional methods. To proper design 3D biological models, a multidisciplinary approach is needed. Proper CAD geometries and simulation and test of microfluidic systems have become increasingly important in the field of 3D biological modeling for understanding and optimizing complex biological processes.

Objectives	Microfluidics offers precise control over fluid flow and the ability to create microenvironments that mimic the physiological conditions of living tissues. Indeed, strategies in micro-nanotechnologies, such as MEMS technologies and high-resolution 3D printing, have gained significant attention in the field of biological twin development. These approaches offer unique opportunities for fabricating intricate structures and precise control over the microscale and nanoscale features. However, to obtain optimized models for biological twin development, it is crucial to investigate and support these strategies with appropriate tools for design, simulations, and testing. Microelectromechanical systems (MEMS) technologies and high-resolution 3D printing have revolutionized the fabrication of microscale and nanoscale structures, allowing for the creation of complex architectures with high precision and resolution. These techniques enable the development of biomimetic structures, scaffolds, and devices that closely resemble the biological systems they aim to mimic. By leveraging the capabilities of micro-nanotechnologies, researchers can create optimized models for biological twin development that offer enhanced functionality and accuracy. Computational modeling techniques have played a significant role in optimizing the design parameters to achieve desired functionalities. These models allow researchers to predict and analyze fluid behavior, optimize mixing efficiency, and simulate the behavior of therapeutic agents within the microfluidic device.

Skills and competencies for the development of the activity	In summary, working on new approaches in micro-nanotechnology for biological twin development and testing requires a multidisciplinary skill set encompassing micro-nanotechnology, biomedical engineering, cell and molecular biology, microfluidics, nanomaterials, data analysis, collaboration, problem-solving, ethical considerations and a commitment to continuous learning. By combining these competencies, researchers can contribute to the advancement of this exciting and promising field.