BIOENGINEERING AND MEDICAL-SURGICAL SCIENCES

PNRR PNC Salute/DIMEAS - Development of in vitro tissue models for testing novel drug delivery systems including micro/nanoparticles and hydrogels

Funded By	Dipartimento DIMEAS
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Context of the research activity	Integrating biology with novel engineering technologies and advanced materials is a key strategy for developing breakthrough approaches to solve unmet clinical needs and to respond to the societal need for more efficient treatments with low ethical and environmental impact. In this contest, in vitro experimental models are starting to be recognized as a powerful tool for advancing in pathologies understanding and for testing the efficiency of new therapies. By mimicking nature, the optimal 3D scaffolds should finely replicate in vitro the physico-chemical and mechanical properties as well as the porous structure of the extracellular matrix (ECM) of the native tissue, at different degrees of aging, in healthy or pathological conditions. Taking inspiration from nature, it is possible to design novel therapies using natural-based agents that can be properly loaded into advanced systems (micro/nanoparticles, hydrogels) for a controlled and sustained release. Progetto finanziato nell'ambito del PNRR - Progetto D3-4Health PNRR Complementare Salute - CUP B53C22005980001
	This PhD programme will aim to the design of advanced in vitro models recapitulating the architecture and composition of physiological organs including also the key elements and actors of physiological processes. Several tissues will be investigated having different features such as exocrine pancreas, bone and intestinal tissue. The 3D models will be applied to test new nanoformulations able to encapsulate natural-based therapeutics and then release them in a controlled manner. With the aim to improve the local release, nanoformulations will be loaded into injectable hydrogels designed exploiting the versatile chemistry of polyurethanes. The Ph.D. student will be responsible for the synthesis and processing of the biomaterials into 3D constructs via additive manufacturing techniques,

Objectives	electrospinning and micro/nano- particles for localized and prolonged drug release. More in detail, the Ph.D. student will develop and validate bioengineered tissue models and will test on them newly designed therapeutics. These final goals will be achieved through a bottom-up approach encompassing the following steps: (i) the design and characterization of new polymeric materials of natural, synthetic or bioartificial origin, with the aim to create a library of different compositions with a wide range of physico-chemical properties (e.g. mechanical properties, degradation kinetics), with the potential to meet the properties of different tissues of the human body; (ii) Synthetized novel polymers having functional groups and mechanical properties able to mimic the composition and the mechanical features of the extracellular environment (iii) the microfabrication of the optimized polymeric biomaterials via advanced fabrication technologies (e.g. melt- and solution- electrospinning, bioprinting, fused deposition modeling) into 3D scaffolds that in vitro recapitulate targeted human tissues such as exocrine pancreas, bone and intestinal tissue both healthy and at different pathological stages; (iv) the surface or bulk functionalization of the designed constructs with proteins or peptide sequences to enhance their capability to mimic the native environment from a biochemical point of view; (v) the validation of the designed bioengineered tissue models from a structural, mechanical and functional point of view; (vi) the design of polymeric micro/nano particles encapsulating natural-derived drugs for targeted and sustained release of their payload; (vii) development of hydrogel-based platforms as carriers for nanoformulation to enhance localization inside tissues; (viii) in vitro characterization of polymeric micro/nano particles (alone or loaded into an hydrogel) in the developed in vitro models for testing new therapeutic approaches with the potential to answer unmet clinical challenges.

Skills and competencies for the development of the activity	We are looking for talented and motivated candidates, preferably with a Master Degree in Biomedical Engineering and with previous experience in the fields of biomaterials, nanotechnology, nanomedicine and tissue engineering. In detail, the optimal candidate should have the following skills: - direct experience on in vitro cell experiments with biomaterials; - knowledge of methods for nanoparticle preparation and polymer hydrogels - knowledge of rapid prototyping technologies. The candidate should possess a good knowledge of English Language in both written and oral forms.