BIOENGINEERING AND MEDICAL-SURGICAL SCIENCES

Ammin/DIMEAS - Multifunctional self-healing hydrogels for drug delivery and tissue regeneration

Funded By	Dipartimento DIMEAS Politecnico di TORINO [P.iva/CF:00518460019]
Supervisor	CHIONO VALERIA - valeria.chiono@polito.it
Contact	MARCELLO ELENA - elena.marcello@polito.it
Context of the research activity	The demand for new therapies against age-related diseases (e.g., chronic wounds, cardiac disorders, etc.) is continuously increasing. Their development requires multidisciplinary research efforts. In this context, multifunctional, regenerative, self-healing, injectable hydrogels are demanded, serving as a platform for precise administration, stimulus-controlled and sustained release of drugs, while presenting structural and biochemical signaling cues for tissue regeneration.
Objectives	The PhD student will develop multifunctional injectable hydrogels for in situ release of drugs and micro/nanoparticles loaded with therapeutics for the treatment of chronic wounds and other diseases (e.g., for cardiac and skeletal muscle regeneration). The hydrogels will be functionalized with bioactive molecules (e.g., peptides) to support tissue regeneration. An injectable self-healing hydrogel platform will be developed based on modified natural polymers (e.g., modified pectin and gelatin), capable of sol-to-gel transition once injected. Tunable viscoelastic properties of the hydrogel will enable ease of administration, penetration and adaptation to the defect cavity (e.g., for the treatment of chronic tunneling wounds) and application in different regenerative fields. The designed hydrogels will also provide an extracellular matrix-like microenvironment supporting cell adhesion, proliferation and migration upon their gradual resorption. Furthermore, they will be exploited as depots for the local controlled and sustained release of drugs and drug-loaded nano- and micro-particles. Drugs will include anti-inflammatory, anti-oxidant and anti-microbial compounds. Hydrogels will be deeply characterized for their physicochemical properties, therapeutic potential as well as the ability to affect cell behavior in vitro. In the perspective of future industrial exploitation, optimal sterilization, storage conditions and preparation protocols will be defined. The activity will be performed within the European project INJECTHEAL (grant agreement: 101177924). Hence, the work includes collaborative activities within INJECTHEAL consortium and opportunities for secondments

	in other EU universities and/or companies. The work will be implemented through achieving the following objectives: (1) Design of biomimetic injectable hydrogels with self-healing properties, exploiting green materials and technologies. (2) Development of a hydrogel platform enabling easy tuning of viscoelastic properties, degradation rate and drug delivery kinetics. (3) Development of reproducible protocols to study hydrogel stability and drug and nano/microparticle release in physiological-like conditions. (4) Analysis of cell response in the presence of hydrogels (non-contact and 2D and 3D contact tests). (5) In vitro validation tests to assess hydrogel safety and efficacy. (6) Study of regulatory requirements, sterilization and scale-up (collaboration with other EU research centers/companies).

Skills and competencies for the development of the activity	We are looking for talented and motivated candidates, preferably with skills/experience in: - Tissue engineering - Drug delivery - In vitro cultures and cell tests We are also looking for a PhD student interested in spending a period in a research centre/company abroad. Excellent communication skills and good knowledge of written and spoken English are required. The PhD student will work in a multidisciplinary team: team-working and willingness to learn new techniques/methods are required. The PhD student should be enrolled on 1 Nov. 2025 with no delays.