POLITECNICO DI MILANO

# PhD in BIOINGEGNERIA / BIOENGINEERING - 39th cycle

## PNRR 118 INTERDISC Research Field: SELF-ASSEMBLING PEPTIDES FOR PREPARATION OF SCAFFOLDS WITH ELASTOMERIC AND ANTIMICROBIAL PROPERTIES FOR BIOMEDICAL APPLICATIONS

| Monthly net income of PhDscholarship (max 36 months) |
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| **€ 1400.0**<br>In case of a change of the welfare rates during the three-year period, the amount could be modified. |

| Context of the research activity | |
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| **Motivation and objectives of the research in this field** | The research team explored the possibility of using short peptide sequences of resilin - the insect elastomeric protein - modified by bromination to obtain smart materials for cell culture and tissue regeneration. The idea is to modify the molecular properties of the peptide by increasing self-assembly to improve the macroscopic and mechanical properties. The brominated peptide has in fact been used to obtain electrospinning networks made of mixtures of brominated peptide and gelatin, a natural polymer widely used in biomedical applications. The results obtained by the team demonstrated that the brominated peptide exhibits different mechanical properties, extensively characterized in Pizzi A, Sori L, et al. Small 32/2022 doi:10.1002/smll.202270174. The peptide can be electrospun alone or in solution with gelatin. Scaffolds can be stabilized by crosslinking processes that avoid degradation. The electrospun matries with brominated peptide have different mechanical properties, showing a behavior similar to that of biological tissues and the possibility of use as systems for cell and tissue culture already to be explored. More recently the scaffolds have revealed antimicrobial properties, showing greater resistance to contamination than the non-brominated case, opening a very interesting development scenario in the health field.<br>The objective of the PhD project is to further characterize the eletrosupn matrices and to better investigate the |

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| | mechanical and the antimicrobial properties of such smart materials with the current peptide, but also with new sequences. The obtained scaffolds will be also tested as supports for setting new physiologic like in-vitro models in cell culture laboratories and also in a biologically relevant environment for a selected application. The biological characterization will benefit of an innovative bicompartmental culture system (TToP – true tissue on platform) developed at AtticLab, which will enable the development of standardized, repeatable and reliable in vitro models of tissue barriers exploiting the new electrospun metrices. |
| **Methods and techniques that will be developed and used to carry out the research** | The peptides and composite materials necessary for scaffold fabrication will be produced according to already optimized protocols. We will evaluate i) new peptide sequences, ii) other technologies to obtain scaffolds (e.g., Wet Spinning, to avoid electric fields/pulses that could hinder the spontaneous self-assembly of the peptide), iii) biopolymers other than gelatin (e.g., collagen) to create new composite materials, v) the phenomenon of resistance to contamination of brominated scaffolds will be characterized and investigated, which could represent an important advance compared to the state of the art. The materials obtained will be extensively characterized from a mechanical and biological point of view (when possible, according to the standard). An extensive experimental cell culture validation will be performed to evaluate the obtained materials as supports for in vitro models and as scaffolds in selected biomedical applications. The proponents already have agreements/collaborations in place with various IRCCS (Besta, Cardiologico Monzino, IEO) for biological validation in a biologically relevant environment, an activity that will bring a further element of interdisciplinarity to the project.<br>The proposed research requires the complementary skills of the two groups involved: the SupraBioNanoLab with the production/characterization protocols at the molecular structural level of the peptide, the AtticLab with the creation and biological evaluation of elastomeric antimicrobial scaffolds which would have important |

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| | repercussions in regenerative medicine of highly deformable tissues (e.g. vessels, urogenital system, lung). |
| **Educational objectives** | Owing to the intrinsic interdisciplinary and multidisciplinary nature of this project a strong educational commitment is required on realization of new elecrospun scaffolds, their characterization from mechanical, biological, antimicrobial point of view, exploring the possibility to use different peptides and different technologies preparing new scaffolds.<br>The main educational objectives are:<br>- acquisition of basic competences in chemical modification, biomaterials properties, bioengineering and biological issues related to the project issues by specific courses available at Polimi and outside Polimi.<br>- acquisition of scientific approach in reviewing literature and in finding operative solutions to his/her own technological and biological issues<br>- acquisition of competences on peptide synthesis and bromination<br>- acquisition of specific competences in electrospinning<br>- acquisition of specific competences in scaffold characterization (scaffold stability, swelling and mechanical properties)<br>- acquisition of specific skills in cell/tissue culture and in handling culturing experiments with non-conventional culture devices (TToP)<br>- acquisition of competences in in antimicrobial properties and its assessment<br><br>All these educational objectives are strengthened by the support provided by the two research groups involved in the project: the SupraBioNanoLab with the production/characterization protocols at the molecular structural level of the peptide, the AtticLab with the creation and biological evaluation of elastomeric antimicrobial scaffolds which would have important repercussions in regenerative medicine of highly deformable tissues (e.g., vessels, urogenital system, lung).<br>The interdisciplinary project will allow a good balance |

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| | between the acquisition of technological skills oriented to the development of new materials and innovative scaffolds and the acquisition of competences oriented to the development of human cellular and tissue in vitro. |
| **Job opportunities** | We believe that this interdisciplinary PhD project, characterized by high innovative and intersectoral content, is a great opportunity for the research and professional growth of a PhD candidate, allowing to develop his/her competences towards a perspective employment in research centers and companies of the biomaterial, biomedical and biotechnological field. The PhD candidate will develop skills of particular interest for biomedical, biotech and biopharma companies or CROs, which are expanding sectors at the national and international level. Potential job opportunities are represented by companies, spin-offs, and start-ups devoted to the development and use of biomaterials, scaffolds and grafts for regenerative medicine, and in vitro models for the evaluation of new drugs and therapeutic treatments. |
| **Composition of the research group** | 1 Full Professors<br>1 Associated Professors<br>2 Assistant Professors<br>2 PhD Students |
| **Name of the research directors** | Monica Soncini DEIB, Pierangelo Metrangolo CMIC |

| **Contacts** |
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| SONCINI: monica.soncini@polimi.it, 02 23993336, Soncini@DEIB (https://www.deib.polimi.it/ita/personale/dettagli/370314), ATTiCLab (https://www.deib.polimi.it/ita/laboratori-deib/dettagli/70), BiomechGroup (https://www.biomech.polimi.it/people-soncini).<br><br>METRANGOLO: pierangelo.metrangolo@polimi.it, 02 23993041/3159, Metrangolo@CMIC (https://www.cmic.polimi.it/en/persone/docenti-e-ricercatori/metrangolo-pierangelo/), SupraBioNanoLab (https://www.suprabionano.eu). |

| **Additional support - Financial aid per PhD student per year (gross amount)** | |
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| **Housing - Foreign Students** | -- |
| **Housing - Out-of-town residents (more than 80Km out of Milano)** | -- |

| Scholarship Increase for a period abroad | |
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| **Amount monthly** | 700.0 € |
| **By number of months** | 0 |

| National Operational Program for Research and Innovation | |
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| **Company where the candidate will attend the stage (name and brief description)** | |
| **By number of months at the company** | 0 |
| **Institution or company where the candidate will spend the period abroad (name and brief description)** | University of Glasgow, Centre for the Cellular Microenvironment |
| **By number of months abroad** | 6 |

| **Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information** |
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| The PhD student will be involved in educational activities along with teaching assistantship. A shared desk and computer will be given to the student for the time needed to carry out the research. |