# BIOENGINEERING AND MEDICAL-SURGICAL SCIENCES

## DIMEAS - Nano and microparticles with osteoinductive, antimicrobial, and antibiofilm ability

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| **Funded By** | Dipartimento DIMEAS |
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| **Context of the research activity** | The objective of this PhD program is to design, characterize, and upscale the production of nanoparticles and/or microparticles for local drug delivery of osteoinductive, antibacterial, and antibiofilm compounds. The particles can be administered alone or in combination with fibrous and hydrogel matrices and will be tested in 3D models of biofilm infection and wound. |
| **Objectives** | Nanotechnology plays a fundamental role in the design drug delivery systems. For instance, nanoparticles have been proven to enhance targeted accumulation of drugs and to reduce their off-target effects. Nanoparticles can also be clustered into larger structures, such as microparticles or combined with local retention systems, such as hydrogels and fibers.<br><br>This Ph.D. program will aim at the design and thorough characterization of nanoparticles to be applied as new tools in bioengineering and nanomedicine in the contexts of tissue regeneration combined with bacterial and biofilm-related infections.<br><br>The Ph.D. student will work in the framework of the European project "Multi-functional hydrogels for promoting bone fracture healing through local induced release of pharmaceutical agents and gradual matrix replacement by the regenerating bone" (Hydroheal) and will be responsible for:<br><br>(i) The design, characterization and production scale-up of nanoparticles for the release of statins or antibacterial compounds;<br>(ii) Their surface-functionalization (e.g., via layer by layer);<br>(iii) Their combination with larger constructs, such as microparticles, hydrogels, or scaffolds;<br>(iv) Their combination with fluorophores or inorganic probes for stimuli-induced activation (e.g., to induce biofilm disruption through heating);<br>(v) Their biological characterization and testing using traditional methods and 3D pathological models;<br>(vi) The preparation and continuous updating of project reports. |

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| | More in detail, the Ph.D. student will:<br><br>• Design and characterize new nanoparticles using different methods and evaluate the scalability of the process and its industrial applicability;<br>• Load the particles with osteoinductive/inflammation reducing agents, such as different statins, and antibacterial compounds, such as peptides, biosurfactants or metal nanoparticles;<br>• Fully characterize the drug loaded formulations;<br>• Functionalize the particles or combine them within hybrid systems to modulate drug release. this can be obtained by exploring different approaches (layer-by-layer, incorporation in microparticles, incorporation in hydrogels or scaffolds..);<br>• Validate the particles using tradition cell / bacteria culture techniques;<br>• Validate the particles by designing advanced 3D tissue models for a more relevant testing;<br>• Participate in project meeting and share their work with project partners. |

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| **Skills and competencies for the development of the activity** | - Design and characterization of nanoparticles and/or microparticles;<br>- Combination of nanoparticles with hydrogels or scaffolds<br>- Cell culture<br>- Design and characterization of 3D tissue models<br>- 3D printing<br>- Ability to work in team and in a multicultural environment |