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Supervisor Expression of Interest
MSCA - Marie Sklodowska Curie Action - (PF) Postdoctoral Fellowship 2024

Supervisor name: Pasquale Vena

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Link "Pagina docente": Micro_biomech_lab
Department Name:Department of Chemistry, Materials and Chemical Engineering Giulio Natta

Research topic: Design of innovative porous ceramic bone tissue engineering scaffolds allowing for improved vascularization and tissue growth.

MSCA-PF Research Area Panels:

- ☐ ECO_Economic Sciences
- ☐ **X ENG_Information Science and Engineering**
- ☐ ENV_Environmental and Geosciences
- ☐ LIF_Life Sciences
- ☐ MAT_Mathematics
- ☐ PHY_Physics
- ☐ SOC_Social Sciences and Humanities
- ☐ CHE_Chemistry

Brief description of the Department and Research Group (including URL if applicable):
The Department of Chemistry, Materials and Chemical Engineering 'Giulio Natta' conjugates competences in chemistry, chemical engineering, biological–biomechanical engineering, materials science, and engineering. The Laboratory of Biological Structure Mechanics (LaBS) was established in Feb. 2000 and has the mission to carry out applied research in diverse areas of biomechanics, with a main focus on implantable devices as well as tissue mechanics. The "*microbiomecanics lab*" is part of the LaBS devoted to the mechanical characterization of materials and tissue at the small scale. The postdoc applicant will work under the supervision of Pasquale Vena and in collaboration of his research group. Pasquale Vena is currently the project coordinator of the MSCA Doctoral Network ReBone (https://rebone.eu/) entitled "End-to-end multidisciplinary optimal design for improved personalized bioactive glass/ceramic bone substitute implants". The postdoc research work will be framed within the ReBone project.

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TITLE of the project: Design of innovative porous ceramic bone tissue engineering scaffolds allowing for improved vascularization and tissue growth.

Brief project description:

Not only is tissue growth crucial for large bone defects, but the vascularization of the new bone substitute is also critical. As a matter of fact, the size of tissue that is generated in vitro can only be limited. After that, the blood supply to the artificial bone will decrease substantially, causing cell death in the non-irrorated areas.

The design of additive manufactured ceramic bone substitutes needs to account for multiple and multidisciplinary constraints allowing for mechanical strength and stiffness, manufacturability factors as well as mechano-biology capability of the implants.

The ability to design those intrinsic geometries must come first, followed by the ability to produce them.

Aims: In this context, the postdoc will develop in-silico models for angiogenesis in the 3D complex architectures of ceramic scaffolds and determine the correlation between the angiogenesis capability and the major geometrical features of the scaffolds.

Methodologies: In order to achieve the above-mentioned aim, the postdoc will develop computational methods (agent based models) for the simulation of the bone-ingrowth process allowing for cell activity, and angiogenesis. Numerical methods for the solution of diffusion equations will be developed also in a multi-grid setting and high performance computing. These models will be applied on different architectures of porous scaffolds suitably designed for biomechanical compatibility in a bone defect treatment process. The architectures of the biomechanically compatible scaffolds are developed within the Marie Curie Doctoral network ReBone which also includes tissue growth in-vitro models. The ReBone project does not develop in depth in-silico models; therefore, the contribution of the postdoc activity will be complementary to the activities developed within the Doctoral Network.

Expected results and impact: by the end of the two-years activity of the postdoc, which will coincide with the end of the ReBone doctoral network, the research will achieve a collection of data (possibly validated by the in-vitro models in ReBone) that explicitly define the correlation between a quantitative measure of the tissue-growth/vascularization capability and morphometric features of the scaffolds, within the architecture for trabecular, cortical and trabecular/cortical transition models developed in the ReBone Doctoral Network.