Institut de Bioenginyeria de Catalunya

COLLABORATIVE IBEC INTERNATIONAL PhD PROGRAMME

Position

1. Project Title:
   Engineering bone marrow niches for HSC maintenance

2. Research project/ Research Group description

Our group 'Microenvironments for Medicine' at IBEC engineer biomaterials with controlled properties for applications in cell engineering, to support in vitro models and as tools for mechanobiology. Here, in collaboration with Miguel Castilho (Associate Professor at the Department of Biomedical Engineering, TuE) we will engineer advanced models of the bone marrow combining functional hydrogels with a new technology volumetric printing (xolography) seeking to build environments that promote maintenance of HSC phenotypes.

3. Job position description

Hematopoietic stem cells (HSCs) are the most widely used adult stem cells in clinical settings as they have the ability to reconstitute the entire blood system. In cases of bone marrow disease and failure (e.g. leukaemias), HSC transplantation is the only available treatment. However, HSC transplantation faces challenges due to insufficient donors and the rapid loss of HSC engraftment and repopulation potential during in vitro culture. Expanding HSCs ex vivo while maintaining their stem cell pool could address these limitations, but existing strategies have struggled to produce clinically relevant cell numbers that are functional. While most focus on understanding and recreating niches for HSC maintenance has been put on recreating bone marrow environment, little is know about which (biochemical and) mechanical cues are present in the BM ECM environment that in fact contribute to HSC maintenance.

In this project, we will engineer bone marrow niches using manufacturing techniques that incorporating hydrogels with biochemical and biomechanical properties that maintain functional HSCs in vitro

Engineering such niches requires interdisciplinary approaches that integrate cellular, mechanical, and environmental insights. Salmeron has developed hydrogels that support both mesenchymal stem cells (MSCs) and HSCs, recapitulating aspects of the bone marrow. Further, recent work by Castilho introduced bone marrow organoids from MSCs and endothelial cells (HUVECs) capable of maintaining healthy HSCs. While these bone marrow organoid cultures self-organize, challenges remain in controlling reproducibility and scalability. To address these issues, biofabrication has emerged as a promising technology to create structurally organized constructs containing living cells and biomaterials, aiming to enhance tissue maturation. Among the various bioprinting strategies developed over the years, Xolography volumetric

bioprinting—a technique recently pioneered by Castilho's lab—has shown unique advantages for (bone Marrow) organoid printing, including spatial controlling stiffness around bone organoids and their continuous production.

Group Leader at IBEC

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Collaborator at ICMS

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