Universitat Pompeu Fabra Barcelona

Master in Bioinformatics for Health Sciences

Master project 2024-2025

Personal Information

Supervisor	Xavier Trepat
Email	xtrepat@ibecbarcelona.eu
Institution	Institute for Bioengineering of Catalonia
Website	https://ibecbarcelona.eu/integrative
Group	Integrative Cell and Tissue Dynamics

Project

Computational systems biology

Project Title:

Modelling stem cell tissues to engineer biohybrid soft robots

Keywords:

soft robotics, biohybrid devices, computational mechanics

Summary:

Biohybrid devices are systems that combine living cells with soft materials to engineer functions that outperform inert machines. One example of this new type of devices is the use of muscle cells to power soft robots that perform functions such as swimming, walking, gripping or pumping. A main goal of our group is the development of a new generation of biohybrid devices based on folded stem cell tissues under optomechanical control. Thanks to the potential of stem cells, these devices will be able to self-heal, to self-assemble, to self-replicate, and to generate significant forces such as those that drive early embryonic development. To achieve this goal, we need computational models that capture the 3D dynamics of stem cell tissues. In this master's project, the student will participate in the development of 3D hierarchical vertex models of stem cell tissues. Using a scalable parallel computational framework, we will describe each surface of each cell in tissues encompassing thousands of cells. We will use these models to understand stem cell tissue dynamics and to design and test biohybrid soft robots with sensing, actuation and control capabilities.

References:

Ricotti, L., Trimmer, B., Feinberg, A. W., Raman, R., Parker, K. K., Bashir, R., ... & Menciassi, A. (2017). Biohybrid actuators for robotics: A review of devices actuated by living cells. Science robotics, 2(12), eaaq0495. Latorre, E., Kale, S., Casares, L., Gómez-González, M., Uroz, M., Valon, L., ... & Trepat, X. (2018). Active superelasticity in three-dimensional epithelia of controlled shape. Nature, 563(7730), 203-208. Alt, S., Ganguly, P., & Salbreux, G. (2017). Vertex models: from cell mechanics to tissue morphogenesis. Philosophical Transactions of the Royal Society B: Biological Sciences, 372(1720), 20150520.

Expected skills:

The project will be adapted to the applicant's background

Possibility of funding:

To be discussed

Possible continuity with PhD:

To be discussed