M2 Internship and PhD opportunity :

Mechanical and biological couplings in cardiac organoids

Physical microfluidics and Bioengineering lab, Institut Pasteur, Paris.
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Keywords : Organoids, 3D culture, Mechanobiology, Quantitative biology.

We wish to understand the interplay between the differentiation and organization of stem cells during the development of the fetal heart. These processes will be studied by building on our recently developed murine cardioid model, which recapitulates key aspects of cardiac organogenesis [1].
In particular we wish to explore the contribution of mechanical cues to cardiac development, which remains poorly understood. Our preliminary results show that encapsulation within a hydrogel can influence cardioid morphology, degree of maturation, and functional activity. We will therefore build on these findings to investigate how controlled mechanical stimulation further influences cardioid development and maturation.

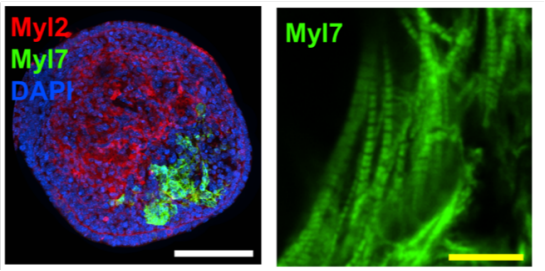


Figure 1 – Cardiac organoid (cardioid, left) and zoom on the sarcomers within it (right).

This project : Cardioids will be encapsulated into immobilized hydrogel droplets within a microfluidic device capable of applying controlled static or dynamic compression through pneumatic actuation. Mechanical stimulation will be applied at defined developmental stages to assess its effects on cardiac differentiation, tissue organization, and functional maturation [2]. We hypothesize that mechanical stimulation can influence cardiac development in a developmentally dependent manner. This project will establish a microfluidic platform for studying cardiac mechanobiology and provide insights into the interplay between mechanical forces and endogenous developmental signalling.

The candidate : The ideal candidate should have a strong background in biophysics, bio-engineering, quantitative biology, or a related area. He/she should be comfortable with cell biology, ideally with a background in quantitative image and data analysis, while working closely with other group members who bring complementary skills on theoretical and experimental aspects. The student will work in a small but growing group within the lab, so the desire to collaborate within a diverse and multidisciplinary team is a prerequisite.

The lab : The project will take place at Institut Pasteur and Ecole Polytechnique, where our research is focused on understanding the link between the single-cell characteristics and the collective properties that emerge at the scale of a population (e.g. [1, 2]). We will interact with theorists in the Paris area and elsewhere.

To apply or for further information : Applicants are invited to send a CV with their academic record and the names of two referees to Charles Baroud (charles.baroud@pasteur.fr) and sebastien.sart@pasteur.fr

References

[1] Vertti-Quintero, N., Delahousse, C., Aristov, A., Traboulsi, T., Cossec, J. C., Baroud, C. N., Sart, S. (2025). Culture of pluripotent stem cells in microscale droplets modulates differentiation and tissue patterning towards organoids on chip. Stem Cell Research Therapy, 16(1), 510.

[2] Jain, S., Belkadi, H., Michaut, A., Sart, S., Gros, J., Genet, M., Baroud, C. N. (2024). Using a micro-device with a deformable ceiling to probe stiffness heterogeneities within 3D cell aggregates. Biofabrication, 16(3), 035010.