Research Internship - Collège de France

Laboratory:
Center for Interdisciplinary Research in Biology - CNRS UMR 7241 / INSERM U1050.
Collège de France
11, place Marcelin Berthelot, 75005 Paris

Team: *Multiscale Physics of Morphogenesis* www.virtual-embryo.com

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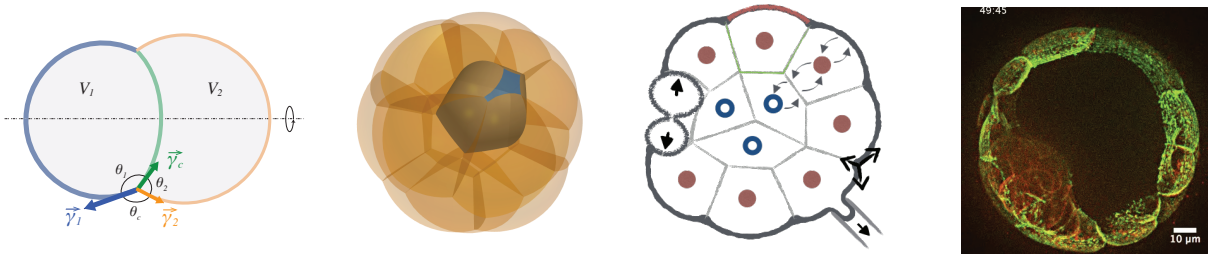
Physical modeling of early mammalian embryo morphogenesis

The quantitative understanding of early mammalian development is essential to the progress of reproductive medicine. Yet, the physical and mechanical principles governing the morphogenesis of mammalian embryos remain largely unknown. Early mouse embryos self-organize[1] by a succession of cell divisions[2], deformations[3] and rearrangements[4], leading ultimately to a stereotypical 3-dimensional structure called the blastocyst. Encapsulating a large fluid cavity, the blastocyst is composed of two major cell lineages, the inner-cell mass and the trophectoderm, which are segregated in inside & outside layers[4].

The aim of this internship is to investigate early mouse embryo self-organization[1] from a theoretical perspective, with an emphasis on the relation between cell-scale mechanics and embryo-scale morphogenesis. According to the candidate's interest, one these aspects may be considered: single embryonic cell rheology, the formation of the blastocyst cavity, the interplay between cell mechanics & fate specification, and the inference of forces inside the blastocyst from microscopy images. The work will consist in deriving reduced models to capture the physics of the process, and if time permits, will be followed by numerical simulations in 3D to obtain realistic quantitative predictions. Work will be performed in close collaboration with the experimental biology group of J-L. Maître at Institut Curie, expert in mouse embryology & cell mechanics (science.institut-curie.org/team-maitre).

The candidate should be trained in physics &/or mechanics/applied mathematics, with the desire to learn & combine several theoretical disciplines to understand biological problems. Strong programming skills (preferentially C++) would be appreciated. The candidate will be hosted at Collège de France in the new team *Multiscale Physics of Morphogenesis,* headed by Hervé Turlier.

The Center for Interdisciplinary Research in Biology (CIRB) is a novel CNRS/INSERM structure at Collège de France regrouping 21 teams working on various biological topics with highly interdisciplinary approaches (cell & developmental biology, computer science, mathematics and physics).



1. Wennekamp et al., A self-organization framework for symmetry breaking in the mammalian embryo. *Nat. Rev. Mol. Cell Biol*. **14 (**2013).
2. Turlier H. et al., Furrow Constriction in Animal Cell Cytokinesis. *Biophysical Journal* **106** (2014).
3. Maître et al., Pulsatile cell-autonomous contractility drives compaction in the mouse embryo. *Nat. Cell Biol.* **17** (2015).
4. Maître J-L., Turlier H. et al., Asymmetric division of contractile domaines couples cell position and specification. *Nature* **536** (2016).