SIZE SCALING AND CELL FATE DETERMINATION DURING EARLY EMBRYOGENESIS

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Project Description:

During early development, one of the most striking consequence of embryonic cleavages is the rapid reduction of cell size. Simultaneously, the first developmental landmarks are established as subsets of cells are acquiring specific fates. Asymmetric divisions, which can be found in a large variety of cleavages patterns, constitute a perfect illustration of this entanglement by producing two daughter cells with different size and fate. Based on this, one fundamental question in developmental biology is to understand the **relationship between cell volume modification and the ability to change cellular identity**. However, until recently, experiments modifying cell size in a developmental context were difficult to perform without interfering with other key processes such as growth, cell cycle or fate determination itself.

Our team recently developed a new method allowing to **mechanically manipulate cell division** (orientation and position) and thus to modify precisely cell volume during early development, in a minimally invasive manner. This new approach offers a unique opportunity to test direct consequences of cell size modification on cell determination.

During this internship, the student will use sea urchin embryos as a model system to study the impact of cell size reduction on cell identity. This project will involve microinjection and micromanipulation of live embryos to generate artificial asymmetric divisions combined with video-microscopy. Modification of cell fate will be assessed using a combination of readouts such as: modification of cell cycle speed, expression of early determination markers, precocious activation of zygotic transcription, or alteration of larval morphology.

Publications:

Sallé, J., Xie, J., Ershov, D., Lacassin, M., Dmitrieff, S., and Minc, N. (2018). Asymmetric division through a reduction of microtubule centering forces. J Cell Biol jcb.201807102.

Tanimoto, H., Sallé, J., Dodin, L., and Minc, N. (2018). Physical Forces Determining the Persistency and Centering Precision of Microtubule Asters. Nat Phys 14, 848–854.

Lacroix, B., Letort, G., Pitayu, L., Sallé, J., Stefanutti, M., Maton, G., Ladouceur, A.-M., Canman, J.C., Maddox, P.S., Maddox, A.S., et al. (2018). Microtubule Dynamics Scale with Cell Size to Set Spindle Length and Assembly Timing. Dev. Cell 45, 496-511.e6.