

Robustness or efficiency in animal cells?

the Role of Mitochondria in Cell tensional homeostasis

Project summary:

Counter-intuitively evolution does not make plant cells efficient in the way they use resources. Green plants use only about 1% to 2% of the total sunlight that reaches them to perform biomass growth (1,2,3). While making a systemic analysis of living entities and particularly interactions networks (signaling networks, ecological networks, molecular networks, physiological networks, neuronal networks...) at all scales we found that living entities are robust. This robustness concept can be described at the physiological scale by the homeostasis definition of Claude Bernard which is the ability of a system to go back to equilibrium after a perturbation.

Could we translate and test this robustness idea at the animal cell level. In this internship our goal is to measure the efficiency of animal cells to convert biochemical energy into mechanical one.

Practically, from an entire organism to a single cell, motion relies on mechanical forces and energy. Force generation through acto-myosin activity and traction at adhesion sites is an energy-consuming process. Although this is evident, the connection between energy metabolism and mechanical force produce by cells to perform basic function such as migration remains largely unexplored. Mitochondria are key regulators of cellular bioenergetics, and remodeling their morphology and localization enables the cell to meet its energetic demands.

The MicroTiss team specializes in measuring cell contractility using traction force microscopy (TFM)(5) and pattern deformation (Fig.1, 4). During the internship, cell contractility will be analyzed while perturbing mitochondrial functions using drugs or KO cell models. The goal of the internship is to investigate how mitochondrial dynamics regulate the magnitude and distribution of intracellular forces, using mouse embryonic fibroblasts (MEFs) as a model and TFM/pattern deformation as a readout.

This internship will provide highly interdisciplinary training, allowing the student to gain skills across different aspects of cell mechanics, spanning fundamental biology and microscopy. The goal being to extend this internship to a Phd in the team.

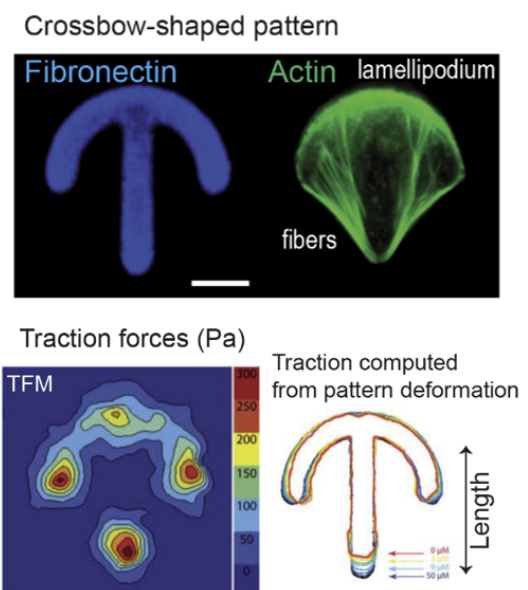


Fig. 1 : Control of cell shape and measure cell contractility. Illustration of cells shape control of cells cultured on crossbow-shaped pattern coated with fibronectin. Forces generated by the cells are quantify by TFM and pattern deformation.

Keywords: Traction force; Bioenergetics; Quantitative microscopy; Patterning

Relevant publications of the team:

- 1** Blankenship, Robert E.; Tiede, David M.; Barber, James; Brudvig, Gary W.; Fleming, Graham; Ghirardi, Maria; Gunner, M. R.; Junge, Wolfgang; Kramer, David M. (2011-05-13). "Comparing Photosynthetic and Photovoltaic Efficiencies and Recognizing the Potential for Improvement". *Science*. 332 (6031): 805–809. Bibcode:2011Sci...332..805B. doi:10.1126/science.1200165. ISSN 0036-8075. PMID 21566184. S2CID 22798697.
- 2** The Green Solar Collector; converting sunlight into algal biomass Wageningen University project (2005—2008)
- 3** Govindjee, What is photosynthesis?
- 4** Tseng Q. [...] Balland M. A new micropatterning method of soft substrates reveals that different tumorigenic signals can promote or reduce cell contraction levels. *Lab. Chip* 11, 2231–2240 (2011).
- 5** Lafaurie-Janvère, J. [...] Balland M, Matthieu Piel. ESCRT-III assembly and cytokinetic abscission are induced by tension release in the intercellular bridge. *Science* 339, 1625–1629 (2013).

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