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Focused-light-induced cytoplasmic streaming (FLUCS). A new paradigm to probe the physiology on intracellular transport.

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Throughout the last decades, access to genetic perturbations, fluorescent labels and modern microscopy advanced our molecular understanding of cell-biological processes tremendously.

The spatio-temporal organization of cells and developing embryos that we observe under these microscopes is widely believed to depend on physical processes such as diffusion and motor-driven intracellular flows. Thus far, however, it remains a challenge to unravel physiology of these physical transport processes, which is due to the lack of suitable perturbation methods.

Here, we exploit thermoviscous expansion phenomena to optically induce hydrodynamic flow in single cells and developing embryos. By controlling such flows inside the cytoplasm of the C. elegans zygote, we reveal the causal implications of intracellular flows during PAR polarization. Specifically, we show i) that hydrodynamic flows inside the cytoplasm localize PAR-2 proteins at the posterior membrane. ii) Induced cortical flows transported membrane-bound PAR molecules and rotated the membrane polarization, leading to iii) the downstream phenotype of an inverted body axis.

Furthermore, we utilize flow perturbations for probe-free active micro-rheology of the cytoplasm and within subcellular compartments. We conclude by emphasizing the opportunities and challenges of combining FLUCS with light-sheet-microscopy.

Mittasch et al., Nat Cell Biol 20 (2018)
Kruse, Chiaruttini, and Roux, Nat Cell Biol 20 (2018)

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Terms and Conditions

Yes

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