Microfluidics for biophysics : a few examples and a focus on intracellular pH regulation.

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In this talk, I will first present microfabrication and microfluidics techniques developed at INPHYNI, then a few examples of the use of such techniques for biophysics [1]-[3]. In the second part of the talk, I will focus on the case of intracellular pH regulation [4]. pH regulation of eukaryotic cells is of crucial importance and influences cell shape or different kinetic, metabolic and transport mechanisms. We develop a microfluidic system to rapidly and precisely control a continuous flow of ionic chemical species to challenge intracellular pH regulation mechanisms and confront predictive models. We monitor the intracellular pH dynamics in real-time using pH-sensitive fluorescence imaging and establish a robust mathematical tool to translate the fluorescence signals to pH values. By varying flow rate across the cells and duration for the rinsing process, we manage to tweak the dynamics of intracellular pH from a smooth recovery to either an overshooting or an undershooting state.

[1] Galiana E. *et al*. Guidance of zoospores by potassium gradient sensing mediates aggregation. J. R. Soc. Interface, **16**, 20190367 (2019)
[2] Puerner C. *et al*. Mechanical force-induced morphology changes in a human fungal pathogen. BMC biology **18**, 1-21 (2020)
[3] Cohen C. *et al.* Kinetics of zoospores approaching a root using a microfluidic device. Phys. Rev. E **111**, 024411 (2025)
[4] Tran, Quang D. *et al*. Rapid microfluidic perfusion system enables controlling dynamics of intracellular pH regulated by Na+/H+ e xchanger NHE1. Lab Chip, **25**, 557-564 (2025)