

Tracking molecular movement to unravel diffusion barriers in cardiac cells

Summary

This is an interdisciplinary project combining physics and biology to study the intracellular environment in the heart muscle. Through the development of cutting-edge experimental and data analysis approaches, it is expected to reveal intracellular environment properties that govern molecular movements and shape its physiology.

Research field:	Physical Sciences
Supervisors:	Rikke Birkedal Nielsen Marko Vendelin Martin Laasmaa
Availability:	This position is available.
Offered by:	School of Science Department of Cybernetics
Application deadline:	Applications are accepted between September 01, 2021 00:00 and September 30, 2021 23:59 (Europe/Zurich)

Description

So that the heart could produce mechanical work and do it consistently, mammalian cardiac muscle cells evolved into highly organized systems. Structures responsible for mechanical work, providing energy, and regulating it through electrical stimulation, are all positioned close to each other to minimize diffusion distances. Yet, the experimental evidence points towards severe restrictions of molecular movement in the heart muscle cell themselves. The physical basis for that is not fully understood and is the aim of this research topic. The specific aim is the identification of diffusion obstacles by locating them in the cell. As molecular diffusion is the basis for many processes in the cell, understanding where diffusion is restricted would have major implications for intracellular physiology by allowing us to analyze all the major energy transfer and signaling pathways quantitatively.

Here, you will design new methods that extend fluorescence correlation spectroscopy-based techniques previously developed in our laboratory by applying cutting-edge data analysis and targeted experimental approaches. Your task will be to design the protocols for experiments and data analysis, perform experiments, and analyze the measurements. As the microscopes are programmed using our in-house developed microscope platform, you will be able to design automated experimental protocols for your studies leading to high-quality data collection. In turn, this allows you to describe in detail the intracellular environment with high spatial precision.

This project is one of the main research lines in our interdisciplinary laboratory combining biology and physics. We have the expertise required for this challenging work and will help resolve the problems and teach you all the necessary skills.

The project is financed through a grant awarded to the laboratory by the Estonian Research Council.

Supervisor: Marko Vendelin

Co-supervisors: Rikke Birkedal Nielsen, Martin Laasmaa

Applicants should fulfil the following requirements:

- MSc in physics, mathematics, or a related field
- Experience with programming in Python
- Highly proficient in spoken and written English

The following experience is beneficial:

- Experimental and/or theoretical biophysics
- Programming in C++
- Working knowledge of SQL
- Working knowledge of statistics
- Working knowledge of stochastic processes

- Light microscopy, confocal fluorescence microscopy
- Working with cells
- Working in wet lab



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