Ph.D. projects in progress

1.

Mentor: Péter Galajda

Doctoral School: University of Szeged, Doctoral School of Theoretical Medicine, University of Szeged, Doctoral School of Multidisciplinary Medicine

Ph.D. student: Imre Pap

Title of the research topic: Single cell level studies of cell cycle and phenotypic characteristics of bacteria using microfluidic technologie

Description of the research topic: We develop various methods based on (optical) micromanipulation and microfluidics to study the cell cycle and the variation of phenotypic characteristics of bacteria over extended periods of time (many generations). Various cellular parameters are measured on single cell level, and analyzed in the context of cell-cell relatedness. This enables us to explore the emergence of phenotypic heterogeneity in clonal populations. Moreover, we are able to test novel concepts of aging of bacterial cells.

2.

Mentor: Péter Galajda

Doctoral School: University of Szeged, Doctoral School of Theoretical Medicine, University of Szeged, Doctoral School of Multidisciplinary Medicine

Ph.D. student: Ágnes Ábrahám

Title of the research topic: Studying bacterial populations using microfluidic methods

Description of the research topic: Numerous biological phenomena involving bacteria are only observed on the population level, such as quorum sensing, swarming and biofilm formation. Microfluidic technologies are suitable for creating precisely engineered physical and chemical environmental conditions for bacterial populations. This enables us to perform experiments that were not possible using traditional methods.

Within the project we study the effect of the physical and (bio)chemical characteristics of the environment on bacterial populations. We especially focus on population dynamics, the spatial distribution of cells (mainly as an effect of chemical gradients that are externally applied or generated by cellular processes), chemotaxis, and cell-cell communication. In experiments on longer timescales we also study the effect of environmental structure and conditions on bacterial evolutionary processes.

3.

Mentor: Lóránd Kelemen

Doctoral School: University of Szeged, Doctoral School of Theoretical Medicine, University of Szeged, Doctoral School of Multidisciplinary Medicine

Ph.D. student: Tamás Fekete

Title of the research topic: Application of optical tweezers to study single cells' surface

Description of the research topic: The optical tweezers provides a modern, practically non-invasive means to investigate biological samples in a controlled manner. Its extended version, the holographic optical tweezers can provide several trapping focal points therefore it is capable of trapping and actuating complex microfabricated 3D object with six degrees of freedom. In the research projects we plan to apply such optically actuated micro-objects to study biological processes that have relevance in the life of single cells. One of these projects is the determination of the protein-protein and protein-macromolecule interaction strength by surface-functionalized microtools where the proteins are the ones that are naturally found in cell membranes. The expected results have relevance in the characterization of transcellular material transport (for instance by the blood-brain-barrier system) where the first step is the attachment of the transported material (single or macromolecules, proteins or nanoparticles) to cell surface receptors. This project will primarily rely on a holographic optical tweezers system combined with a fluorescent microscope.