Analyzing multi-cellular dynamics of infection and immune processes

Frederik Graw[1,2]

[1]Department of Medicine 5 – Hematology and Oncology, Friedrich-Alexander-Universität Erlangen-Nürnberg and University Hospital Erlangen, 91054 Erlangen, Germany; [2]Deutsches Zentrum Immuntherapie (DZI), Friedrich-Alexander-Universität Erlangen-Nürnberg and University Hospital Erlangen, 91054 Erlangen, Germany

The spread of a pathogen within an infected host, as well as the dynamics of immune responses represent complex dynamical systems that involve various cell types and factors. Identifying the key factors that determine the outcome of an infection requires to study these dynamics within physiological conditions that account for tissue-structure and the spatio-temporal interaction of the different factors. Advances within experimental culture systems, but also live-cell microscopy techniques have increased our ability to study host-pathogen interactions in increased level of detail. However, analyzing these data and getting to a mechanistic understanding of the various biological processes involved requires an interdisciplinary approach that combines image analysis, mathematical modeling and improved methods for parameter inference.

In my talk, I will show how the combination of detailed individual cell-based models with experimental data from live-cell imaging and long-term cell population measurements can be used to reveal the interactive dynamics of infection and immune processes within tissues. To this end, I will introduce different methods that were developed to improve parameter inference and analysis for such complex systems. Applying them to experimental data, we are able to reveal how environmental restrictions and single cell characteristics shape the spread of viruses within multi-cellular systems, and how local immune responses contribute to the clearance of infections.