

# Image-based Systems Biology

## Dynamics, Function & Morphology of Infection Processes

The focus of the research group Applied Systems Biology is on mathematical modeling and computer simulation of infection processes caused by human-pathogenic fungi. The spatio-temporal data basis for these models is acquired by automatizing the data analysis of microscopy images on infection processes for high-throughput scanning. We are developing our own Java Image Processing Pipeline ([JIPipe](#)), which particularly addresses ImageJ-users and provides a visual programming language for everyone. Our aim is to unravel secrets of the dynamical, functional and morphological aspects of host-pathogen interactions by the image-based systems biology approach. This approach seeks to take full advantage of the information contained in images and includes the following three steps:

- Automated analysis of image data for high-content and high-throughput screening,
- Quantitative description of biological processes by appropriate characteristic measures,
- Construction of image-derived spatio-temporal models and predictive computer simulations.

The Applied Systems Biology Research Group provides an overview of current projects at <https://asb.hki-jena.de> and makes its open source software tools available on GitHub: <https://github.com/applied-systems-biology>.

## Collaborations, Funding & Teaching

Image-based systems biology represents a generic link between experiment and theory in interdisciplinary studies and offers an enormous range of opportunities for cooperation, since microscopic and spectroscopic data are routinely collected in nowadays experiments. This explains why the research group Applied Systems Biology is an active collaboration partner in the [BMBF](#)-funded [Center for Sepsis Control and Care](#) at the [Jena University Hospital](#) as well as in two [DFG](#)-funded collaborative research centers in Jena: [FungiNet 124](#) – “Pathogenic fungi and their

human host – networks of interaction” ([Project B4](#)) and [PolyTarget 1278](#) – “Polymer-based nanoparticle libraries for targeted anti-inflammatory strategies” ([Project Z01](#)) as well as in the DFG-funded research training group [RTG 2723](#) - "Materials-Microbes-Microenvironments" ([Project F](#)). Furthermore, the BMBF-funded "Multi-Model-Simulator Project" within the funding line "[Computational Life Sciences](#)" is led by Prof. Figge. He is also the coordinator of the BMBF-funded "Basic Technology 3" within the "[Leibniz Center for Photonics in Infection Research](#)" as well as of the DFG-funded National Research Data Management initiative "[NFD14Bioimage](#)".

In the recently established [Excellence Cluster](#) – “Balance of the Microverse” at the [Friedrich Schiller University Jena](#), Prof. Figge is coordinator of the research area on “[Data Synopsis](#)” as well as a member in the interdisciplinary management board of the “[Microverse Imaging Center](#)”. Furthermore, Prof. Figge is the speaker of the [Leibniz](#)-funded ScienceCampus [InfectoOptics](#), which is a collaborative initiative where researchers from the life sciences and optics/photonics closely work together with the aim of investigating and combating infectious diseases by means of novel optical technologies. In the Research Campus [InfectoGnostics](#), methods for application in the diagnosis of infections are being further developed; for example, in the [ADA](#) project, where a platform for screening for *Staphylococcus aureus* / MRSA in human and veterinary medicine is being developed. Furthermore, Prof. Figge recently became a member in the executive board of the [Beutenberg Campus e.V.](#) which is about “Life Science meets Physics”.

Every year, the research group Applied Systems Biology is involved in the organization of an international symposium with two alternating topics: [Image-based Systems Biology \(IbSB\)](#) in the even years and [Systems Biology of Microbial Infection \(SBMI\)](#) in the uneven years. Each of these events attracts an international audience of about 70 participants.

Last but not least, the research concept is further supported by the lectures on [Image-based Systems Biology](#) and [Systems Biology of Immunology](#) to educate bachelor and master students in this modern research approach and to teach the basics of analytical and quantitative methods for modeling dynamic systems.

Taken together, the research group Applied Systems Biology is a link between the two profile lines [LIGHT](#) and [LIFE](#) of the [Friedrich Schiller University Jena](#). This is also reflected by Prof. Figge being the deputy coordinator of the [Jena School for Microbial Communication](#) as well as his memberships in the faculties of the [International Leibniz Research School for Microbial and Biomolecular Interactions](#), the [Jena Center for Soft Matter](#) and the [Michael Stifel Center Jena](#).