

IbSB-6

B4: Image data analysis and agent-based modelling of the spatio-temporal interaction between immune cells and human-pathogenic fungi

M.T. Figge, S. Dietrich, T. Lehnert, C.M. Svensson, S. Timme

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Marc Thilo Figge, Sandra Timme, Stefanie Dietrich, Carl-Magnus Svensson, Teresa Lehnert, Jena

Summary

- Analysis, interpretation and modelling of microscopic image data
- Investigation of morphological, functional and dynamical aspects of host-pathogen interactions
- Generation of hypothesis to be tested in experiment

- Image-based systems biology approach:
1. Automated image processing
 2. Derivation of quantitative measures
 3. Virtual infection modelling and computer simulation

Project progress to date

Image based systems biology of infection involves the development of strategies and methods for the quantitative analysis and modelling of information contained in microscopic images. Project B4 focuses on all three aspects of image-based systems biology and applies this approach to the image data on infection processes acquired by our CRC/TR partners.

Automated pipeline for analysis of microscopic images:

- Segmentation and modelling of hyphal growth (B4 + C1):

Quantification of phagocytosis assays (B4 + A1):

Virtual infection models in whole blood and in lung alveoli:

- Agent-based computer simulations (B4 + C3):

Evolutionary game theory on graphs (B4 + A1 + B1 + C5):

Counterplay of pathogen-driven infection and host-induced inflammation across various time scales in alveolar sacs

Role of alveolar macrophages depends on infection-dose

Publications

1. Kuehnlein, S., Timme, S., Figge, M., Dietrich, S., Lehnert, T., Figge, M. (2015) Tracking the interaction of Aspergillus fumigatus and host cells in a murine model of invasive aspergillosis. *PLoS ONE* 10: e0141111.
2. Kuehnlein, S., Timme, S., Figge, M., Dietrich, S., Lehnert, T., Figge, M. (2015) Quantitative analysis of Aspergillus fumigatus hyphal growth. *PLoS ONE* 10: e0141111.
3. Kuehnlein, S., Timme, S., Figge, M., Dietrich, S., Lehnert, T., Figge, M. (2015) Automated quantification of the propagation of Aspergillus fumigatus hyphae in a murine model of invasive aspergillosis. *PLoS ONE* 10: e0141111.
4. Kuehnlein, S., Timme, S., Figge, M., Dietrich, S., Lehnert, T., Figge, M. (2015) Automated quantification of the propagation of Aspergillus fumigatus hyphae in a murine model of invasive aspergillosis. *PLoS ONE* 10: e0141111.
5. Kuehnlein, S., Timme, S., Figge, M., Dietrich, S., Lehnert, T., Figge, M. (2015) Automated quantification of the propagation of Aspergillus fumigatus hyphae in a murine model of invasive aspergillosis. *PLoS ONE* 10: e0141111.
6. Kuehnlein, S., Timme, S., Figge, M., Dietrich, S., Lehnert, T., Figge, M. (2015) Automated quantification of the propagation of Aspergillus fumigatus hyphae in a murine model of invasive aspergillosis. *PLoS ONE* 10: e0141111.
7. Kuehnlein, S., Timme, S., Figge, M., Dietrich, S., Lehnert, T., Figge, M. (2015) Automated quantification of the propagation of Aspergillus fumigatus hyphae in a murine model of invasive aspergillosis. *PLoS ONE* 10: e0141111.
8. Kuehnlein, S., Timme, S., Figge, M., Dietrich, S., Lehnert, T., Figge, M. (2015) Automated quantification of the propagation of Aspergillus fumigatus hyphae in a murine model of invasive aspergillosis. *PLoS ONE* 10: e0141111.
9. Kuehnlein, S., Timme, S., Figge, M., Dietrich, S., Lehnert, T., Figge, M. (2015) Automated quantification of the propagation of Aspergillus fumigatus hyphae in a murine model of invasive aspergillosis. *PLoS ONE* 10: e0141111.
10. Kuehnlein, S., Timme, S., Figge, M., Dietrich, S., Lehnert, T., Figge, M. (2015) Automated quantification of the propagation of Aspergillus fumigatus hyphae in a murine model of invasive aspergillosis. *PLoS ONE* 10: e0141111.

Project aims of the second funding period

- Design of new tools and workflows to investigate morphological, functional and dynamical aspects of host-pathogen interactions by the image-based systems biology approach:
- Processing of live cell microscopy data on confrontation assays
 - Automated recognition and statistics of time-ordered event patterns
 - Advancement of virtual infection models for a higher level of detail
 - Improvement of model parameter estimation algorithms
 - Experimental design of confrontation assays by computer simulations

Project plan

WP1: Development of algorithms for the automated analysis of time-resolved image data

WP2: Automated high-throughput and high-content screening of time-resolved image data

WP3: Experimental design of phagocytosis assays via computer simulations

WP4: Advancement of virtual infection modelling and of estimation of model parameters

WP5: Quantitative predictions of sensitive parameters in infection scenarios

WP6: Support of CRC/TR partners based on methods developed in the first funding period

Role within CRC/Transregio 124

