Migration and Interaction Tracking for Quantitative Analysis of Phagocyte-Pathogen Confrontation Assays

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Introduction

Invasive fungal infections are emerging as a significant health risk for humans. The innate immune system is the first line of defense against invading micro-organisms and involves the recruitment of phagocytes, which engulf and kill pathogens, to the site of infection.

To gain a quantitative understanding of the interplay between phagocytes and fungal pathogens, live-cell imaging is a modern approach to monitor the dynamic process of phagocytosis in time and space. Because this requires the processing of large amounts of video data, we developed a novel framework, called AMIT (algorithm for migration and interaction tracking [1, 2]) for the automated high-throughput analysis of multi-channel time-lapse microscopy videos of phagocyte-pathogen confrontation assays.

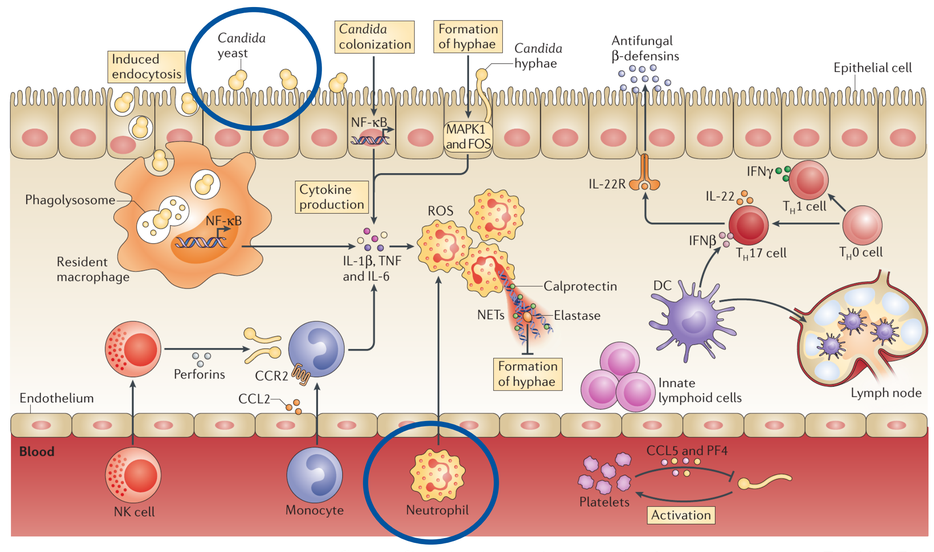


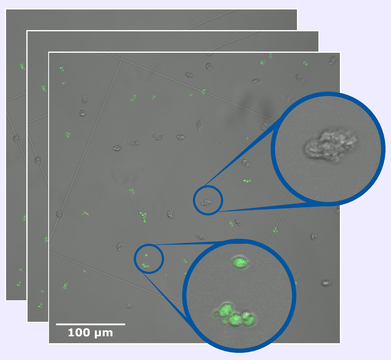
Figure modified after Netea *et al.*,*Nat. Rev. Immunol* 15 (2015)

Algorithm for Migration and Interaction Tracking

Data

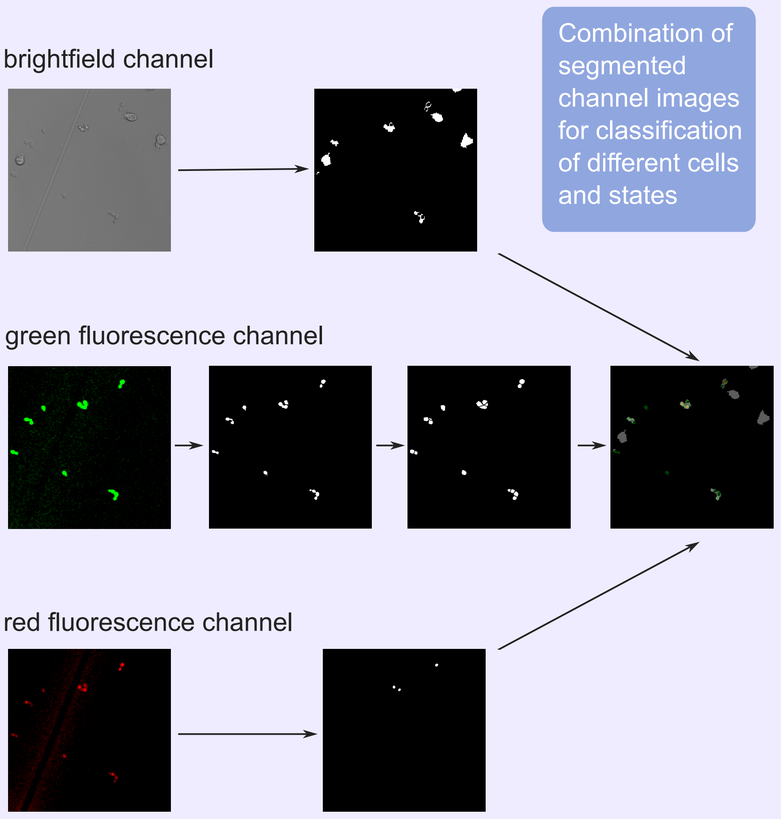
Multi-channel time lapse microscopy videos of confrontation assays

- 1 hour
- 360 frames

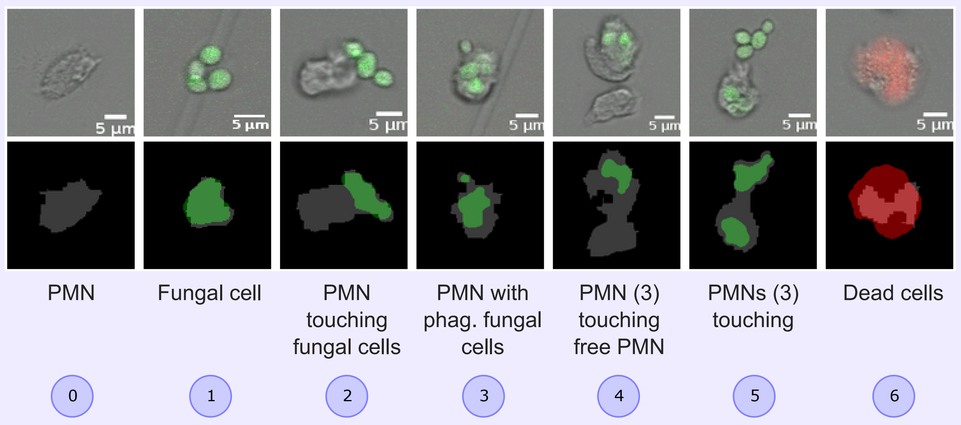


PMNs - no staining
C. glabrata - GFP-labeled
dead cells - PI-staining

Segmentation of multi-channel time-lapse microscopy videos

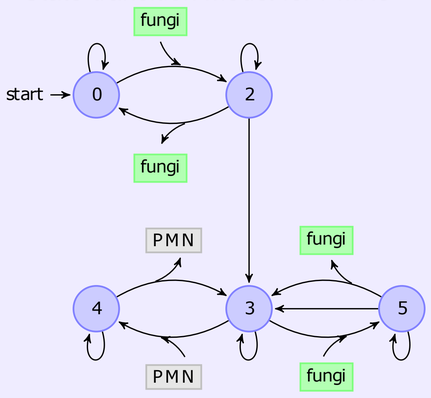


Classification of PMN states

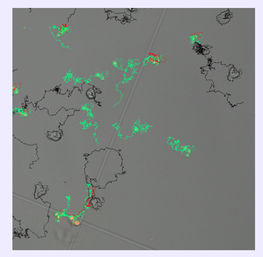


Cell Tracking and Interaction Detection

State-transition model for PMNs

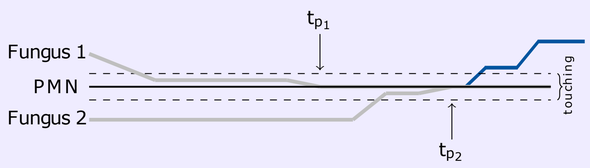


Cell tracking



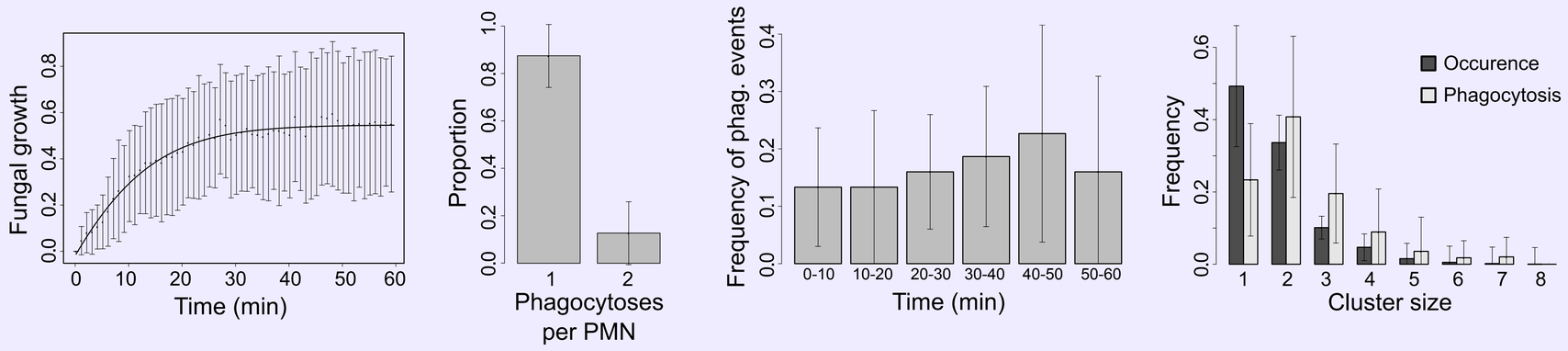
Individual tracking of fungal cells and dead cells incorporated into tracking of PMNs

Optional User-Intervention



To handle uncertainties in interaction detection and to detect novelties (e.g. "dumping" [3])

Cell Track Analysis for Generation of Quantitative Results



References
[1] Brandes, S., Dietrich, S., Hünniger, K., Kurzai, O., Figge, M.T. *Medical Image Analysis* (2016)
[2] Brandes, S., Mokhtari, Z., Essig, F., Hünniger, K., Kurzai, O., Figge, M.T. (2015) *Medical Image Analysis* (2015)
[3] Essig, F., Hünniger, K., Dietrich, S., Figge, M.T., Kurzai, O. *Fungal Genetics and Biology* (2015)

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