Cell migration with Quantitative Phase Imaging

Application note

Cell migration plays a pivotal role in processes such as embryonic development, tissue repair, and immune responses. Cell migration evaluation is critical for studying cell behavior, elucidating underlying mechanisms, and evaluating the effects of various treatments or conditions on migration patterns. To understand these processes fully, it is crucial to precisely define individual cells and track their movements over time. Therefore, Quantitative Phase Imaging by Q-Phase which ensures automatic and accurate cell segmentation and cell tracking is a suitable solution for such studies.

Cell segmentation and tracking – looking at individual cells

For evaluation of cell migration and movement dynamics parameters like Euclidean length and meandering index are used. These parameters provide insights into how cells traverse through tissues and their migratory behavior.

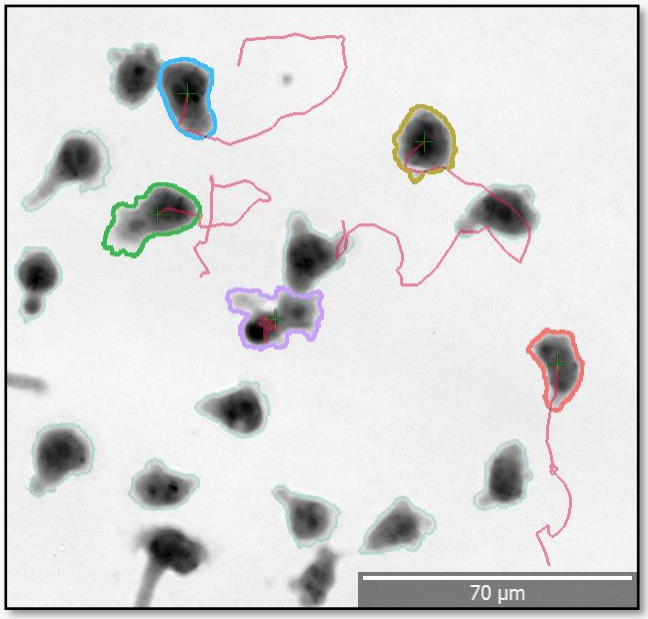


Fig. 1: Example of individual cell segmentation and tracking of 10-minute lymphocyte cell observation.

The Euclidean length, also known as the linear distance or direct path length, represents the straight-line distance between the starting and ending points of a cell's trajectory. The meandering index quantifies the degree of cell trajectory irregularity or the tortuosity of the cell's path.

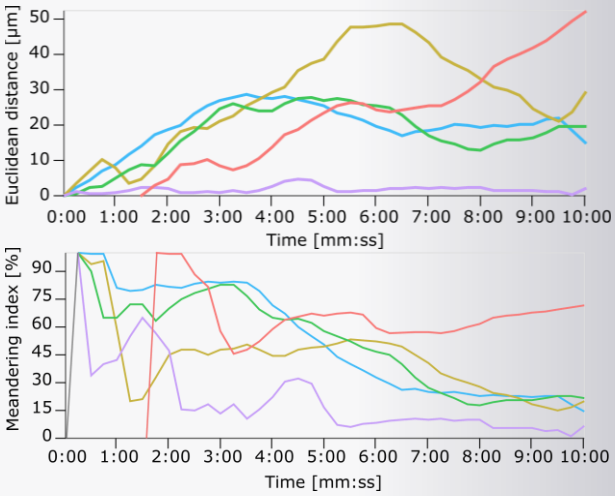


Fig. 2: Graphs of Euclidean distance and Meandering index of individual cells shown in Fig.1.

Thanks to high-quality and coherence-gatting effect, Q-Phase makes it possible to study the dynamics of individual cells even in a scattering milieu such as 3D collagen matrix in fine details [1].

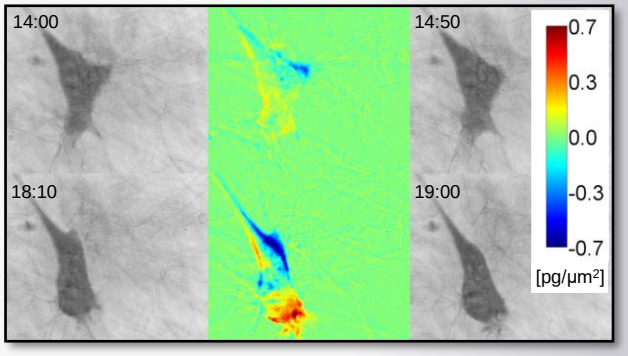


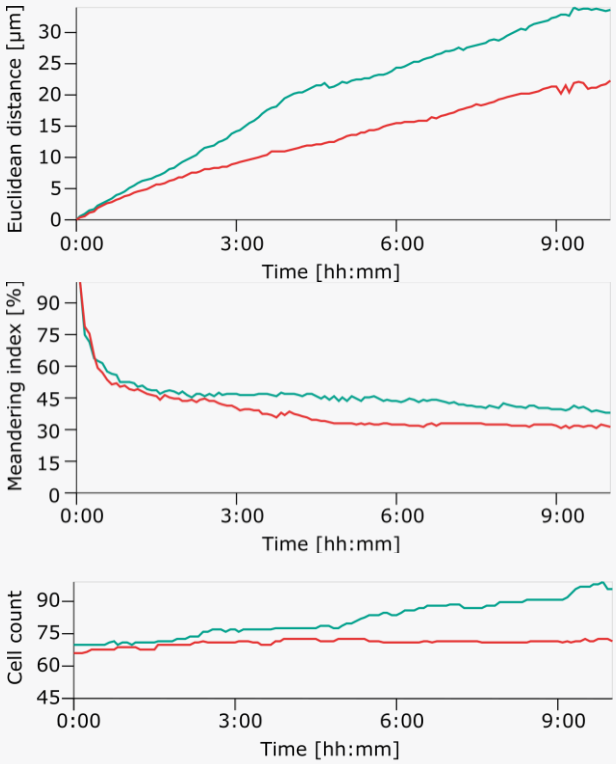
Fig. 3: Example of cell dry mass distribution analysis. The colored images are the subtraction of previous and following images and show the movement of cell dry mass. Areas, where the mass increased are in red, and areas, where the mass decreased, are in blue. The image depicts polarized cell dry mass distribution in the motile mesenchymal cell.

Application note

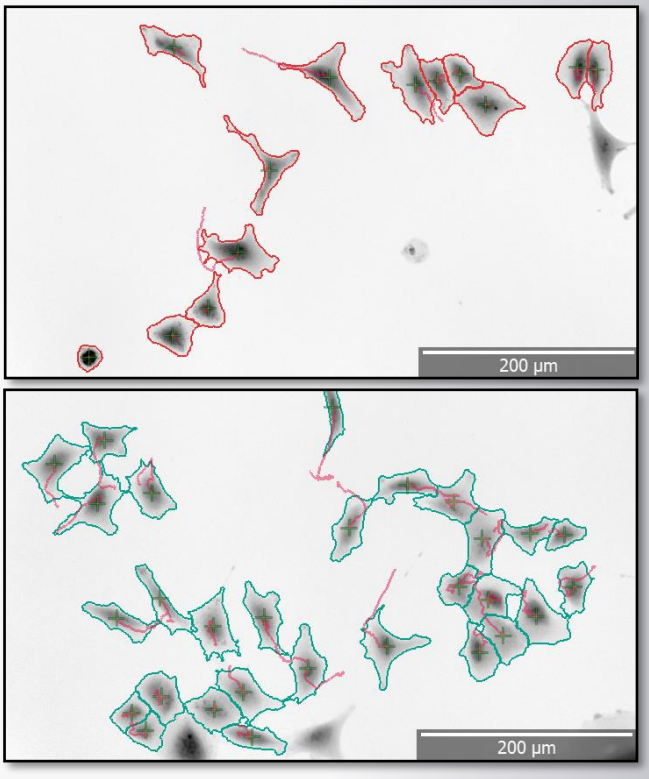
Effects of different treatments on cell migration – looking at populations

Quantitative Phase Imaging as a non-invasive label-free method gives researchers the opportunity to study and compare cell reactions to different treatments. The differences between treatments can be recognized quickly and are verified with image data from the whole experiment time.

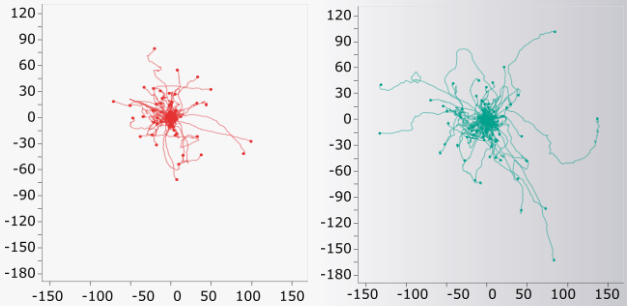
As an example, the A549 cell population treated with niclosamide was compared to the control sample. The observation took 10 hours and the evaluation is based on the cell dynamics of migration, morphological changes and cell growth. The real-time monitoring of the cells helps us to observe unexpected changes in the behavior of tumor cells.



▲ Fig. 4: Graphs of Euclidean distance, Meandering index and cell count of A549 cell population treated by niclosamide (red) and control (turquoise).



▲ Fig. 5: Example images of treated (red) and control (turquoise) cells.



▲ Fig. 6: Rose plots of treated (red) and control (turquoise) cells.

In this experiment difference between migration characteristics in treated and control cells was clearly shown and this quantitative phase imaging-based method was suggested as a method for primary assessment of medicines for expected migrastatic potential [2].

References

[1] Tolde O. et al. Quantitative phase imaging unravels new insight into dynamics of mesenchymal and amoeboid cancer cell invasion. Scientific reports 8.1 (2018): 12020.

[2] Šuráňová M. et al. Primary assessment of medicines for expected migrastatic potential with holographic incoherent quantitative phase imaging. Biomedical Optics Express 14.6 (2023): 2689-2708.

Q-Phase microscope is a valuable tool for live cell imaging and analysis of cell migration. Its software enables automated evaluation of a wide range of data in amounts sufficient for obtaining statistically significant results. Moreover, all data are available for visual biological validation.

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