

FUCCIJ—A Novel Image-Analysis Tool to Construct Cell Lineage Trees from FUCCI Cell-Cycle

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Abstract

Dynamic cell cycle analysis through time-lapse imaging of FUCCI cells opens new venues to better understand a variety of cellular processes. The lack of tools to automatically detect and track cells changing in fluorescence color in time, prompted us to develop an ad hoc software: FUCCIJ. FUCCIJ allows to specifically reconstruct lineage trees of single FUCCI cells.

We describe here a novel ImageJ/FIJI plugin, which allows to process movies (Brightfield/phase, Red fluorescence and Green fluorescence are generally acquired for such experiments). After background subtraction, denoising and spot enhancement, automatic cell detection is combined with user- based editing, allowing to correct false positive or false negative detections. Lineage tree generation is based on a frame-to-frame algorithm taking into account the FUCCI color sequence. This is then combined with a lab-own developed combinatorial and probabilistic model where theoretical expectations are combined with the results of detection. Lineage trees can be displayed, and cell cycle parameters, including phase length, position, fluorescence intensity, can be extracted for further analysis.

FUCCIJ was successfully used to analyze cell cycle characteristics of neural stem cells isolated from FUCCI mice and tested on different cell types with completely different morphologies, such as tail tip fibroblasts as well as mouse embryonic stem cells expressing the FUCCI reporter.

Keywords

FUCCI, fluorescence images, tracking, cell lineage

