Cell migration

Cell migration is a central process in the development and maintenance of multicellular organisms. Tissue formation during embryonic development wound healing and immune responses all require the orchestrated movement of cells in particular directions to specific locations.

Cell migration is regulated by intracellular signaling pathways (ICSP) and extracellular matrix (ECM), plays an indispensable role in many physiological and pathological process such as normal tissue development and cancer metastases. However, there is a lack of rigorous and quantitative tools for analyzing the time-varying characteristics of cell migration in heterogeneous microenvironment, resulted from, e.g., the time-dependent local stiffness due to microstructural remodeling by migrating cells.

Liu et al. developed a wavelet-analysis approach to derive the time-dependent motility parameters from cell migration trajectories, based on the time-varying persistent random walk model. In particular, the wavelet denoising and wavelet transform are employed to analyze migration velocities and obtain the wavelet power spectrum. Subsequently, the time-dependent motility parameters are derived via Lorentzian power spectrum. Our results based on synthetic data indicate the superiority of the method for estimating the intrinsic transient motility parameters, robust against a variety of stochastic noises. We also carry out a systematic parameter study and elaborate the effects of parameter selection on the performance of the method. Moreover, we demonstrate the utility of our approach via analyzing experimental data of in vitro cell migration in distinct microenvironments, including the migration of MDA-MB-231 cells in confined micro-channel arrays and correlated migration of MCF-10A cells due to ECM-mediated mechanical coupling. Our analysis shows that our approach can be as a powerful tool to accurately derive the time-dependent motility parameters, and further analyze the time-dependent characteristics of cell migration regulated by complex microenvironment [1)].

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Liu Y, Jiao Y, He D, Fan Q, Zheng Y, Li G, Wang G, Yao J, Chen G, Lou S, Shuai J, Liu L. Deriving time-varying cellular motility parameters via wavelet analysis. Phys Biol. 2021 Apr 28. doi: 10.1088/1478-3975/abfcad. Epub ahead of print. PMID: 33910180.