

Title: From Discrete to Continuous Models of Cell Movement: an Application to Medical Implants

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Abstract:

Mathematical modeling of cell movement is needed to aid in the deeper understanding of vital processes such as embryogenesis, angiogenesis, tumor metastasis and immune reactions to foreign bodies. In this work, we develop multiscale models of cell movement in response to external stimulus, incorporating both a random and a biased component. In order to model the random nature of the movement, an individual based (IBM) model is created to simulate cells moving in the presence of a heterogeneously distributed stimulus molecules. The discrete IBM model is then upscaled, starting with transition probabilities of the individuals at each site, to obtain a corresponding continuous differential equation (DE) model. Continuous models allow for a more general study of larger domains. Under traditional modeling assumptions the proposed new models reduce to previously developed models in the literature. Next, we present a set of numerical experiments which show very good agreement between the new continuous DE and discrete IBM models for a variety of different values of the parameters. Furthermore, applications of the new mathematical models to infection control on medical implants are also presented.