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Chemoattractant distribution in complex geometry impacts the trajectory of clustered cell migration

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Abstract

Cell migration is a vital aspect of animal development, homeostasis, and disease progression, yet numerous questions persist regarding how this process is regulated. Despite having characterized many types of individual cell movements, there has been limited focus on how clusters of cells collectively migrate through diverse and complex extracellular environments. Cells are induced to move in response to chemical attractants. To investigate this further, we have centered our attention on the chemoattractant concentration of migration of border cells during Drosophila egg development. We create a 1D model incorporating the geometrical elements of the egg chamber and obtain the distribution of chemoattractant through the length of the chamber. We determine reasonable biophysical parameters of chemoattractant. We construct a force-based model that maps concentration to a steady receptor activation and force generation to analyze and simulate the cluster center motion. This model compares well with the variety of cluster trajectories in experiments by controlling the nurse cell juncture locations and depths.