McCormick

Northwestern Engineering

Emergent Collective Chemotaxis Without Single-Cell Gradient Sensing

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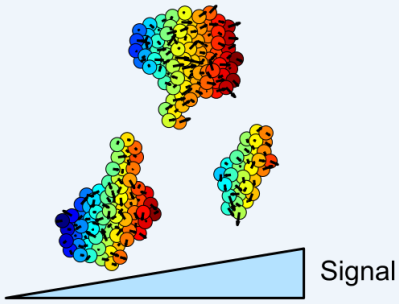

Many eukaryotic cells chemotax, sensing and following chemical gradients. However, experiments have shown that even under conditions when single cells do not chemotax, small clusters may still follow a gradient. This behavior has been observed in many cell types, but its origin remains puzzling. I propose a new mechanism underlying this "collective guidance" where individual cells must measure the mean value of the attractant, but need not measure its gradient to give rise to directional motility for a cell cluster. This theory provides analytic results for how cluster velocity and directionality (chemotactic index) depend on the number and organization of cells in the cluster, leading to a "mobility matrix" for a cluster, similar to the one used in low Reynolds number fluid mechanics. I show that the collective guidance hypothesis can be directly tested by looking for strong orientational effects in pairs of cells chemotaxing. I also discuss how a cell cluster can process signals chemically, how its scheme of adapting to these signals and amplifying them can change the cluster's speed and directionality, and how these results will change depending on the extent and type of cell-cell cohesion.

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