

Aggregation-Diffusion equations and systems in mathematical biology: stationary states, phase transitions and qualitative behavior.

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We discuss microscopic and continuum cell-cell adhesion models and their derivation based on the underlying microscopic assumptions. We will derive these macroscopic limits via mean-field assumptions. We propose an improvement on these models leading to sharp fronts and intermingling invasion fronts between different cell type populations. The model is based on basic principles of localized repulsion and nonlocal attraction due to adhesion forces at the microscopic level. We also review the applications of these models in cell sorting in developmental biology. We will analyse the mathematical properties of the resulting aggregation-diffusion and reaction-diffusion systems based on variational tools. The concept of H-stability of the interaction potential plays an important role in the appearance of phase transitions in these models.