Modelling collective cell movement in biology

Abstract
Collective cell movement occurs in many areas of biology, both in normal circumstances and in disease. Here, we review some recent work in three different areas - acid-mediated cancer cell migration, cranial neural crest cell migration, and epithelial cell movement. These applications lead to three different mathematical frameworks, namely, a coupled system of nonlinear partial differential equations, a hybrid model combining a partial differential equation with an off-lattice individual-based model, and an individual-based model for epithelial sheets. We show that the results are consistent with experimental observations as well as predicting new, and subsequently validated, biological phenomena and that mathematically, these models reduce to nonlinear transport equations with the macroscopic tissue level diffusion coefficient incorporating the microscopic cell level behaviour.