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Integrin mediated Cell Migration: Multiscale Models, Analysis and Numerics

Invasion is a key property of cancer cells, whereby the contact with the surrounding tissue both enables the cells to move along tissue fibers and stimulates the production of proteolytic enzymes that destroy the tissue network, thus enhancing cell migration. The product of the tissue degradation is seen as a chemotactic signal influencing the movement direction of the cells.

Existing models for the migration of tumor cells deal with the interactions of the cells with the environment but do not account for biochemical processes in the cell or on its surface. This processes are however very important, since the dynamics of receptors on the cell surface and the cytoskeleton structure are decisive in determining the speed of the cell as well as the secretion of proteolytic enzymes.

We present a model incorporating this subcellular mechanisms in a kinetic equation for cell movement, which is then supplemented by a reaction-diffusion equation for the chemoattractant along with an integro-differential equation for the tissue fibers. We then address the question of existence and uniqueness of solutions for this strongly coupled system of equations.

This strongly coupled and high dimensional model presents a real challenge for the design of a suitable simulation methodology. Selected simulation results illustrate important phenomena that arise in the model.