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Mathematical Modeling and Numerical Simulations for the Influence of Heat Shock Proteins on Tumour Invasion

Invasion is a key property of tumor cells; thereby, they encounter a large variety of soluble and substratum-bound factors which can influence the different stages of their migration. There are at least two mechanisms promoted by such factors: chemotaxis and haptotaxis. These in turn are influenced by the intracellular dynamics. In our talk we focus on the effect of heat shock proteins (HSP), a class of functionally related proteins whose expression is enhanced when cells are exposed to elevated temperature or other stresses and which have been recently proposed to influence cancer cell migration. Our mathematical model has a multiscale character, accounting both for the microscopic, intracellular level on which these proteins are acting and for the macroscopic level of cell population. It consists of a system of reaction-diffusion equations for the density of cancer cells, of the extracellular matrix and the concentration of matrix degrading enzymes, which is then coupled with a delay differential equation for the HSP dynamics. We propose several different ways for modeling the time lag and perform numerical simulations in order to assess the effect of our choices on the behaviour of the system.