Global weak solutions in a PDE-ODE system modeling multiscale cancer cell invasion

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We prove the global existence, along with some basic boundedness properties, of weak solutions to a PDE-ODE system modeling the multiscale invasion of tumor cells through the surrounding tissue matrix. The model accounts on the macroscopic level for the evolution of cell and tissue densities, along with the concentration of a chemoattractant, while on the subcellular level it involves the binding of integrins to soluble and insoluble components of the peritumoral region. The connection between the two scales is realized with the aid of a contractivity function characterizing the ability of the tumor cells to adapt their motility behavior to their subcellular dynamics.

The resulting system, consisting of three partial and three ordinary differential equations including a temporal delay, in particular involves chemotactic and haptotactic cross-diffusion. In order to overcome technical obstacles stemming from the corresponding highest-order interaction terms, we base our analysis on a certain functional, inter alia involving the cell and tissue densities in the diffusion and haptotaxis terms respectively, which is shown to enjoy a quasi-dissipative property. This will be used as a starting point for the derivation of a series of integral estimates finally allowing for the construction of a generalized solution as the limit of solutions to suitably regularized problems.