A mathematical path to a hybrid 3-D multi-organ cancer invasion framework and virtual patient environment

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1. Abstract

The ability to locally degrade the Extracellular Matrix (ECM) and invade in the neighbouring tissue is a key process that distinguishes cancer from normal cells. It is also a critical step in the tumour progresssion and cancer metastasis. The tissue invasion involves the coordinated action of the cancer cells, the ECM, the Matrix Degrading Enzymes, and the Epithelial-to-Mesenchymal transition (EMT); a cellular (re-)programming mechanism through which cancer cells switch from an Epithelial-like proliferative phenotype to acquire Mesenchymal-like invasive properties.

In this presentation, we introduc a series of 2- and 3D mathematical models that describe the growth of the Epithelial-like (ECs) and the invasion strategy of the Mesenchymal-like cancer cells (MCs). We first address simpler model versions where we discuss the existence of classical solutions, and proceed with a more elaborate multiscale and hybrid SDE-PDE model and its predictive capacity of realisteic experimental situations. We conclude with some findings from our most recent model extensions to multi-organ conformation and our first steps towards the mathematical development of a virtual cancer patient.

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