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Mathematical Modelling of Cancer Ecology

We model the metabolism and behaviour of a developing tumour in the context of its microenvironment, with the aim of elucidating what drives the hallmarks of malignancy [1]. The multiscale, multistage, highly nonlinear nature of cancer progression [2] calls for a dual modelling approach that can link continuous tissue-level spatiotemporal patterns with discrete cell-level adaptations at the tumour-host interface. Of particular interest is the acid-mediated invasion hypothesis [3], which suggests that tissue hypoxia, adoption of the glycolytic phenotype [4], and acquisition of resistance to acidic byproducts of the glycolytic phenotype comprise a critical stage in tumour progression. Many open questions remain concerning the details of this hypothesis and how it fits into the somatic evolution of cancer, illustrating just one of many research avenues for modelling the somatic evolution of cancer in general. We have generalised an existing continuum model of the acid-mediated invasion hypothesis [5] by considering additional, potentially important, biological features of cancer invasion, such as realistic acid-induced cellular death terms and cellular competition. Using both analytical and numerical methods, we firstly explore how a wave of tumour cell invasion is influenced by the acquisition of acid resistance, with further studies investigating parameter sensitivity and the impact of modelling invasion with more than one spatial dimension.

References

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