

Tumor angiogenesis and vascular patterning: a mathematical model

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Abstract-

Understanding tumor induced angiogenesis is a challenging problem with important consequences for diagnosis and treatment of cancer. Recently, strong evidences suggest the dual role of endothelial cells on the migrating tips and on the proliferating body of blood vessels, in consonance with further events behind lumen formation and vascular patterning. In this paper we present a multi-scale phase-field model that combines the benefits of continuum physics description and the capability of tracking individual cells. The model allows us to discuss the role of the endothelial cells's chemotactic response and proliferation rate as key factors that tailor the neovascular network. Importantly, we also test the predictions of our theoretical model against relevant experimental approaches in mice that displayed distinctive vascular patterns. The model reproduces the in vivo patterns of newly formed vascular networks, providing quantitative and qualitative results for branch density and vessel diameter on the order of the ones measured experimentally in mouse retinas. Our results highlight the ability of mathematical models to suggest relevant hypotheses with respect to the role of different parameters in this process, hence underlining the necessary collaboration between mathematical modeling, in vivo imaging and molecular biology techniques to improve current diagnostic and therapeutic tools.

Index Terms-

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