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Multiscale Modeling of Cell Interaction in Angiogenesis: From the Micro- to Macro-scale SAMARA PILLAY, PHILIP MAINI, HELEN BYRNE, University of Oxford — Solid tumors require a supply of nutrients to grow in size. To this end, tumors induce the growth of new blood vessels from existing vasculature through the process of angiogenesis. In this work, we use a discrete agent-based approach to model the behavior of individual endothelial cells during angiogenesis. We incorporate crowding effects through volume exclusion, motility of cells through biased random walks, and include birth and death processes. We use the transition probabilities associated with the discrete models to determine collective cell behavior, in terms of partial differential equations, using a Markov chain and master equation framework. We find that the cell-level dynamics gives rise to a migrating cell front in the form of a traveling wave on the macro-scale. The behavior of this front depends on the cell interactions that are included and the extent to which volume exclusion is taken into account in the discrete micro-scale model. We also find that well-established continuum models of angiogenesis cannot distinguish between certain types of cell behavior on the micro-scale. This may impact drug development strategies based on these models.

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