Discrete Markov Chains: A Novel Approach to Tumor Angiogenesis

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Angiogenesis, the development of new vasculature, is a critical process in the growth of new tumors. Driven by a goal to understand this aspect of cancer proliferation, I developed a discrete computationally optimized mathematical model of angiogenesis that specializes in intercellular interactions. Using parameters calculated through Sensitivity Analysis and experimentally observed data, I modeled vascular endothelial growth factor spread and dynamics of endothelial cell movement in a competitive environment.   Simulation testing yields the critical limits of angiogenesis to be 102 um and 153 um respectively, beyond which angiogenesis will not successfully occur. Cell density in the surrounding region and the concentration of extracellular matrix fibers are also found to directly inhibit angiogenesis. Through these three factors, I postulate a method for establishing criticality of a tumor based upon the likelihood of angiogenesis completing.   This research expands on other work by choosing factors that are patient-dependent through an specialized Cellular Potts model , which serves to optimize and increase accuracy of the model. By doing such, this model establishes a theoretical framework for analyzing lesions using angiogenic properties, with the ability to potentially compute the criticality of tumors with the aid of medical imaging technology.

Awards Won:

Third Award of $1,000