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Immune Modulation of Tumor Growth Through Inflammation and Predation

Cancer cells can elicit an immune response in the host, which is generally tumor-suppressive, but for weak responses may actually be tumor-promoting. We propose that this complex dynamic may be understood as a process of immune stimulation by the tumor, followed by cytotoxic targeting by the immune cells, which acts to alter tumor size and growth characteristics and subsequent immune stimulation. Just how these influences interact has complex implications for tumor development and cancer dormancy.

To show this, we have developed a two-compartment model consisting of a population of cancer cells and a population of immune cells. The model incorporates the combined effects of the various immune cell types, exploiting general principles of self-limited logistic growth and the physical process of inflammation, which, as will be discussed, may be either tumor-promoting or tumor-inhibiting.

A Markov chain Monte Carlo method is used to determine parameter sets that predict tumor growth equally well, but at the same time also predict fundamentally different underlying dynamics. The results underscore the ultimately polar nature of final tumor fate (escape or elimination), while at the same time showing how persistent regions of near-dormancy may precede either of these two outcomes.

Another important finding is that near- and long-term responses of a tumor to immune interaction may be opposed; that is to say, a response dynamic that appears to be more promoting of tumor growth than another in the near term may be superior at curtailing tumor growth in the long-term, even to the point of establishing dormancy while the other allows for tumor escape.

The striking variability observed even in this simple model demonstrates the significance of intrinsic and unmeasurable factors determining the complex biological processes involved in tumor growth in an immune competent host. Consequences and biological interpretations of this work will be discussed in terms of treatment approaches that exploit immune response to improve tumor suppression, including the potential attainment of an immune-induced dormant state.