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# MODELING MECHANOBIOLOGY OF TUMOR DEVELOPMENT AND TREATMENT

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## ABSTRACT

Cancer is a complex disease process that involves multiple spatial and temporal scales. Cancer cells are often characterized by genetic mutations, changes in signaling pathways and cell-cell interactions. However, in order to develop a tumor, the cells must combine intracellular changes with mechanical processes that enable its expansion, exerting forces on other cells, migration, remodeling of cell microenvironment and distant tissue colonization. Driven by cutting-edge mathematical models, in silico oncology provides powerful tools to investigate various aspects of cancer development at various levels (genes, cells, tissue). In particular, the tumor microenvironment plays an important role in the regulation of whole tumor dynamics, from initiation to therapeutic response. Mathematical modeling is playing an increasingly important role in identifying the core dynamics of tumor growth, assessing hypotheses on the potential underlying key mechanisms, and generating new therapeutic strategies for various stages of cancer.

In this special session, we will see high-quality interdisciplinary collaborations between mathematical oncologists and experimentalists. The topic will cover a broad range of studies that deal with cancer dynamics and recent advances in mathematical oncology, from investigating the fundamental mechanisms of cancer biology to the application of state-of-the-art therapeutic interventions. We will discuss mathematical models that analyze, for example, the nonlinear mechanical behaviors of tumor growth, inter- or/and intra-cellular dynamics, angiogenesis, interactions between stromal cells and cancer cells, role of the microenvironment in regulation of cancer progression, cancer cell invasion, the role of the immune system etc., and therapeutic strategies applied across a broad range of cancers.

For example, tumor spheroids grown in vitro have been widely used as models of in vivo tumor growth because they display many of the characteristics of in vivo growth, including the effects of nutrient limitations and the effect of stress on growth. There are numerous biochemical and biophysical processes involved whose interactions can only be understood via a detailed mechanical mathematical model. The mathematical model may

have a continuum description or a cell-based description, or hybrid approach that incorporates both continuum and cell-level descriptions. The cellular description of the model allows us to examine the effects of cell–cell adhesion, mechanical stress (compressive or tensile) and variable growth rates. We will discuss how the models can predict a number of cellular behaviors that have been observed experimentally.