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COLLOQUIUM

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Cancer Metastasis as a Mathematical Rare Event?

The Role of Nanomechanics

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Abstract

Randomness and noise are inherent in biological systems such as cancer. A particularly striking example is the apparent randomness of the metastatic process. Out of billions of cells in a typical tumor, only a very small percentage, if any, will succeed in establishing a metastatic site from which a secondary tumor can form. What governs these rare events of successful metastasis? After decades of work, traditional biochemistry and genomics approaches studies still have not fully explained the metastatic mechanism. Intracellular mechanics are one metastatic driver that shape every step of the metastatic process. Uniquely, our strategy for analyzing metastasis links all metastatic stages via a combined experimental/computational approach. In physics and statistics, rare events have been described mathematically by a concept called 'large deviation theory' (LDT) that has been successful in describing the statistics of events such as floods, earth-quakes, and extinctions. Based on LDT, we posit that the probability of 'successful' metastasis is exponentially sensitive to variations in the mechanical properties of the cancer cell cytoskeleton. We measure the mechanical properties via a unique nanomechanical imaging approach that we will describe in this talk, the data from which is designed to be used as inputs to the LDT model. Because metastasis cause 90% of cancer patient deaths and morbidity, cells with an increased risk of metastasis would become a primary first line target.