Biology and Medicine Through Mathematics Conference

2022

May 19th, 3:30 PM - 4:00 PM

A mathematical model of microtubule assembly and polarity in dendrites

Anna Nelson
Duke University, anelson@math.duke.edu

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March 14, 2022

In neurons, the microtubule cytoskeleton is responsible for long-range and long-term intracellular transport of mRNAs and proteins. Microtubules, comprised of tubulin dimers, are defined by their polarity and their highly dynamic assembly process, where each end of the microtubule can grow and depolymerize by stochastically switching between states of catastrophe and growth. The polarity and overall dynamics of neuronal microtubules are known to be stable throughout a lifetime. For example, the microtubules in the dendrites of *Drosophila* fruit flies are almost all minus-end-out and the axonal microtubules are plus-end-out. However, microtubule orientation and dynamics can change in the event of injury, and microtubule growth and catastrophe are known to be dependent on available tubulin. To understand how what mechanisms control the equilibrium microtubule length, we propose a stochastic mathematical model of individual microtubule growth and catastrophe using parameters informed by experimental data. Several biologically relevant mechanisms are explored in the model, including availability of tubulin in the cell, dependence of catastrophe events on the microtubule length, and how severing proteins regulate microtubule length. This work is in close collaboration with biological experimentalists and fluorescence microscopy experiments are used to validate and support such mechanisms.