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Kinetic Proofreading of Cytoskeletal Structures DOUGLAS SWANSON, NED WINGREEN, Princeton University — Cytoskeletal polymer dynamics play a role in cellular processes as varied as reproduction, locomotion, and intracellular transport. Microtubules are cytoskeletal biopolymers that grow by accumulating tubulin subunits bound to guanosine triphosphate (GTP). The subunits hydrolyze GTP to guanosine diphosphate (GDP), causing a conformational change in the protein that destabilizes the microtubule. GDP-bound subunits tend to depolymerize, leading to stochastic microtubule disassembly in a process known as dynamic instability. Over time polymerization and depolymerization come to steady state, leading to a local steady-state concentration of tubulin subunits. This may be viewed as a kind of "kinetic proofreading," in which the system consumes energy actively to "proofread" the steady-state subunit concentration. We suggest that the same mechanism could also "proofread" between different cytoskeletal structures. For example, we show that a small free-energy difference between two polymer orientations, combined with dynamic instability, can strongly drive the system towards the lower free-energy state. This might help to explain the long-time stability of many cytoskeletal structures despite the short-time rapid turnover of the individual subunits.

Douglas Swanson
Princeton University

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