Microtubules are not like other polymers. Whereas polymers such as F-actin will grow continuously as long as the subunit concentration is high enough, a steadily growing microtubule can suddenly shrink even when there is ample αβ-tubulin around. This remarkable behavior was discovered in 1984 when Tim Mitchison and Marc Kirschner deduced that microtubules switch from growth to shrinkage when they lose their GTP caps. They called this switching behavior dynamic instability. Dynamic instability became a foundation of cell physiology; upon it we have built our explanations for how dividing cells segregate their chromosomes, how fibroblasts migrate into wounds during healing, and how neurons extend their axon and dendrites. In this talk, I will describe my lab’s recent efforts to understand the molecular basis of dynamic instability.