Abstract

The timing of key events in the eukaryotic cell cycle is remarkably stochastic. Special attention had been paid to the START transition, when the cell starts to synthesize DNA. Experiments have shown that START in budding yeast proceeds in two distinct steps, both of which are stochastic. We therefore generalized earlier work and studied a model in which the cycle has two parts, the durations of both of which are assumed to be random and independent. We find a stability condition on their distributions: For the distribution of cell sizes be stable in the limit of many generations, all moments of both distributions must be finite and the sum of the mean durations must be less than the cell-size doubling time. When these conditions are satisfied, the asymptotic size distribution has inverse-power-law form and we derive an equation for the exponent.

In our current work, we are taking a closer look at the cellular reactions responsible for the stochasticity in these and similar transitions. Their dynamics can be described by stochastic differential equations, allowing us to write a path-integral representation for the transition rate. When this rate is small, we can evaluate it for a model in which mRNA lifetimes are much shorter than protein ones and a key protein feeds back to promote transcription of its own DNA (as is known to happen at START).