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A signals-and-systems approach to the biology of osmo-adaptation in budding yeast

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Abstract

The propagation of information through signaling cascades spans a wide range of time-scales, including the rapid ligand-receptor interaction and the much slower response of downstream gene expression. To determine which dynamic range dominates a response, we use periodic stimuli to measure the frequency dependence of signal transduction in the osmo-adaptation pathway of Saccharomyces cerevisiae. We apply system identification methods from control engineering to infer a concise predictive model. We find that the dynamics of osmo-adaptation is dominated by a fast-acting negative feedback through the kinase Hog1 that does not require protein synthesis. At elevated osmo-shocks an additional, much slower, negative feedback through gene expression allows cells to adapt faster to future stimuli.