A Single-Molecule View of Biological Action at a Distance

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BOTH proteins and DNA can suffer extensive deformation and conformational changes as part of their normal function. For example, transcriptional regulation can involve the binding of transcription factors at sites on the DNA that are not immediately adjacent to the promoter of interest. This action at a distance is often mediated by the formation of DNA loops: Binding at two or more sites on the DNA results in the formation of a loop, which can bring the transcription factor into the immediate neighborhood of the relevant promoter. We have been conducting a three-pronged attack on these problems using a combination of statistical mechanical modeling, single-molecule biophysics experiments and single-cell studies of gene expression in living cells. The aim of this work is to demand a detailed quantitative analysis of the ability of simple models of gene regulation to account for both biochemical and in vivo observations.