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Multi-scale Modeling of Chromosomal DNA in Living Cells[1]

ANDREW SPAKOWITZ, Stanford University

The organization and dynamics of chromosomal DNA play a pivotal role in a range of biological processes, including gene regulation, homologous recombination, replication, and segregation. Establishing a quantitative theoretical model of DNA organization and dynamics would be valuable in bridging the gap between the molecular-level packaging of DNA and genome-scale chromosomal processes. Our research group utilizes analytical theory and computational modeling to establish a predictive theoretical model of chromosomal organization and dynamics. In this talk, I will discuss our efforts to develop multi-scale polymer models of chromosomal DNA that are both sufficiently detailed to address specific protein-DNA interactions while capturing experimentally relevant time and length scales. I will demonstrate how these modeling efforts are capable of quantitatively capturing aspects of behavior of chromosomal DNA in both prokaryotic and eukaryotic cells. This talk will illustrate that capturing dynamical behavior of chromosomal DNA at various length scales necessitates a range of theoretical treatments that accommodate the critical physical contributions that are relevant to in vivo behavior at these disparate length and time scales.

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