

Stochastic Model of Supercoiling-Dependent Transcription

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We propose a stochastic model for gene transcription coupled to DNA supercoiling, where we incorporate the experimental observation that polymerases create supercoiling as they unwind the DNA helix and that these enzymes bind more favorably to regions where the genome is unwound. Within this model, we show that when the transcriptionally induced flux of supercoiling increases, there is a sharp crossover from a regime where torsional stresses relax quickly and gene transcription is random, to one where gene expression is highly correlated and tightly regulated by supercoiling. In the latter regime, the model displays transcriptional bursts, waves of supercoiling, and up regulation of divergent or bidirectional genes.

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