

DNA supercoiling-transcription interplay in eukaryotes

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RNA polymerase (RNAP) translocation during transcription is accompanied by positive supercoiling (overtwisting) of the downstream DNA and negative supercoiling (untwisting) of the upstream DNA. The resulting DNA torsional response can slow down the RNAPs. In eukaryotes, this torsional response is modified by the presence of nucleosomes: each nucleosome stores negative writhe and can thus buffer the torsional response to positive supercoiling. Additionally, nucleosomes present steric hindrance to RNAP movement. The competition between these two effects is likely to determine the transcription dynamics in eukaryotes. Here, we calculate the DNA torsional response as a function of the nucleosome density and, incorporating it into a previously described model of the transcription-supercoiling interplay, show that the buffering of the DNA torsional stress by nucleosomes can speed up RNAPs, despite the steric hindrance. The effect of steric hindrance can, however, dominate at low nucleosome turnover to slow down transcription. Overall, we present a mechanistic description of the supercoiling-transcription interplay in eukaryotes.