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Dynamics of DNA in vitro and in vivo

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While the structure of DNA has reached iconic status, its dynamics are equally important for its biological function. The thermal fluctuations of DNA gives rise to fundamental properties, such as its entropic elasticity, and enable many biological functions like the formation of regulatory DNA-protein complexes. More recently, evidence is emerging that active, ATP-hydrolysis driven processes also contribute to the motion of DNA in vivo. These active processes can enhance the efficiency of self-assembly processes involving DNA quite substantially. In a living cell, on the other hand, the motion of the DNA is severely constrained by numerous topological barriers, like supercoiling and protein binding, which in turn can locally enhance, but globally restrict the formation of regulatory DNA-protein complexes. In my talk I will review the dynamics of DNA and the interplay between thermal fluctuations, active processes, and topological constraints in the context of in-vitro experiments with optical tweezers, and in-vivo studies of the bacterial chromosome using fluorescence techniques, and interpret the results in the framework of statistical mechanics and polymer physics.