ABSTRACT

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Deoxyribonucleic acid (DNA) is the carrier of all genetic information within a cell. Within eukaryotic cells DNA is efficiently packed into chromatin through the formation of a complex of DNA and histone proteins. This complex is called chromatin. Because of the formation of chromatin, DNA is extraordinarily condensed in eukaryotic cells. This condensation leads to a very limited resolution of optical techniques that investigate the structure and function of DNA by attaching fluorescent markers. It would thus be of considerable utility to develop a method for stretching chromatin to a predictable extension, so that a direct relationship between base pair number and spatial location is obtained. Such methods exist for bare DNA, but not chromatin.

In this dissertation I investigate methods for stretching chromatin using surface and nanofluidic stretching. In the former, chromatin is electrostatically attached to a positively charged surface. In the latter, chromatin is confined to channels about 100 nm in diameter, and hundred of microns long. I find that nanofluidic stretching leads to a more homogeneous stretching of chromatin when compared to surface stretching. Physical models were evaluated for the description of the stretching process. I find that the classical worm-like chain model yields qualitatively correct predictions, but a quantitative treatment is limited by the knowledge about the mechanics of chromatin.

My results indicate that nanofluidic stretching of chromatin may become useful for future studies that aim to directly image epigenetic modifications on chromatin molecules.

The Nanofluidic Analysis of Chromatin

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