UCLA ENGINEERING
Chemical and Biomolecular Engineering

SEMINARS IN CHEMICAL AND BIOMOLECULAR ENGINEERING

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Presented by:
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"Self Assembly with DNA: from materials design to chromatin"

The ability to engineer the self-assembly of nano-scale objects to create highly ordered materials is of considerable scientific and practical interest. This new class of materials represents a powerful approach for engineering a next generation of devices, whose mechanical, optical, and electrical properties can be precisely tuned at the molecular scale. Though significant strides towards this goal have been achieved in recent years, the complexity achieved in engineered systems is still far surpassed by that achieved by nature. Precise self-assembly is achieved by nature through proteins and nucleic acids that fold into intricate, three-dimensional, and importantly, functional structures. A promising avenue towards improved engineered systems is to draw on discoveries from biophysics in order to inspire new approaches and paradigms for self-assembly and materials design.

In this talk, I explore the interplay between biophysics and engineering in the context of DNA self-assembly. We begin at the smallest length-scales of DNA, first by understanding the hybridization of DNA, and then at how hybridization can be used in materials to direct the self-assembly of gold nanoparticles. We report evidence of a tunable mechanical response in these assemblies, thereby suggesting the possibility of mechanical meta-materials constructed using DNA. Our discussion then proceeds to larger length scales, where we examine the biophysical processes that control the compaction of DNA into chromatin. Using a detailed molecular model, we explore the free energies and dynamics of smallest building block of chromatin, a protein-DNA complex called the nucleosome. Our results are in quantitative agreement with existing experimental measurements, and help to explain the molecular factors that dictate the first stages of DNA compaction into chromatin. Lastly, we present a multi-scale approach that can couple information across different length scales of chromatin in order to examine the folding of large regions DNA. By drawing on both the biophysics and engineering literature, the findings presented here suggest new approaches for materials design, and offer new paradigms for synthetic systems that seek to mimic the complexity achieved by nature.

Joshua Lequieu received his B.S. in Chemical Engineering from Cornell University, and his Ph.D. in Molecular Engineering from the University of Chicago under the guidance of Juan J. de Pablo. He is currently a Postdoctoral Researcher with Glenn H. Fredrickson at University of California -- Santa Barbara working on block polymer self-assembly.