IMPRS on Multiscale Biosystems

Title: Optically controlled DNA compaction/decompaction

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Project description: The transport of DNA through a membrane into a cell is the key step in gene therapy. Today, mostly "functionalized" viruses are used to deliver a gene vector into a target cell. Considering the risks of this procedure, new strategies for gene delivery are called for. We aim at devising methods to transform DNA polymers into compact coils that can penetrate a cell membrane without the need for a container. In principle, compaction can be achieved by decorating the DNA strand with a suitable surfactant (Figure 1). We have shown that when properties of the surfactant can be switched back and forth between "more hydrophilic" and "mostly hydrophobic", a corresponding transition between compacted state and decompation (elongated states) can be achieved.[1]

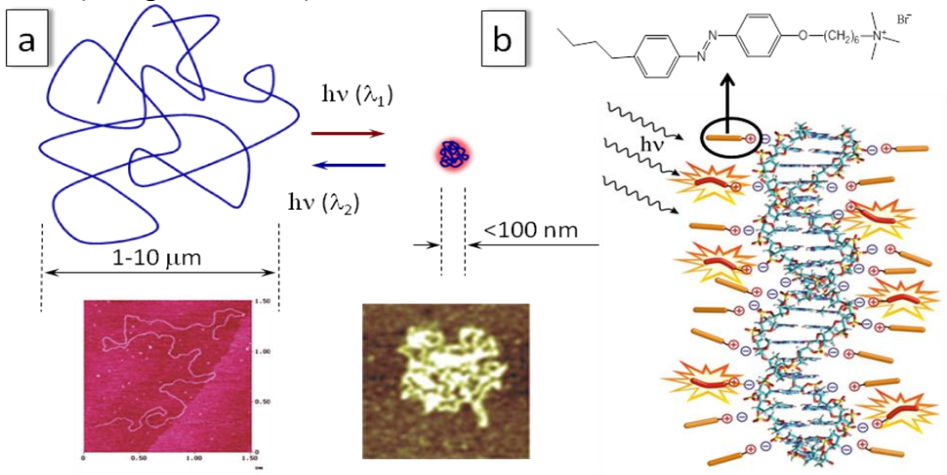

Figure 1. (a) Cartoon of the coil-globule transition induced by light. Atomic force microscope (AFM) micrographs of the corresponding conformations of DNA molecule. (b) Scheme of the DNA-photosensitive surfactant complex.

The prospective student will characterize the transitions from the loose coil state to the compact globular shapes by state-of-the-art experimental methods. He or she will learn how to modify the "design" of the surfactant with advanced synthesis protocols. Its optimization will be guided in selected cases also computationally. Does a new side group affect the solubility? Will compaction run faster? Is it necessary to change the wavelength of the stimulus? Atomistic modeling techniques are important tools to complement the intuitive understanding of molecular scale processes.

Required background: The potential student should have a background in physical chemistry, with a potential slant on theoretical methods.
Paper to read before the interview:

1. Santer, S. et al.«DNA compaction by azobenzene-containing surfactant» *Phys Rev E*, 84 (**2011**) 021909

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