

Title: Condensation transition in DNA-PAMAM dendrimer fibers studied using optical tweezers

Authors: F. Ritort(1), S. Mihardja(2), S. B. Smith(2) and C. Bustamante (2)

Addresses: (1) Departament de Física Fonamental, Facultat de Física, Universitat de Barcelona, Diagonal 647, 08028 Barcelona (Spain)

(2)Department of Physics, University of California, Berkeley, CA94720, USA

E-Mail: ritort@ffn.ub.es

Abstract:

In eukaryotes, the DNA is compacted in a complex nucleoprotein structure known as chromatin. Condensation of the DNA into chromatin, which mainly involve histone proteins (i.e. histone octamer complex and linker histones), is recognized to be an important mechanism in protecting the genetic information from external factors, as well as storing the long DNA into a compartment with dimensions on the order of microns [1]. Polyamidoamine (PAMAM) dendrimers are unique polymers with a defined spherical structure [2]. At physiological pH conditions, PAMAM dendrimers are positively charged and are thus able to interact electrostatically with DNA [3]. In vitro experiments have shown that dendrimers can efficiently transfer genetic material through cell membranes in a variety of mammalian cell lines. When mixed together, DNA and polyaminoamide (PAMAM) dendrimers form fibers that condense into a compact structure. We use optical tweezers [4] to pull condensed fibers and investigate the decondensation transition by measuring force-extension curves (FECs). A characteristic plateau force (around 10pN) and strong hysteresis between the pulling and relaxation cycle are observed for different dendrimer sizes, indicating the existence of a transition between two phases (condensed and extended) of the fiber. The dependence of the FECs on the condensation protocol and the fact that dendrimers do not detach off the DNA during the pulling cycle shows that dendrimers remain non-specifically and irreversibly bound on the DNA backbone. Upon salt variation FECs change noticeably confirming that electrostatic forces drive the condensation transition. Finally, we propose a simple model for the decondensing transition that qualitatively reproduces the FECs and which is confirmed by AFM images.

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