Biomolecules under mechanical force

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Abstract

Recent advances in single molecule experiments have raised many challenges. These challenges can be met by a proper understanding of the inter- and intra-molecular interactions in the framework of physics followed by suitable theoretical models substantiated by extensive numerical simulations. In this review, we briefly discuss experimental, theoretical and numerical techniques used to examine the dynamics of biomolecules under the application of external mechanical force. We focus on issues which require special attention: the relationship between the mechanical stability of a protein and the secondary structure of its native conformation, the dependence of the free energy landscape on the pulling direction and secondary structure content, unfolding of a protein through a pore, protein re-folding under quenched force etc. We pay special attention to a single stranded DNA, where the force-extension curve shows the multi-step plateau for the chain made up of adenine while poly-thymine exhibits entropic response only. There are many interesting predictions related to unzipping of double stranded DNA, e.g. re-entrance in the force-temperature phase diagram, existence of an "Eye-phase", effects of random disorder etc. based on model studies which require further investigation. We will also discuss cases where the theoretical descriptions of the models fail to explain the experimentally observed behavior and when further refinement is needed in order to describe the outcomes of the experiments. Finally we suggest certain experimental protocols to observe theoretical predictions *in vitro*.