BIOMATERIALS

Forces in Biomolecular Systems SFB 863

The mechanical genome

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Abstract:

DNA of eukaryotes (animals, plants, fungi) is organized by being wrapped around protein cylinders to form fundamental packaging units: the nucleosomes. Since this means that the DNA is strongly bent, the positions of the nucleosomes are largely determined by the mechanical properties of the underlying DNA sequence. This has been referred to as the "nucleosome positioning code" by the late Jonathan Widom. However, it is still an open question whether the positioning of nucleosomes is merely a side product of the mechanical properties of given DNA sequences (e.g. that of genes) or whether positioning is the product of a mechanical evolution of DNA molecules. Here we provide evidence for the latter scenario. Using a computational nucleosome model we first demonstrate the theoretical possibility of multiplexing classical and mechanical genetic information. We explain that the natures of DNA elasticity, of the genetic code and of the biological base pair sequences come together in such a way that multiplexing can occur in real genomes. In a second step we show that two yeast genomes show mechanical codon biases which give evidence for a nucleosome positioning signal multiplexed with genes. This suggests that the exact positions of nucleosomes play crucial roles in the gene regulation of these organisms. Our findings show how two levels of information can be encoded independently along one and the same DNA sequence suggesting parallel evolutions in genomes.

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