DNA nanopores as tunable detectors

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DNA nanotechnology [1-3] has shown that the self-assembly properties of nucleic acids open many possibilities to design molecular devices, including motors and logic circuits.This paper focuses on DNA nanotubes [4], made of a small number (~20) single stranded that self-assemble into intertwined helices. The formation of a correct structure requires an annealing process, which removes unwanted alternative pairings. The interest of these nanotubes is the possibility to tune their geometric properties, such as width and length, in response to exterior inputs. Their typical length (~15nm) and width (~6nm) make the detection of geometric changes quite difficult. In this talk, I describe nanotube modifications that allow their insertion into lipid bilayers. Measurement of current across a stable bilayer can detect insertion and desorption of single DNA nanopores with typical values of conductivity in the range of 1.5 to 2nS, which correspond to current jumps of ~50pA for 30mV difference of potential. Two difficulties need to be solved in this process. First, hydrophobic modifications of DNA nanotubes create an amphipatic object with some tendency to aggregation. Furthermore, the number of modifications determines the degree of insertion. In other words, low degree of insertion means low level of detection. To solve this issue, we have considered insertion of the nanopore into a flat DNA platform, which allows to significantly increase the number of possible hydrophobic modifications. Second, the interaction with an external input (in our case an oligonucleotide) needs to trigger a conformational change with detectable electric signature. I will discuss different strategies [5] to tackle this question. Finally, aptamers can also be interfaced with DNA nanotubes to expand the possible range of inputs.

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