

Conformationally Selective Electronic Energy Transfer from the Natural Bases to 2-Aminopurine in DNA

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Absorption of ultraviolet radiation by DNA usually results in ultrafast non-radiative decay and harmless dissipation of the energy as heat. However, on rare occasions, photoexcitation results in DNA damage (mutation). It is well established that the major damage occurs in the form of pyrimidine dimers, but some pyrimidine sites are more susceptible to damage than others. Electronic energy transfer along the DNA duplex may be important in concentrating excitation energy at mutational hotspots.

The study of energy transfer in DNA is inhibited by the extremely low fluorescence quantum yields of the bases and the similarity of their absorption spectra. The introduction of 2-aminopurine (2AP), a fluorescent analogue of adenine,^[1] as an acceptor, enables inter-base energy transfer to be studied by conventional fluorescence measurements. Previously, Nordlund and coworkers used steady-state fluorescence spectroscopy of 2AP to study energy transfer in a variety of single- and double-stranded DNA oligomers and concluded that energy transfer from adenine to 2AP is much more efficient (by an order of magnitude) than transfer from the other bases.^[2]

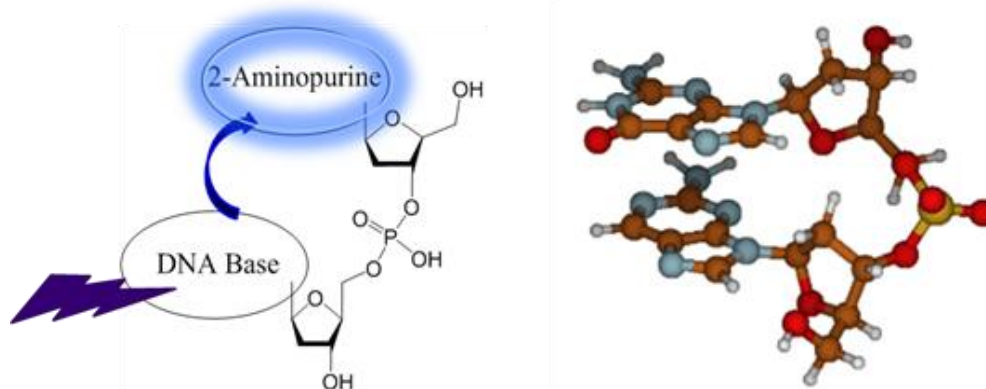


Figure 1. Electronic energy transfer from a natural base to 2-aminopurine in DNA dinucleotides selectively excites well-stacked conformations.

We have used time-resolved fluorescence spectroscopy to probe energy transfer from the natural bases to 2AP in dinucleotides and oligonucleotides. We find that excitation of 2AP indirectly, via energy transfer, results in different fluorescence decay characteristics from those observed when 2AP is excited directly. This reveals that energy transfer results in the preferential excitation of conformational states in which 2AP is highly stacked with its neighbouring bases (Figure 1).^[3] These states are characterized by short fluorescence lifetimes (< 100 ps) and low quantum yields (<0.01). Consequently, previous steady-state measurements, which have assumed that the fluorescence quantum yield of 2AP in oligonucleotides is independent of the excitation pathway, have substantially underestimated energy transfer

efficiencies. We will report a re-evaluation of energy transfer efficiencies between the natural bases and 2AP, in 2AP-containing dinucleotides, and discuss the influence of conformational dynamics on energy transfer in DNA.

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References:

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