Helix formation of oligodeoxyribonucleotides containing base-aromatic ring conjugates

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ABSTRACT

Novel nucleoside analogues with base moieties containing pyrene groups have been synthesized and incorporated into oligodeoxyribonucleotides (ODNs). ODNs containing tandem pyrene residues at the 5'-end gave fluorescence spectra characteristic of eximers that were diminished by duplex formation of the ODNs with complementary strands.

INTRODUCTION

The stacking interaction as well as hydrogen bond formation between nucleobases have been recognized as the major factors stabilizing duplex formation of nucleic acids. It has been reported that oligodeoxyribonucleotides (ODNs) containing nucleoside analogues carrying aromatic groups, instead of nucleobases, form stable duplexes and triplexes without forming hydrogen bonds. Recently, nucleoside-aromatic group conjugates (Fig. 1A) have been synthesized and incorporated into ODNs. Duplex and triplex formation of the ODNs containing the conjugates were stabilized, supposedly by stacking interactions between the aromatic groups and nucleobases as illustrated in Fig. 1B. In this report, the properties of ODNs containing multiple conjugates are described. If the conjugates are continuously connected, the aromatic groups may fall into line along the helical axis as illustrated in Fig. 1C. In such strings, the aromatic groups may interact with each other and show properties characteristic of cluster formation.

Figure 1. Schematic representation of the structure of the nucleoside-aromatic ring conjugates in DNA strands. A) Structure of nucleoside-aromatic group conjugates. B) The aromatic residue attached at the 5'-end of the duplex is stacked on the base pair. C) Supposed helical structure of contiguously connected conjugates.

Figure 2. The structure of the 2'-deoxyinosine-pyrene conjugate 1 and ODNs containing 1.
RESULTS AND DISCUSSION

Sequences of ODNs containing 2'-deoxyminosine-pyrene conjugate are shown in Fig. 2. Pyrene residues are located at the 5'-ends of ODNs, with two and three pyrene residues being contiguously connected in ODN-II and ODN-III, respectively. Fluorescence emission spectra of ODN-I were similar to pyrene monomer emissions (Fig. 3A). In contrast, excimer fluorescence became more significant in the di- and tri-pyrene–attached ODNs, ODN-II and ODN-III (Fig. 3B and C). Similar increasing excimer intensity, corresponding to the accumulation of continuous pyrene residues, was observed in a pyrene-conjugated peptide. Interestingly, the excimer emission intensity decreased with duplex formation (ODN-III – ODN-IV, Fig. 3D), thus the accumulated pyrene system can be used as a bio-sensor for detecting nucleic acids such as viral RNA.

REFERENCES