DNA nanostructures involving unusual structures:
i-motif and G-quadruplexes.

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Most DNA-based higher order structures are based on DNA duplexes stabilized by Watson-Crick base pairs. However, a number of non-classical pairing patterns are possible between or within DNA strands. These interactions result in the formation of unusual structures, among them G-quadruplexes and i-motifs (Fig. 1). These structures have clear advantages over conventional duplex DNA, such as enhanced thermal stability, conductivity, and sensitivity to chemical stimuli (for a review: (1))

G-quadruplexes (G4) are formed with G-rich DNA and RNA sequences. A major drawback of G4 designs is the lack of control over the assembly process. We recently provided solutions to this problem (2, 3). In addition, we designed biosensors based on G-quadruplex formation (4) and used G4 structures to control DNA origami operations (5). Finally, we recently demonstrated that G-rich DNA sequences may function as a double switch whose function is based on different triggers provided that their secondary (6).

The DNA i-motif is formed under slightly acidic conditions from cytosine rich DNA sequences. We have shown the formation of a "double quadruplex" structure with i-motif and G4 structures on the same strand. The structural switching can be employed as a NOTIF logic gate (7). I-motif DNA structures have actually been extensively used in the fabrication of nanodevices, biosensors and delivery systems, taking advantage of their exquisite pH-sensitivity. Using scaffolding templates, we provide evidence that i-motif can be formed at physiological pH, offering new perspective for the design of DNA-based pH-nanosensors acting in a physiological pH range.

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