Biochemistry

DEVELOPMENT OF A NOVEL DNA DUMBBELL AS A MOLECULAR WIRE

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DNA dumbbells were synthesized and ligated to develop a new design construct for molecular wires. The dumbbells contained the Drew-Dickerson stem sequence [d(CCAACGTTGG)] with four thymines in single stranded loops that covalently sealed the oligonucleotide. Modified bases were introduced to the interior positions of the loop to enable directed covalent attachment of gold and titanium dioxide nanoparticles to the DNA oligonucleotide. Hairpins with T_4 loops and complementary stem sequences were synthesized with a four base pair sticky end. The hairpins were mixed in equimolar concentration. The sticky ends were ligated with T_4 ligase. Gel purification was used after ligation to purify doubly ligated products. Carboxy-dT modifiers were synthesized into the hairpins at loop positions 2 and 3. Dithiol phosphoramidite (DTPA) modifiers were synthesized into the complementary hairpins also at loop positions 2 and 3. Structural features of these DNA dumbbells were examined by circular dichroism from 205 to 320 nm over the temperature range of 20° to 55° C in 5°C increments on a JASCO J-810 spectrophotometer. Additionally, DNA dumbbells were modeled with HyperChem version 5.0. The utility of these DNA dumbbells as molecular wires was developed through the directed attachment of metal nanoparticles with unique electronic signals. To this end, the DTPA modifiers were covalently attached to a gold nanoparticle. The free carboxylic acids on carboxy dT modifiers enable the covalent attachment of a TiO_2 via a dopamine linker. DNA dumbbells provide a novel construct for development of molecular wires.