Manipulating Matter on the Nanoscale: Incorporated Branched Junction Inside a DNA Tensegrity Triangle

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DNA-sequenced engineering of protein nucleants may reduce limitations associated with protein crystallization and structure determination for structure-based drug development. This project investigates a novel approach for maximizing the potential of nucleation via DNA triangle scaffolds which incorporate branched junctions. Branched junctions integrate two nucleation mechanisms, pore entrapment and electrostatic attractions, in addition to the mechanisms of biocompatibility and epitaxy inherent to DNA. Four versions of the junction-triangle structure were designed, differing in junction arm length varying from 4bp to 7bp. The structures were annealed from synthetic DNA, analyzed under native gel electrophoresis, and crystallized. Electrophoresis confirmed attachment of the junction and elucidated the 150bp band as the designed junction-triangle structure. Arm length exhibited positive correlation with both the 150bp band weight (R =.906) and the percentage of product for each structure within the 150bp band (R=.963), indicating greater structure formation for longer arm lengths. Crystals only formed for the 7bp structure, confirming the presence of an epitaxial mechanism not only for nucleation but also in organization of nuclei. Energy models of 4bp to 7bp structures created in the Nanoengineer program showed edge rigidity and supercoiling as major determinants in structure formation, dictated by arm length. Design, synthesis, and characterization of the junction-triangle structure with tuning stability by varying arm length can optimize engineered protein nucleants. Further investigation could allow for enhanced protein crystallization and structure determination essential for identification of suitable protein drug targets and development of highly-specific drugs.

Awards Won: