Breaking Symmetry: Synthesizing Asymmetrical DNA Motifs Revealing New Structural & Functional Properties

Karelic, Omer (School: Stuyvesant High School)

DNA nanotechnology is a rapidly developing field with broad applications in medicine and engineering. The field concerns itself with understanding DNA's structural applications through building crystal lattices out of base unit motifs constructed with DNA Oligonucleotide strands. Currently, research in the field focuses on symmetrical and pseudo symmetrical crystal motifs accounting for only a fraction of possible theoretical spatial combinations, avoiding geometrically asymmetrical base unit motifs. The motivation of this project is to expand the current understanding of DNA crystallography by exploring a new realm of crystal lattices: DNA crystals made out of base units with strands of varying lengths. This project found for the first time that asymmetrically coded motifs could crystallize. The study produced 146 clear crystals exhibiting robust and often novel spatial geometries. One experimental variation formed a novel crystal with cavities passing through it directionally which diffracted down to 5.9 Angstroms, proving robust crystal formation and indicating high crystal clarity. Producing these novel structures opens doors into further research of DNA nanotechnology's applications in the fields of medicine, optics, and data transmission. For instance, current dialysis treatments lack the ability to remove Protein Bound Uremic Toxins from the blood, leading to tissue degradation and further chronic issues. In this project, aptamers attached to the novel 'filter' crystal generated in the study could aid with active filtration of toxins in dialysis. These applications will be significant in understanding the molecular world to develop real-world therapeutics and solutions.

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