3D-NuS: A Web Server for Automated Modeling and Visualization of Non-Canonical 3-Dimensional Nucleic Acid Structures

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The inherent conformational flexibilities of nucleic acids (DNA, RNA, etc.) facilitate the formation of a range of conformations such as duplex, triplets, quadruplexes, etc., which play crucial roles in biological processes such as mismatch repair, replication, recombination, transcription, translation, gene regulations, etc. These unconventional base pairing and structural conformations on DNA/RNA structures at different sequence contexts also impose alterations in normal cell function which can lead to deformities and diseases (cancer, fragile X syndrome, etc.). To understand the role of these unusual nucleic acid structures in aforementioned biological phenomena and diseases, structural details at atomic level is indispensable. But, experimental methods (such as X-ray crystallography, NMR, etc.) are not always successful in determining structural details and are expensive. Further, structural insights about nucleic acid triplets, which are generally not tractable to structure determination by X-ray crystallography or NMR techniques, are essential to establish their biological functions. A web server, namely 3D-NuS (http://lith.ac.in/3dnus/), has been developed to generate energy minimized models of 80 different types of triplets, 64 types of G-quadruplexes, left handed ZDNA/RNA duplexes, RNA-DNA hybrid duplex along with inter- and intra-molecular DNA or RNA duplexes comprising a variety of mismatches and their chimeric forms for any user defined sequence and length. It also generates an ensemble of conformations corresponding to the modeled structure. These structures may serve as good starting models for docking proteins & small molecules with nucleic acids, NMR structure determination, cryo-electron microscope modeling, DNA/RNA nanotechnology applications and molecular dynamics simulation studies. The operational milestones that would be accomplished in future include generation of aforementioned structures with modified nucleic acids such as PNA and LNA, intra-molecular triplets, complex duplexes and models with user defined structural parameters.