Programmable rolling circle technique-based DNA architectures for biomedical applications

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Enzymatic amplification techniques such as rolling circle amplification or transcription (RCA or RCT) have allowed rapid synthesis and effective modification of DNA or RNA strands with specific sequences in aqueous media in a cost-effective way. In this work, we have shown a few compelling examples of using rolling circle techniques to develop new biosensors and to construct DNA-inorganic hybrid nanostructures for applications in drug delivery, biocatalysis, and bioimaging. Firstly, we adapted the RCA technique to transfer the target input into fluorescent output signals, achieving ultrasensitive and selective detection of nucleic acids. We also reported RCA-based strategies to synthesize multifunctional DNA constructs with increased biostability, facile attachment of biomolecules, and high payload capacity. Furthermore, we integrated two aptamers into RCA-based structures to fabricate an intracellular aptasensor nanoprobe, allowing ratio-metric measurements of a cytosolic analyte. Therefore, these designer platforms represent a promising opportunity to develop new functional materials that can substantially advance numerous applications of nucleic acids in biomedical research.