Aptamers in Electrochemistry: Expanding Horizons in Biosensing, Bioassays, and Electrocatalysis

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Abstract
This lecture highlights the remarkable potential of aptamers, short single-stranded nucleic acids or peptides, as molecular recognition elements in the field of electrochemistry. Aptamers have gained significant attention due to their high affinity, specificity, ease of synthesis, and stability. Their application as recognition elements in electrochemical sensors allows for selective binding to target analytes, enabling the detection and quantification of various molecules, including small molecules, proteins, toxins, and whole cells. This has led to the development of ultrasensitive biosensors for applications in clinical diagnostics, environmental monitoring, and food safety. In addition, aptamers have emerged as powerful tools in electrochemical bioassays, facilitating the study of biomolecular interactions and dynamics. By combining aptamers with advanced techniques such as impedance spectroscopy, cyclic voltammetry, and chronoamperometry, researchers can investigate binding kinetics, thermodynamics, and conformational changes, thereby gaining valuable insights into aptamer behavior and complex biological processes. The advantages of aptamers, such as reproducibility, low batch-to-batch variation, and ease of modification, make them highly promising in electrochemistry. However, careful consideration of optimal immobilization strategies and sample matrices is essential to ensure reliable results. Overall, this lecture emphasizes the significant impact of aptamers in electrochemistry, paving the way for sensitive detection, comprehensive biomolecular analysis, and the development of efficient electrochemical systems.