Nanobioconjugates for signal amplification in electrochemical genosensors

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Abstract

Nanobioconjugates are hybrid materials that result from the coalescence of biomolecules onto nanomaterials surfaces [1]. They have demonstrated the ability to dramatically increase the signal response of a biorecognition event when assembled in biosensors [2]. In this context, nanobioconjugates hold the potential to solve the limitations of conventional clinical assays in terms of analysis time, detection limits and costs. Biomolecules that integrate the nanobioconjugates include proteins, antibodies, aptamers, carbohydrates, and single and double DNA strands, among others. The use of a specific biomolecule depends on the biosensor application. For example, DNA is frequently used in the development of genosensors associated with pathogenic infections such as COVID-19 [3], Zika virus and other infections transmitted by vectors [4, 5], detection of bacteria, cancer biomarkers, among others [6]. Biomolecules are bounded to nanomaterials to build the nanobioconjugates, which are commonly assembled in biosensing platforms, either modifying the transducer or as a signaling tag, to enhance the signal response.

This work aims to show a general strategy for the design of a nanobioconjugate for the amplification of the electrochemical signal recorded in genosensors for the detection of viral infections. As a proof-of-concept, we developed an electrochemical sandwich-type biosensing platform for the differential detection of RNA of the Zika virus and its discrimination against Dengue and Chikungunya related arboviruses [4]. And a nanobioconjugate based on gold nanoparticles (AuNPs) and DNA where a ruthenium complex, intercalated in between the DNA strands, served as a signal electrochemical reporter [5]. The resultant nanobioconjugate increased the signal response of the electrochemical genosensor dramatically, allowing for the ultrasensitive detection of RNA of the Zika virus in real serum samples from infected patients in concentrations down to fM. The approach demonstrated to be useful for the detection of viral RNA levels of clinical relevance and holds the potential for the development of electrochemical biosensors to fight pandemics.

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