Graphene-Enhanced Electrochemical DNA Scaffold-based Biosensors for Point-of-Care Serology

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Abstract

In a globalised world, it is increasingly important to refine and simplify vaccination decision-making by providing reliable, cost-effective, and eco-friendly serological testing directly at the point of care (PoC). A particular focus has been on diseases such as measles, HAV, and dengue; the project aims to yield significant public health benefits, including creating personalised vaccination strategies, reducing patient wait times, and improving global health outcomes, especially in international travel medicine. This initiative presents a constructive approach to enhancing public health infrastructure and responsiveness in a rapidly changing global landscape.

Focused on detecting antibodies for vaccine-preventable diseases such as measles, hepatitis A (HAV), and dengue, several sensor approaches have been reported for electrochemical detection using DNA- based sensors (E-DNA).[1,2] By integrating a DNA scaffold modified with a redox reporter and specific epitopes, the project introduces a new methodology for antibody detection. In this system, when antibodies are absent, the redox reporter interacts freely with the electrode, generating a measurable electrochemical signal. However, the binding of antibodies to their target epitopes creates steric hindrance, which reduces the interaction between the reporter and the electrode, resulting in a detectable decrease in the signal. This streamlined, single-step diagnostic test is designed for implementation in international travel clinics, enabling efficient assessments of immune status that support targeted vaccination strategies while reducing dependence on conventional, time-consuming serological methods. In this work, a thorough analysis of the state of the art is reported to understand the most promising immunologic systems and the key open challenges for integration in PoC solutions.

References

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Figures

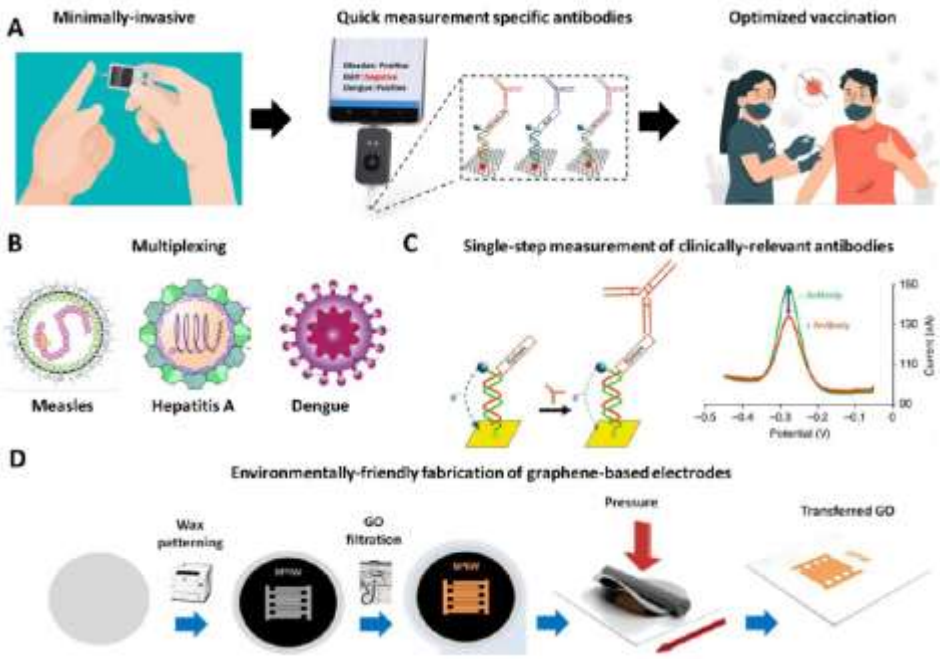

Figure 1: A) The SerDNA project aims to develop a rapid diagnostic test able to measure multiple clinically relevant antibodies at the point of care to optimise the vaccination of individual patients. B) We will target three vaccine-preventable diseases: Measles, Hepatitis A and Dengue. C) The sensing concept relies on the use of E-DNA scaffold sensors, given their ability to measure antibodies in a single step and in less than 5 minutes. D) In order to maximise the analytical performance of E-DNA scaffold sensors, they will be integrated into environmentally friendly graphene-based electrodes modified with nanoparticles synthesised for this specific project.