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ENGINEERING DNA-NANODEVICES FOR THE RAPID, SINGLE STEP DETECTION OF CLINICALLY RELEVANT ANTIBODIES

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DNA has the most predictable and programmable interactions of any natural or synthetic molecule. It shows unique binding specificity and thermodynamic stability, and it can be rapidly synthesized and modified using automated methods.[1] These features have revealed the unprecedented power in using DNA as a programmable material at the nanoscale. Recent advances in the field have demonstrated the unprecedented capability in using engineered nucleic acid nanodevices for various applications, including biosensing and molecular diagnostics.[3]

In this talk we will discuss different strategies to develop optical and electrochemical DNA-nanodevices for the rapid, single-step detection of clinically relevant antibodies. Antibody detection plays a pivotal role in the diagnosis of pathogens and monitoring the success of vaccine immunization. To allow early diagnosis, prompt therapeutic actions and efficient immune-based therapy monitoring antibodies detection methods should be sensitive, quantitative and specific but also rapid and easy to use. Unfortunately, however, current methods routinely used for this purpose in clinical settings either require reagent-intensive laboratory-based techniques (ELISA and other heterogeneous, sandwich-type assays), multiple time-consuming incubation steps (e.g Western Blot assay, radioimmunoassay), and/or sophisticated equipment (e.g. surface plasmon resonance).

Motivated by the above arguments, our journey through this topic will start with an optical nucleic acid-based platforms able to measure Immunoglobulins of type G and E (IgG and IgE) levels directly in blood serum and other bodily fluids in few minutes and without washing steps.[3-4] Our sensing strategies couple the advantages of target-binding induced co-localization and nucleic acid conformational-change nanoswitches. These platforms can be adapted to the detection of any antibody for which the recognition element (i.e. antigen) can be coupled to the nucleic acid anchoring strand. In the second part of the talk we will explore the translation of the optical sensing platform into an electrochemical format which allows both POC applications and large-scale analysis. Finally, we will discuss some clinically relevant applications, such as the monitoring of monoclonal antibody titers (i.e. Trastuzumab) in plasma samples of patients under breast cancer immunotherapy, and the immune response in HIV-infected patients under vaccine treatments.

References

[1] Seeman N. C., Sleiman H. F. DNA nanotechnology. Nat. Rev. Mat. 3, 2018, 17068.

[2] Ye D., Zuo X., Fan C. DNA nanotechnology-enabled interfacial engineering for biosensor development. Ann. Rev. Anal. Chem. 11, 171.

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[3] Porchetta A., Ippodrino R., Marini B., Caruso A., Cuccari F. and Ricci F. J. Am. Chem. Soc., 2018, 3, 947.
[4] Bertucci, A., Porchetta, A., Ricci, F. Antibody-templated assembly of an RNA mimic of green fluorescent protein. Anal. Chem. 2017, 90, 1049.