Empowering the genome, methylome and immune response with modern electrochemical biosensing: a new journey towards precision medicine

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The indisputable role played by genome, methylome and the immune system in the most prevalent diseases, such as cancer or neurodegenerative diseases, as well as in other unexpected ones, such as COVID-19, is clearer than ever. The interrogation of specific mutations and methylations in nucleic acids as well as the aberrant production of circulating immunoglobulins against self or external antigens associated with the onset and progression of cancerous, infectious and neurodegenerative diseases, among others, are considered highly predictable and valuable alarm signals about their triggering in the sophisticated machinery that makes up our organism. Moreover, since diseases are generally characterized by broad molecular marker profiles with considerable overlap between different diseases, the need for multiplexed molecular marker profiling approaches becomes particularly important.

Combining the unique opportunities offered by targeted proteomics for candidate antigen identification and state-of-the-art multiplexed electrochemical biosensing with the advantages of using magnetic materials and novel bioreceptors produced by modern technologies (HaloTag, Phase Display and targeted mutation), disruptive multiplexed and multi-omics technologies have been developed, allowing not only to discover but also to determine and evaluate the clinical potential of new molecular markers to advance both research and the implementation of precision medicine in cancer, Alzheimer's and viral infectious diseases. The biotools developed have allowed the detection of specific mutations and methylations in nucleic acids in cancers with high prevalence and mortality [1] and the discovery of new molecular signatures of autoantibodies against tumor antigens (circulating [2], exosomal [3] or proteoforms [4]) and against phage-display and aberrant peptides [5] for the early, accurate and minimally invasive diagnosis of colorectal cancer and Alzheimer's disease and of specific immunoglobulins against ectodomains of the SARS-CoV-2 spicule protein produced by targeted mutation [6]. The versatility of the latter bioplatforms to identify vulnerable populations from those with natural or acquired immunity, monitor infection, evaluate vaccine efficacy, and even identify the variant responsible for infection is remarkable.

The excellent results provided by the developed biotools, in terms of sensitivity, selectivity, ease of use and accessibility for all users, not only corroborate the potential genome, methylome and immune response-related molecular markers for advancing research and implementation of precision medicine but also reveal the great versatility and potential of the cutting-edge targeted proteomics-electrochemical biosensing-bioreceptor trio to provide relevant information on key aspects of known and unexpected diseases, as well as on their onset, severity and immune response, enabling their rapid, simple, affordable and precision management in diverse settings.

References

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