Advancing Cancer Detection: Harnessing Biosensors for Early Diagnosis

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Abstract

Cancer remains one of the most pressing global health challenges, with early detection being pivotal for effective treatment and improved patient outcomes [1]. To achieve this goal, we proposed a biosensor capable of detecting elevated cancer biomarkers in blood samples, specifically CEA and CA 19-9. For this purpose, we use previously developed, innovative graphene oxide chip technology functionalized with antibodies [2] to enable precise and efficient cancer marker detection. This biosensor platform utilizes changes in resistance as a means of detection, offering a highly sensitive and reliable method for identifying cancer biomarkers in blood samples. In this study, in the first stage, the reduced graphene (rGO) based biosensor has been successfully functionalized with CEA antibodies, demonstrating its sensitivity to CEA protein. Moreover, based on a linear detection response across a wide range, from 0.02 pg/mL to 200 ng/mL, The calculated limit of detection (LOD) for CEA protein is between 1 ng/mL and 1.4 ng/mL. Given that the normal reference range for CEA protein in blood is 0-2 ng/mL, with higher values potentially indicating abnormal conditions such as cancer, the limit of detection (LOD) of our biosensor is lower than this reference range, making it well-suited for effective use in practical, real-world applications. in the second stage, the rGO-based biosensor was modified to detect the CA 19-9 protein. The LOD for CA 19-9 is calculated to be 0.52 U/mL based on linear detection between 1.85 µU/mL and 37 mU/mL. Similarly to CEA, this LOD is lower than the normal reference range specified to be 37 U/mL for CA 19-9. The optimized biosensor exhibits high sensitivity and selectivity with an instant response in the ms range.
Ultimately, the successful development of this biosensor holds the potential to revolutionize cancer screening strategies by addressing critical unmet needs in the early detection and monitoring of various cancer types, offering patients and healthcare providers a reliable, non-invasive tool for timely intervention and improved patient outcomes.

References

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Figures

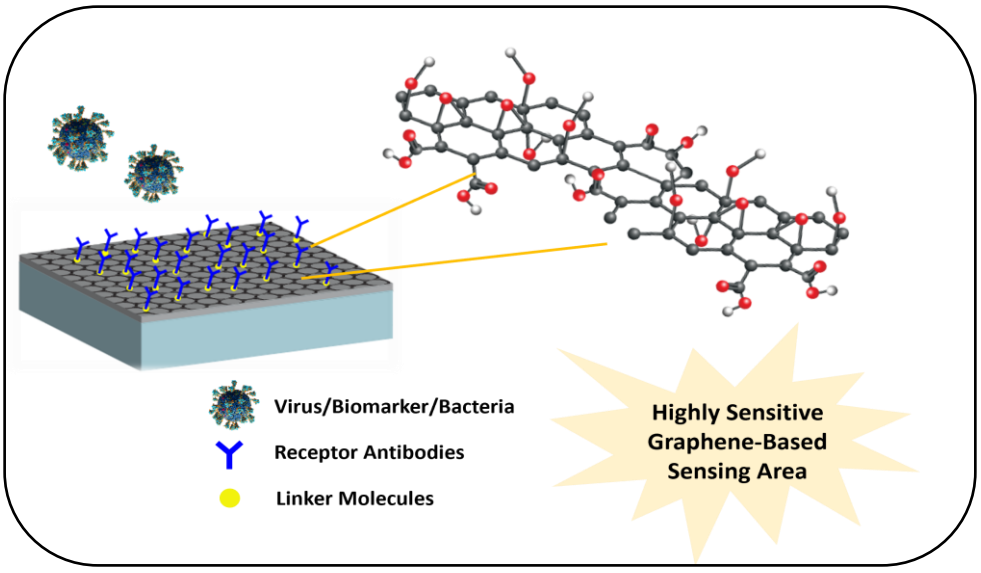

Figure 1: Biosensor schematic and principle based on antibodies immobilization into the reduced graphene oxide surface.