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Biocatalytic Sensors: Potentials, Maxims and Mechanisms for Optimal Performance

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Abstract

Biocatalytic sensors are devices which consist of bioactive functionally grafted layers of catalysts or analytical pieces which are in contact with transducers that help to convert biological signals into electrical pulses. They are essentially distinct materials whose design, application, immobilization, and transducing capacities induce/infuse distinct properties that offer several advantages in science, engineering, and medicine. The essentiality of biocatalytic sensors cannot be overemphasized; however, for successful application, it is necessary to understand their origins, nature, mechanism of operation, as well as their behavioral activities in different media within favorable conditions. Hence, three categories of biosensors, whose mechanisms of operation would be discussed include the biocatalytic,

bioaffinity, and microbial groups. In addition, the synthesis and mechanisms of immune, DNA, thermal, and piezoelectric biosensors, will be discussed in relation to their indispensable functionalities in multitudinous facets, such as the food industry, where quality checks are conducted to detect poisonous substances and glucose levels, in metabolic engineering, where in vivo assessments and monitoring of cell responses to metabolism are carried out and in medicine, where drugs, heart diseases, and the human papilloma virus can be X-rayed; biosensors also find application in defense/military technology and marine science, just to mention a few. In today's world, a myriad of biosensors, assume the form of membrane-bound microorganisms/enzymes, antibodies, receptors, or multilayered (matrix-enzyme) nanocomposites, all geared towards the maximization of the synergistic effect which these combinations offer in order to advance humanity. With the advent of newly discovered hyperthermophiles, it would be an interesting thing to consider their usage in biosensing especially at temperatures that can sometimes be twice above 50 °C, which may be unfavorable for most enzymes. However, the potentials of these biosensors are yet to be exploited maximally owing to the dearth in the understanding of the basic principles underlying the conditions within which they work best. To effectively optimize the potentials/performances of biosensors, a good understanding of the nature/characteristics of such systems, the principle on which they operate alongside the system's pH, temperature, and type of medium, which either favor or mare their activities are required. Hence, this chapter's discourse will essentially focus on the mechanisms and modes of operation of existing biosensors as well as recent/futuristic applications of potential bioactive materials, anchored on graphene and other potential substrates.

Keywords

- **Biofabrication**
- **Biorecognition**
- **Biocatalytic sensors**
- **Electrochemical sensors**
- **Optical sensors**
- **Piezoelectric/magnetic biosensors**

- **Mechanical biosensors**
- **Thermal biosensors**

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