International Journal of Advance and Innovative Research
Volume 6, Issue 2 (XXXIX): April - June, 2019
ISSN 2394 - 7780

BIOSENSOR FOR BRAIN: A REVIEW

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ABSTRACT
This review outlines biosensor designs to enhance the sensitivity and detection with less biofouling occurrence and minimal detection of interference species. There are many challenges in the development of a reproducible and stable implantable biosensor because many factors and limitations may affect the detection performance. However, the incorporation of multiple scales is needed to address the basic issues and combinations across the various disciplines needed to achieve the success of the system to overcome the challenges in the development of an implantable biosensor.

***Keywords**: brain glutamate, biosensing techniques, electrode*

INTRODUCTION

Biosensor

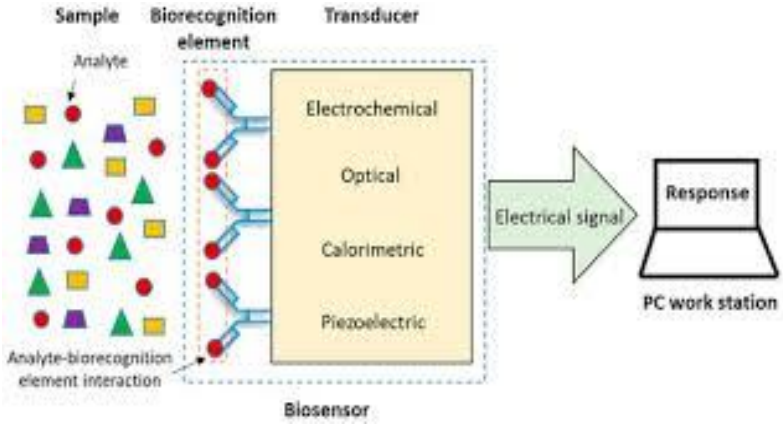

Figure-1: Schematic representation of a typical biosensor

A biosensor is defined as a sensor that transforms chemical information from a biochemical reaction concentration of a sample component to an analysis composition into an analytically helpful signal (1). The term biosensor has been widely applied to a number of devices used to monitor incorporate biotic elements. A biosensor is composed of two elements: a biological recognition unit that specifically interact with a target and a transducer that is able to convert a change in the property of the solution or electrode surface, as a result of complex formation, into a recordable signal. Used to monitor incorporate biotic elements.[1] An electrochemical biosensor is a self-contained integrated device, which is capable of providing specific quantitative or semi-quantitative analytical information using a biological recognition element (biochemical receptor) that is retained in direct spatial contact with an electrochemical transduction element [1].

The detection of a biological system in the form of a biochemical as an example analyte concentration will translate the information into a chemical or physical output, which is referred to as the sensitivity. The key idea of this identification system is to provide a high degree of selectivity for the analyte to be measured a transducer is part of a sensor, also referred to as a electrode, which transfers the signal from the analyte or the output of the reaction product into an electrical signal. Thus, a transducer provides a bidirectional signal transfer It consists of 3 parts: a "sensitive biological element" in which the sensitive elements can be created by biological engineering. Next, the "transducer" element" (works in a physicochemical way; electrochemical) that transforms the signal that results from the interaction of the analyte with the biological element into another signal (i.e., transducers) that can be more easily measured and quantified. An associated signal processor displays the results in a user-friendly way. A common example of a commercial biosensor is the blood glucose biosensor, which uses the enzyme glucose oxidase to break down blood glucose.

Potentiometric measurements are involved in the determination of potential differences between an indicator and reference electrode or two reference electrodes separated by a permselective membrane when there is no significant current flowing between them. The transducer could be an ion selective electrode (ISE), which is an electrochemical sensor based on a thin film or selective membrane coating. The potential differences between

ISSN 2394 - 7780

indicators and the reference electrode are proportional to the logarithm of the ion activity or concentration, which has been described by the Nerst-Donnan equation..

When the permselective membrane layer is placed adjacent to the potentiometric detector, several points must be considered: (i) Transportation of the substrate or analyte to be analysed to the electrode or biosensor surface.(ii) Diffusion of the analyte to the reacting membrane layer.(iii) Reaction of the analyte in the presence of enzyme.(iv) Diffusion of the product reaction towards the detector and solution

MONITORING OF ANALYTE

Hydrogen peroxide

Highly sensitive H2O2 electrodes have been combined with H2O2 producing oxidization to construct useful biosensors for various analytes. This approach is typically conducted at a relatively high applied potential for direct oxidation on the electrode surface for this study. The H2O2 generated as a result of the enzyme-catalysed oxidation of substrate (i.e., analyte) and the transfer of electrons to oxygen is subsequently oxidised or reduced at the electrode surface to provide a measurable current that can be correlated with the analyte concentration[2

$$H2O2 \rightarrow O2 + 2\,H+ + 2e \quad (1)$$

The focus of this study is the platinum electrode, which is involved in the oxidation H2O2 with the interaction of platinum oxides, such as Pt (OH)2.

$$H2O2 + Pt(OH)2 \rightarrow Pt(OH)2.\ H2O2 \quad (2)$$

$$Pt(OH)2.\ H2O2 \rightarrow Pt + 2\,H2O + O2 \quad (3)$$

$$Pt + 2\,H2O \rightarrow Pt(OH)2 + 2\,H+ + 2e \quad (4)$$

it undergoes a non-redox platinum catalysed disproportionate reaction at the electrode surface. The extent of this reaction varies with the electrode material and its pre-treatment (3).

Type of Electrode

Many types of electrodes have been designed to develop an increased sensitivity towards a target analyte. Furthermore, the stability, persistency, flexibility, simple and low cost architecture of the electrode are key factors for the development of a biosensor. The first-generation biosensor methods of H2O2 detection that utilise potentials of +700 mV vs an Ag/AgCl reference electrode are more prone to interferences as a result of higher recording potentials. To improve the selectivity of biosensor, techniques have been used, such as polymer coatings on platinum, polyaniline (2-3).

Platinum (Pt) electrode

Platinum is a very useful electrode for the detection of glucose and other neurotransmitters, and some modifications have been performed for the Pt electrode with carbon for improvement (51). The advantage of using a Pt electrode is that it permits a fast measurement and very fast preparation to enhance the sensitivity of the electrode (25).

Type of Membrane Layer

Recent biosensor research has designed an immobilisation and modification of electrodes. A suitable polymer must be selected as the immobiliser that may eliminate a variety of electroactive species which have the potential to act as interferents. Enzyme immobilisation

Glutaraldehyde Cross-linking

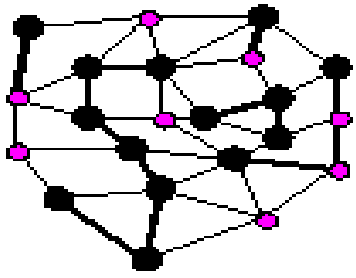

Figure: 2 Schematic representation of immobilization methods for biosensor construction● : enzyme molecule
● : crosslinker molecule

Cross linking is a widely used method of enzyme immobilisation. It is used to both stabilise the enzyme and provide a higher loading of active enzyme (3). At a basic pH,

ISSN 2394 - 7780

Effect of pH

pH is important for the electropolymerisation and activation of the enzyme. Most of the enzyme is active at a neutral medium during experiments using a phosphate buffer as a medium; the importance of pH for the reaction of phosphate buffer in terms of the development of a surface binding site for H2O2 from a precursor site through an interaction with $H2PO4^{-}$ from the electrolyte. A steady state response of the Pt electrode for H2O2 detection at a fixed potential (E = + 584 mV vs Ag/AgCl) with the concentration of 10 mM, pH range from 6 to 8, has the optimised current densities.

EFFECT OF CURRENT POTENTIAL IN ELECTROPOLYMERISATION

Researchers have studied the optimum current potential for electropolymerisation. Which suggests the best potential current for H2O2 sensitivity. This causes the selectivity against decrease as the current potential increases up to +700 mV. Although each study proposed a different optimum current potential, an investigation has determined the best current density range is for H2O2 to oxidise.Electrochemical biosensors always have an upper limit of the linear concentration range. This limit is directly related to the biocatalytic or biocomplexing properties of the biological receptor; however, in the case of enzyme-based biosensors, it may be significantly extended via an outer layer diffusion barrier to substrate S. The compromise for this extension in the linear concentration range is a decrease in sensor sensitivity. The local substrate concentration, within the reaction layer, can be at least two orders of magnitude lower than the bulk solution. In relation to the typical parameters for Michaelis- Menten kinetics, i.e., KM and Vmax, enzyme based biosensors are often characterized by their apparent KM and (Rss-Rbl)max: the first parameter represents the analyte concentration, which yields a response equal to half of its maximum value, (Rss-Rbl)max, for an infinite analyte concentration. When the apparent KM is substantially larger than its value for soluble enzyme, it indicates that a significant substrate diffusion barrier is present between the sample and the reaction layer or the rate of the reaction to the co-substrate S' with the enzyme is increased.As for the enzyme solution kinetics, the apparent KM is typically determined by Line weaver-Burk reciprocal plots, As for any electrochemical sensor, one should state the composition and the number of standards used and how the sample matrix is simulated. It may be necessary to specify procedures for each biosensor type and application.. The working concentration range, which may considerably extend the linear concentration range, is determined by the lower and upper limits of quantification [3-4].

SELECTIVITY AND RELIABILITY

Biosensor selectivity is determined and expressed as for potentiometric sensors. It depends on the choice of the biological receptor and transducer. Many enzymes are specific. When transducer interfering substances are well identified, their influence may be restricted by the application of appropriate inner or outer membranes.. The first method consists of measuring the biosensor response to interfering substance addition: a calibration curve for each interfering substance is plotted and compared with the analyze calibration curve under identical operating conditions. The selectivity is expressed as the ratio of the signal output with the analyze alone to that with the interfering substance alone at the same concentration as the analyze. In the second procedure, interfering substances are added, at their expected concentration, into the measuring cell, which contains the typical analyte concentration at the mid-range of its expected value. The selectivity is subsequently expressed as the percentage of variation of the biosensor response. Although more easily quantified than the calibration curve comparison performed in the first procedure, the second method is characteristic of each application and presents a more restricted significance. This selectivity may depend on the analyte concentration range, which is determined. The reliability of biosensors for given samples depends on both their selectivity and reproducibility. It must be determined under actual operating conditions, i.e., in the presence of potential interfering substances. A reliable biosensor response means that analyte concentration should not fluctuates with any interfering species within the sample matrix. Thus, for each type of biosensor and sample matrix, one should clearly quantify specific interference species that should be eliminated. This reliability determination is necessary for the accuracy assessment of biosensor.

REPRODUCIBILITY, STABILITY, AND LIFETIME

The definition of reproducibility is the same for electrochemical biosensors as any other analytical device: reproducibility is a measure of the scatter or drift in a series of observations or results performed over a period of time. In general, it is determined for the analyte concentrations within the usable range. The operational stability of a biosensor response may vary considerably depending on the sensor geometry and method of preparation, as well as the applied receptor and transducer For operational stability determination, we recommend consideration of the analyte concentration, the sequential contact of the biosensor with the analyte solution, temperature, pH, buffer composition, presence of organic solvents, and sample matrix composition.

ISSN 2394 - 7780

Finally, the mode of assessment of the lifetime should be specified, i.e., by reference to the initial sensitivity, upper limit of the linear concentration range for the calibration curve Biosensor stability may also be quantified as the flow, when the sensitivity evolution is monitored during either storage operational conditions. It is useful for biosensors for which evolution is either during a rather short period of time. [3-4]

CONCLUSION

The technical fundamentals of electrode, properties and performance must be understood. Biosensor responses will be controlled by the kinetics of recognition and transduction reactions.

ACKNOWLEDGEMENT

Authors are thankful to authorities of University Grants Commission, Pune for providing the financial assistance.

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