BASIC CONCEPTS OF BIOSENSOR AND ITS APPLICATIONS

Abstract

Biosensors are devices that acquire impulses from the body and convert them into quantifiable electrical signals. It needs the integration of biological entities corresponding proteins/enzymes, RNA, and DNA to electrochemical transducers in order to distinguish and observe precise biological analytes, such as the way that antigens and antibodies interact. There are five sections to it. We give a thorough overview of biosensors and biosensing technologies, as well as information on significant developments in the area and illustrations of the various biomolecular sensing methods. The use of biosensors has produced better outcomes and success in a number of settings, involving the identification of microbes, the environment, nutrition bioanalysis, and also medical labs. A variety of biological analytes can be detected with biosensors.

Keywords: Biosensors, Applications, biosensing technologies, environment, nutrition bioanalysis

Author

Dr. Amit Karmakar
Assistant Professor
Department of Physiology
Tamralipta Mahavidyalaya affiliated to the Vidyasagar University
a.karmakar@tmv.ac.in

I. INTRODUCTION

An analytical tool known as a biosensor produces signals that are proportionate to the analyte concentration in the reaction in order to detect biochemical responses. Biosensors are utilized for errands like exposure of pollutants, disease surveillance, pathogens detection, and drug development and illness indicators in bodily fluids (saliva, blood, sweat, urine) [1]. Biosensors are devices having receptor-transducer designs that could be applied to read the biochemical or biophysical characteristics within the medium, according to theory. A biological/organic recognition aspect, which permits the recognition of particular biological constituents in the medium, is an intriguing characteristic that sets these sensors apart from others [2].

## II. BIOSENSOR SYSTEM AND ITS COMPONENTS

A biosensor characteristically be made up of an antibody, enzyme, nucleic acid, cell, or aptamer as the bio-receptor, a semi-conductor or nanomaterial as the transducer, and an electronic organization that includes a processor, signal amplifier, and display [3]. In CMOS-based microsensor systems, for occasion, transducers and electronics can collaborate [4, 5]. Frequently referred to as a "bioreceptor," the recognition component cooperates with the target analyte by means of biomolecules or receptors produced from biological systems. This interaction is measured by the biotransducer, which produces a detectable signal that is proportionate to the target analyte's concentration in the sample. The primary the design goal of a biosensor is to deliver quick, actual examinations at the facility of care or concern the location of sample collection [6, 7, 8].

Typical biosensors include the ensuing components.

- **Analyte:** A risky ingredient that must be located. For example, glucose is used as an "analyte" in the analysis of a biosensor with the ability to measure glucose.

- **Bioreceptor:** A molecule known as a bioreceptor is one which acknowledges the analyte in a certain manner. A few examples of bioreceptors are cells, enzymes, DNA, aptamers and antibodies. The procedure for producing a indicator (in the form of light, heat, pH, charge or mass shift, etc.) as a reaction to the bioreceptor coming into interaction with the analyte is called as bio-recognition.

- **Transducer:** One form of energy is changed into a different via a component referred to as a transducer. The transducer in a biosensor is responsible for converting a bio-recognition experience into a calculable signal. Signalization is the duration for this energy transformation progression. Maximum transducers provide electrical or optical signals.

- **Electronic:** The electronics component of the biosensor prepares the transduced signal for display by processing it. It is constructed of complicated electrical circuitry

that intensifies signals and converts analog signals into digital signals, between other signal conditioning responsibilities. The biosensor's display gadget after which quantifies the processed signals.

- **Display:** An operator interpretation system gives the worker understandable figures or curves, similar to a computer's liquid crystal display or through printer. This element often comprises of a hardware-software setup that generates understandable biosensor results. The output signal can be numerical, visual, horizontal, or even an image liable on the display's necessities [1].

Components of biosensor

Analyte   Bioreceptor   Transducer   Electronics   Display
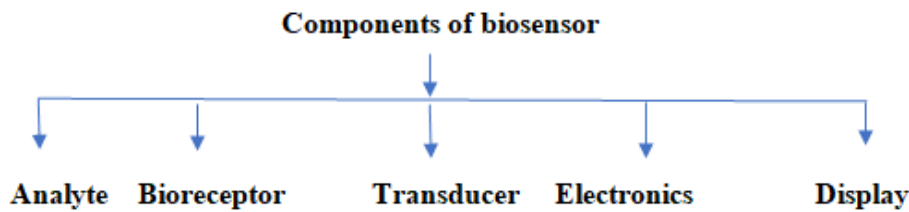
1. **Characteristics of a Biosensor:** Each biosensor has a unique set of static and dynamic characteristics. The optimisation of these features has an impact on the biosensor's functionality.

- **Selectivity:** Selectivity may be the greatest a crucial component of a biosensor. The capability of a bioreceptor to recognize one particular analyte in a sample that contains different mixes and impurities is referred to as selectivity. The interaction between an antigen and an antibody is the greatest illustration of selectivity. On the surface of the transducer, antibodies are frequently immobilized and used as bioreceptors. The next step is exposing the antigen to a solution (typically a buffer such as salts), which is thereafter exposed to the transducer, which only allows antibodies to attach to antigens. When choosing bioreceptors, selectivity is a key factor to take into account when building a biosensor.

- **Reproducibility:** The capability of the biosensor to give the same results under the same testing circumstances is referred to as reproducibility. Reproducibility is defined by the transducer and electronics of a biosensor, which are specific and precise. Precision is the ability of the sensor to reliably yield the same findings when a sample is tested multiple times, whereas accuracy states to the sensor's capability to provide a mean value that is reasonably near to the real value. Reliable and robust inferences about a biosensor's reaction are made possible by reproducible signals.

- **Stability:** The stability of the biosensing system describes how vulnerable it relates to disruptions in the environment both inside as well as beyond it. These interruptions may cause the signals that a biosensor produces is being measured to drift. This can distort the concentration being measured and jeopardize the precision and accuracy of the biosensor. Stability is the furthermost vital factor in applications where a biosensor needs extended incubation times or continuous monitoring. The stability of a biosensor might be impacted by the response of electronics and transducers, which may be temperature-sensitive. The sensor must be properly tuned in order to produce a consistent reply. The grade to which the analyte connects with the bioreceptor and

its affinity may also have an impact on stability. High affinity bioreceptors, which promote the analyte's covalent or strong electrostatic connection, boost the stability of a biosensor. One more element that influences How stable is the bioreceptor's ageing over time as a measurement.

- **Sensitivity:** The lowest concentration of the analyte which a biosensor can detect is known as its sensitivity or limit of detection (LOD). In many environmental and medical monitoring applications, a biosensor is required to verify traces of analytes found in a sample at minimal levels of analyte ng/ml or even fg/ml. In particular, when circulating blood levels of the prostate-specific antigen (PSA) are 4 ng/ml or higher, doctors prescribe prostate cancer biopsy procedures. Sensitivity is therefore recognized as a crucial aspect of a biosensor.

- **Linearity:** Linearity is a property that displays the correctness of the restrained response to a straight line for a set of dimensions with various analyte concentrations in the mathematical equation $y=mc$, where c is the analyte concentration, y is the output signal, and m relates to the biosensor's sensitivity. Regarding the biosensor's linearity, it can be impacted by equally the biosensor's resolution and the concentration range for analytes being tested. The slightest alteration in an analyte's concentration essential to cause a variation in the biosensor's response is known as the resolution of the biosensor. A good resolution may be needed in accordance with the application, as the majority of biosensor applications required besides analyte recognition, monitoring of analyte concentrations more than a broad operating array. The array of concentrations of analytes for which the biosensor response fluctuations in a linear fashion with concentration is referred to as the term "linear range," which is also related to linearity [1].

2. **Classification of Biosensors:** According to the sort of biotransducer they use, biosensors can be categorized by means of a variety of methods [9,10].

- Biosensors can be categorized into classes such as mass dependent, electrochemical, radiation sensitive, optical, and more [11] depending on the transduction principle that is being used.

- If bioelement is taken into account as the foundation of classification, then the numerous sets of biosensors that might be acquired include nucleic acid, enzyme, saccharides, proteins, ligands, oligonucleotides, etc [12].

- Classes of glucose, DNA, mycotoxins, toxins, medicines, or enzyme-based biosensors could be developed reliant on the kind of distinguished analyte [13].

3. **Applications of Biosensors:** Biosensors can be applied to raise the standard of living in a variety of ways. This includes using them for a variety of purposes, such as disease detection, environmental monitoring, defence, food safety, and drug development. Among the foremost applications of biosensors is the recognition of biomolecules that either cause illness markers or drug targets.

Electrochemical biosensing approaches, for instance, can be used to produce clinical instruments for the detection of protein cancer biomarkers [14–16], glucose monitoring in diabetic individuals, and additional health-related targets [17,18,19].

4. **Applications in Tissue Engineering:** Biosensors are crucial to the viability of many tissue engineering applications, including the production of "particular onchips for organs" and protective the three-dimensionality and arrangement of cell cultures, where the destiny of tissues and cells is straight linked with the presence of small biomolecules (such as adenosine, hydrogen peroxides, glucose, etc.) [20].

5. **Applications in Food Sector:** Identifying drug residues in food, including antibiotics and growth stimulants, with a focus on meat and honey. Salmonella, Listeria monocytogenes, campylobacter, E. coli strain 0157:H7 and E. coli are some of the bacteria that frequently cause food to degrade and pose health risks. These bacteria are frequent issues for the food industry because they decrease consumer demand for food if the food supplied by the establishment becomes polluted with these biological agents that cause food to degrade [21]. In addition to bacteria, fungus are another prevalent source of food spoilage and serious health issues that, in many instances, can be fatal. Common fungal species that contaminate food include Botrytis sp., Aspergillus, Colletotrichum, and many others. Fungal toxins can also be identified utilizing optical Surface Plasmon Resonance (SPR) biosensors because of their amazing selectivity, decreased prices, and simplicity and speed of monitoring through biosensors [22,23,24,25].

6. **Environmental Applications of Biosensors:** Applications in the environment include the detection of pesticides, the exposure and identification of organophosphates, and the identification of contaminants in river water, such as heavy metal ions [26].

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