**BIOSENSOR APPLICATION IN HEALTHCARE**

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**Abstract**

This paper discusses various biosensors in detail, where the biosensor consists of bioelement and a sensor element. Biosensor is a device that consists of two main parts: A bioreceptor and a transducer. Bioreceptor is a biological component that recognizes the target analyte and transducer is a physicochemical detector component that converts the recognition event into a measurable signal. Biomolecules such as enzymes, antibodies, receptors, organelles and microorganisms as well as animal and plant cells or tissues have been used as biological sensing elements. Biosensors are applications in disease monitoring, drug discovery, and detection of pollutants, disease causing micro-organisms and markers that are indicators of a disease in bodily fluids. High-level overviews of different types of biosensors are given and the working principles, constructions, advantages and applications of many biosensors are also presented.

**Keywords**

Biosensor, Transducer, Application of Biosensor, Biosensor in Health care

1. **INTRODUCTION**

The history of biosensors started in the year 1962 with the development of enzyme electrodes by the scientist Leland C. Clark. Since then, research communities from various fields such as very large scale integration (VLSI), Physics, Chemistry, and Material Science have come together to develop more sophisticated, reliable and mature biosensing devices for applications in the fields of medicine, agriculture, biotechnology(1). Biosensor is a device that consists of two main parts: A bioreceptor and a transducer. Bioreceptor is a biological component (tissue, microorganisms, organelles, cell receptors, enzymes, antibodies, nucleic acids, etc) that recognizes the target analyte. Other part is transducer, a physicochemical detector component that converts the recognition event into a measurable signal. The function of a biosensor depends on the biochemical specificity of the biologically active material. The choice of the biological material will depend on a number of factors via the specificity, storage, operational and environmental stability. Biosensors can have a variety of biomedical, industry, and military applications. The major application so far is in blood glucose sensing because of its abundant market potential. Biomolecules such as enzymes, antibodies, receptors, organelles and microorganisms as well as animal and plant cells or tissues have been used as biological sensing elements. Microorganisms have been integrated with a variety of transducers such as amperometric, potentiometric, calorimetric, conductimetric, colorimetric, luminescence and fluorescence to construct biosensor devices(2).

1. **PRINCIPLE OF BIOSENSOR**

Biosensors are operated based on the principle of signal transduction. These components include a bio-recognition element, a biotransducer and an electronic system composed of a display, processor and amplifier. The bio-recognition element, essentially a bioreceptor, is allowed to interact with a specific analyte. The transducer measures this interaction and outputs a signal. The intensity of the signal output is proportional to the concentration of the analyte. The signal is then amplified and processed by the electronic system(3).

1. **TYPES OF BIOSENSOR**
   1. **Resonant Biosensors**

In this type of biosensor, an acoustic wave transducer is coupled with an antibody (bio element). When the analyte molecule (or antigen) gets attached to the membrane, the mass of the membrane changes. The resulting change in the mass subsequently changes the resonant frequency of the transducer. This frequency change is then measured(4).

* 1. **Optical-detection Biosensors**

The output transducer signal that is measured is light for this type of biosensor. The biosensor can be made based on optical diffraction. In optical diffraction based devices, a silicon wafer is coated with a protein via covalent bonds. The wafer is exposed to ultraviolet (UV) light through a photo-mask and the antibodies become inactive in the exposed regions. When the diced wafer chips are incubated in an analyte, antigen-antibody bindings are formed in the active regions, thus creating diffraction grating. This grating produces a diffraction signal when illuminated with a light source such as laser. The resulting signal can be measured or can be further amplified before measuring for improved sensitivity(5).

* 1. **Thermal Detection Biosensor**

This type of biosensor is exploiting one of the fundamental properties of biological reactions, namely absorption or production of heat, which in turn changes the temperature of the medium in which the reaction takes place. They are constructed by combining immobilized enzyme molecules with temperature sensors. When the analyte comes in contact with the enzyme, the heat reaction of the enzyme is measured and is calibrated against the analyte concentration. Common applications of this type of biosensor include the detection of pesticides and pathogenic bacteria(3).

* 1. **Ion-Sensitive Biosensors**

These are semiconductor Field Effect Transistor (FET) having an ion-sensitive surface. The surface electrical potential changes when the ions and the semiconductor interact. This change in the potential can be subsequently measured. The Ion Sensitive Field Effect Transistor (ISFET) can be constructed by covering the sensor electrode with a polymer layer. This polymer layer is selectively permeable to analyte ions. The ions diffuse through the polymer layer and in turn cause a change in the FET surface potential. This type of biosensor is also called an ENFET (Enzyme Field Effect Transistor) and is primarily used for pH detection(6).

* 1. **Electrochemical Biosensors**

Electrochemical biosensors are mainly used for the detection of hybridized Deoxyribonucleic Acid (DNA), DNA-binding drugs, glucose concentration, etc. The underlying principle for this class of biosensors is that many chemical reactions produce or consume ions or electrons which in turn cause some change in the electrical properties of the solution which can be sensed out and used as measuring parameter. Electrochemical biosensors can be classified based on the measuring electrical parameters as: conductimetric, amperometric and potentiometric(7).

* + 1. **Conductimetric Biosensors**

The measured parameter is the electrical conductance/resistance of the solution. When electrochemical reactions produce ions or electrons, the overall conductivity or resistivity of the solution changes. This change is measured and calibrated to a proper scale. Conductance measurements have relatively low sensitivity.

* + 1. **Amperometric Biosensors**

This is perhaps the most common electrochemical detection method used in biosensors. This high sensitivity biosensor can detect electroactive species present in biological test samples. Amperometric biosensors produce a current proportional to the concentration of the substance to be detected. The most common amperometric biosensors use the Clark Oxygen electrode.

* + 1. **Potentiometric Biosensors**

These are the least common of all biosensors, but different strategies may be found nonetheless in this type of sensor the measured parameter is oxidation or reduction potential of an electrochemical reaction. The working principle relies on the fact that when a voltage is applied to an electrode in solution, a current flow occurs because of electrochemical reactions. The voltage at which these reactions occur indicates a particular reaction and particular species.

* 1. **Nucleic Acid-based Biosensors**

A nucleic acid biosensor is an analytical device that integrates an oligonucleotide with a signal transducer. The nucleic acid probe is immobilized on the transducer and acts as the bio-recognition molecule to detect DNA/RNA (Ribonucleic acid) fragments(8).

* 1. **Nanobiosensors**

Nanosensors can be defined as sensors based on nanotechnology. Development of nanobiosensor is one of the most recent advancement in the field of Nanotechnology. The silver and certain other noble metal nanoparticles have many important applications in the field of biolabelling, drug delivery system, filters and also antimicrobial drugs, sensors(8).

1. **APPLICATION OF BIOSENSOR**

Biosensors are highly valuable devices for measuring a wide spectrum of analyte including organic compounds, gases, ions and bacteria(9)(10).

Some of the major applications of biosensors are listed below:

* Drug Discovery and Protein engineering
* Disease Detection
* Soil Quality monitoring
* Prosthetic Device
* Monitoring glucose level in diabetes patients
* Food analysis
* Environmental applications
* Wastewater treatment.

The trends in biosensor technology over the past 30 years have taken this equipment from simple and cheap components to the integration of several sensor systems into one unit including multiple analytes, making these systems smaller and tailored for mass production. The vision for the biosensor industry is to create microscale technology that will be suitable for performing sample preparation, analysis and diagnosis all with one chip(11).

* 1. **Biosensors in medical for disease diagnosis**

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| **No** | **Biosensors** | **Disease Diagnosis or Medical Application** |
| 1 | Glucose oxidase electrode based biosensor | Diabetes |
| 2 | Uric acid biosensor | Cardiovascular and kidney disease |
| 3 | Hydrogel based biosensor | Regenerative medicine |
| 4 | Silicone biosensor | Cancer biomarker |
| 5 | Nanomaterial based biosensors | Infectious diseases |
| 6 | Electrochemical biosensor | Antibiotic sensitivity of bacteria |
| 7 | Microfbricated biosensor | For drug development |
| 8 | Fluorescence tagged biosensor | Molecular systems inside the cell |

1. **BIOSENSORS IN THE HEALTH CARE** 
   1. **E-health**

Research on cell phone based nanobiosensor models, for example, Lateral flow assays (LFA), flow cytometry, and optical recognition has been of global research interest. Cases of few marketed cell phone based models are iHealth, AliveCor, GENTAG, Mobile Assay, and Cells scope.

* 1. **Lab-on-a-chip (LOAC)**

The idea was started from microfluidics related thoughts. Recent trend confirm us that it can be fall into nanofluidic field now in light of reducing the size of devices and response volume of fluidics. LOAC is a flow channels either in glass or silicon substrates and will be incorporated with stream infusion/pumping framework considering liquid transport inside the chip and sample handling for detection.

In the view of biosensor innovation, LOAC is the finished framework which can do a complete bio-sample handling and investigation framework on a chip scale. A bio-sample with a little measure of liquid is acquainted with the chip, then blended with reagents and supports, responded to frame items took after by assembly of it to a division unit for investigation, coordinated on the same wafer. LOAC will significantly affect the diagnostics business, both regarding concentrated lab examination and the point of care testing(10).

1. **CONCLUSION**

Since the invention of clerk’s electrode biosensor in 1950s, significant development has been done in the field of biosensor in these 65 years. Use of it is done in many areas like: scientific research, health care, environment, food application etc. However the practical application of biosensors in medical science is still in infancy period. Now a day’s electrochemical and enzyme based biosensors are used in clinical diagnostic laboratory for the detection of glucose, urea, creatinine and lactate. But in present era major focus is on cancer related diagnostic test with easy to use and fast analysis of tumor biomarkers.

Recent advancements in biosensors have seen an interest of wearable technology. Wearable Biosensors like Ring Sensor allow continuous cardiovascular (CV) monitoring. Continuous monitoring would allow emergency detection and also for long-term assessment to establish the right dose of medication. Another one is Smart Shirt which is based on the information provided by the wireless, miniature sensors enclosed in shirt. The vital signals and information gathered by the various sensors on the body travels through the smart shirt controller for processing transmitted to the monitoring station and used for clinical diagnosis.

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