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**RK Prajapati**
Department of Chemistry,
D. J. College, Baraut Baghpat,
Uttar Pradesh, India

**Corresponding Author:**
**RK Prajapati**
Department of Chemistry,
D. J. College, Baraut Baghpat,
Uttar Pradesh, India

# Currents application of biosensor in environmental pollutions

**RK Prajapati**

**Abstract**
In modern times, the need for a pollution-free environment and the effects of pollution on health has received the most attention from science and technology. As the world witness evolutionary transformation, the environmental safety is one of the major concerns of scientists today, as the world's health is greatly influenced by the changes in ecology. The release of toxic pollutants, such as chemical toxins and pathogens, from man-made activities and industries urgently required careful monitoring and appropriate control. Therefore, the detection and diagnosis of environmental contaminants and health hazards requires efficient scientific and technological tools. The biosensor is the most attractive analytical tool for better monitoring of contaminants in the environment. Biosensor technologies, especially MIP-based biosensors, offer better possibilities in meeting diagnostic parameters. The structural and functional principles of biosensors are based on a combination of nanotechnology and analytical medicinal chemistry. This chapter describes the use of biosensors to detect contaminants in biosensor-based environments.

**Keywords**: Biosensor, environmental monitoring, MIPs, electro-sensors

## Introduction
Biosensors are a class of molecular sensors that have recently enjoyed great success in the field of clinical diagnostics. Recent developments indicate that they are now poised to have a similar impact on environmental monitoring practices. The use of biochemical reactions combined with the latest in his sensor technology and electronics has the potential to rapidly and inexpensively quantify a wide range of analytes of interest in the environment. Environmental safety is a major concern worldwide. Careful monitoring and management are therefore two of India's global and sub-continental priorities [2]. As toxicant control is a fundamental requirement for pollution remediation, researchers are interested in finding permanent solutions for environmental monitoring [1-3]. Pollutants emitted by agriculture, intensive human activities, and industry are primarily organic and inorganic toxic compounds. The use of biosensors is required to detect and monitor the actual condition of soil, water and air samples due to the presence of contaminants such as pesticides, potentially toxic elements, pathogens, toxins and endocrine disrupting compounds [4]. The main environmental toxicants are divided into four classes: (i). Organochlorine pesticides (aldrin, chlordane, DDT (dichlorodiphenyltrichloroethane), dieldrin, endrin, heptachlor, mirex, toxaphene), (ii). fungicides (i.e. hexachlorobenzene, (iii). industrial chemicals (PCB - polychlorinated biphenyl and its by-products) and (iv). heavy metal The possibility of their quantification by using specific biosensors constitutes a significant advantage in controlling them [5].
Biosensors are used as analytical devices that convert biological or chemical reactions into electrical signals. A biosensor or sensor should respond selectively, continuously, rapidly, specifically and ideally without additional reagents, and various criteria should also be taken into account. This should be distinguished from bioassays or bioanalytical systems, which require additional processing steps such as the addition of reagents [6]. The biosensor is being developed for a variety of applications including environmental and bioprocess control, food quality control, agricultures, military and especially medical applications. In fact, most commercially available biosensor systems are used for clinical and product contaminant detection/verification in the food, beer, and pharmaceutical markets [7, 8].

Currently, biosensors are the fastest growing segment, with an estimated annual growth rate of 60%. The main impetus came from the healthcare sector, but there was also pressure from other sectors. B. Food quality assessment and environmental monitoring. Most of this current effort involves potentiometric and amperometric biosensors and colorimetric paper enzyme strips. However, in the coming years, all important types of transducers used in biosensors are likely to be thoroughly investigated. Although the development of biosensor technology has expanded significantly, further commercial success has been hindered. There is a technological gap between the sensors that the market demands and the sensors that are available on the market. Typical unsolved problems associated with biological materials used in biosensors are: (1) low stability; (2) high cost; (3) lack of enzymes or receptors capable of recognizing specific target analytes. This obstacle to the success of biosensors has been overcome to some extent with the advent of MIPs.

MIP-based sensors can be developed for almost any substance, even those that lack natural enzymes or receptors. However, in such sensors binding of the template analogue to the receptor must be efficiently coupled with signal generation. A thin MIP on electrode/optrode is under development. Traditionally, MIPs have been used as a selective sensing layer in sensor devices. Slow diffusion and recombination kinetics are limiting parameters, often precluding the application of his MIPs in chemical sensing. Some approaches, such as surface imprinting, which form sensing sites on the membrane surface, lead to more efficient sensor devices. Specificity, their stability and potentially lower production costs are certainly the strongest arguments for MIPs in sensing compared to immobilized bio-receptors such as antibodies and enzymes. The

MIP is combined with a variety of transducers such as capacitive [9], impedance [10], amperometric [11], mass sensing [12] and optical sensor plate formats [13]. Quartz crystal nanobalance (QCN) sensors are believed to be high-performance mass-sensing sensors for measuring materials in the nanogram range using a single piezoelectric quartz crystal [14]. Greater selectivity allows sensing chemists to analyze templates based on preferential accumulation or transport to the recognition layer. However, the specificity, affinity and capacity of the polymers need to be significantly improved to meet the requirements of practical applications. Moreover, most sensors require selective detection under aqueous conditions for environmental monitoring and agricultural applications, which remains a challenge for most MIP receptors reported so far.

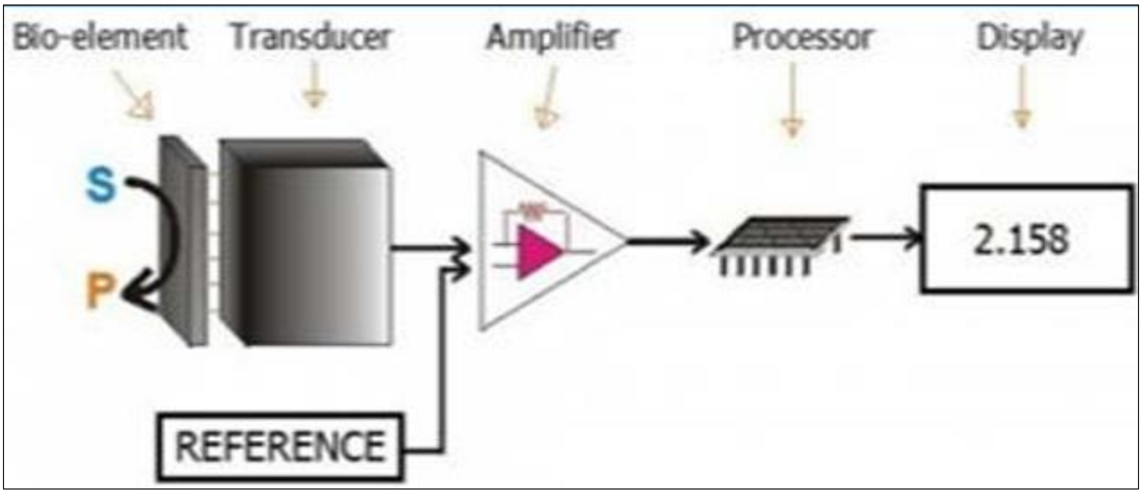


**Fig 1:** Diagrammatical Model of Biosensors

Operation of a Biosensor can be seen easily understood by following flow scheme.

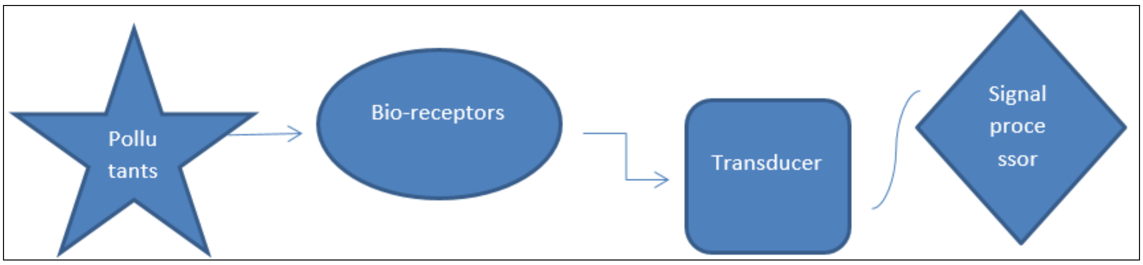


**Fig 2:** Working of a biosensor

**Molecular imprinted polymers and molecular imprinting**

Many studies have been reported to develop synthetic recognition systems specific to particular molecules [15, 16]. However, the multistep procedures required to prepare these hosts are often time consuming, resulting in low yields and consistently high specificity of the synthesized materials. It may not be. A new process has been introduced. This is a new synthetic method for creating specific receptor sites on cross linked polymers. This process is called imprinting polymerization [17]. Molecular imprinting techniques involve the formation of template-monomer complexes followed by polymerization. During polymerization, the shape of the self-assembled template-monomer complex is captured and ligands bind to specific receptor structures. It is the basis of most biological processes such as ligand-receptor binding, substrate-enzyme reactions, translation and transcription of the genetic code, and is therefore of universal interest.

In the pre-polymerization mixture, dissolved target analytes interact with functional monomers through covalent, non-covalent, or metal coordination interactions. Functional monomers serve to localize the chemically active portion of the target molecule during copolymerization. Molecular imprinting can therefore be divided into two main classes: Covalent imprinting (pre-assembly approach) and non-covalent imprinting (self-assembly approach) and semi-covalent imprinting (between functional monomer building blocks and target molecules in the pre-polymerization mixture and during recombination) and due to the nature of the interaction.

**Biosensors used in environment monitoring**

Biosensors are used for qualitative environmental monitoring of inorganic and organic priority pollutants through physical, chemical and biological evaluation. Pollutants are classified into different groups according to their chemical structure, mechanism of action and efficacy. A wide variety of environmentally relevant compounds are possible. Various types of biosensors used for pollutant detection are shown in Table 1 [18].

**Heavy Metals**

Heavy metals are one of the most dangerous environmental pollutants and due to their non-biodegradable nature, even trace amounts impose a threat to human health. The most common metallic contaminants widely present in the environment are heavy metals such as lead, chromium, zinc, mercury, cadmium and copper. Heavy metals are released into ecosystems in the form of wastewater from industrial wastewater, municipal solid waste, commercial fertilizers and pesticides. They accumulate in biological systems and cause toxicity up the food chain. Existing heavy metal analysis techniques such as spectroscopy, volumetric and chromatographic methods are accurate but have limitations such as high cost and lack of skilled technicians. Bacterial biosensors are currently used to measure heavy metals in various environmental samples. They use enzymes and DNA as biological receptors, optical and electrochemical conversion systems [19, 20].

**Biochemical Oxygen Demand (BOD)**

Biochemical Oxygen Demand (BOD or BODs), an important parameter is primarily used to estimate the amount of biodegradable organic pollutants in water. This method is time consuming and hardly suitable for online process monitoring. Based on this fact, the BOD biosensor method is used for rapid measurement of wastewater samples. Optical biosensors have been developed for the parallel measurement of BOD in wastewater samples in multiple samples. The biosensor monitors his BOD concentration in wastewater samples via an oxygen sensor film secured to the edge of a glass sample vial. Oxygen consumption is determined. Recently, his BOD biosensor using yeast with an oxygen probe was developed and can detect organic pollutants within 15 minutes [21].

**Nitrogen Compounds**

Nitrogen Compounds

Nitrogen compounds (nitrites) are commonly used as food preservatives (extending shelf life) and as soil fertilizers to increase soil fertility. These compounds can have serious effects on human health if ingested continuously. They pollute groundwater and surface water and destroy the aquatic environment. Their harmful effects are based on irreversible reactions with hemoglobin leading to serious health problems. Various biosensor devices are used to measure nitrogen compounds in water samples. Another highly sensitive enzymatic conductivity biosensor has been validated and used in natural water samples [22].

**Polychlorinated biphenyls (PCBs)**

Polychlorinated biphenyls (PCBs) are highly toxic aromatic organic compounds. They are everywhere, even though some countries around the world have banned their production. Most PCBs accumulate in the food chain due to their high lipophilicity. Over 209 polychlorinated biphenyl congeners exist in the environment and food chains worldwide. Gas chromatography and mass spectrometry (GC-MS) were used to measure PCBs. Over time, the advent of another class of biosensors, immuno-sensors, has proven to be more effective in detecting (PCBs). It has the advantage of direct extraction without additional purification steps [23, 24]. Another aromatic organic compound belonging to the phenol family is also a toxic organic pollutant, commonly distributed in the environment as industrial wastewater. Phenolic compounds are used in the manufacture of pharmaceuticals, antioxidants, polymers, pesticides, detergents, dyes, etc.

Substituted phenols are toxic because they readily penetrate skin and cell membranes and affect bio-catalytic kinetics and respiration and photosynthetic processes. Electrochemical DNA sensors have been identified for environmental screening of toxic aromatic compounds and molecular interactions between contaminants and DNA. A tyrosinase-based amperometric biosensor has been developed to determine the phenolic index in environmental samples [25].

Contaminants, presence of pathogens. e.g. Bacteria, viruses, etc. in sewage, untreated and treated water are major environmental problems leading to public health problems. New technologies such as a biosensor are being manufactured for rapid identification of microbial contaminants used as surface plasmon resonance-based sensors for real-time monitoring of pathogens in liquid samples. The possibility of developing biosensors at specific locations should be investigated for constant and continuous monitoring [26].

**Table 1:** Biosensors applied for the determination of pollutants in real samples

| Analyte | Sample source | Transducer, recognition element |
|---|---|---|
| Pesticides | River water | Optical, immunochemical |
| Phenols | Wastewater | Electrochemical, enzymatic |
| Linear alkyl benzene sulphonate (LAS) | River water | Electrochemical, bacteria |
| Toxicity | Wastewater | Electrochemical, bacteria |
| Toxicity | Wastewater | Optical, bacteria |
| Alkanes | Groundwater | Optical, bacteria |

| | | |
|---|---|---|
| Estrogens and xenoestrogens | Real water samples (lake and a sewage plant) | Optical, human estrogen receptor (EC) |
| BOD | River water | Optical, Pseudomonas sp. |
| Zinc dichromate chromate | Soil (extract) | Optical, bacteria |
| Mercury arsenite | Soil (extract) | Optical, Pseudomonas sp. |
| Daunomycin, PCBs, aflatoxin | River water (pre-concentrated) | Electrochemical, DNA |
| Chlamydia trachomatis (DNA) | River water (pre-concentrated) | Electrochemical, DNA |

**Conclusions**

This review paper highlights the need for fast, reliable, and stable devices for detecting environmental contaminants using biosensors. However, sensitivity and selectivity requirements are necessary when biosensors are used in complex and unpredictable environmental samples with varying compositions. Independent transducers developed while using biosensors to detect environmental pollutants are important to consider for their continued application potential. In most studies, biosensor performance is evaluated using standardized laboratory samples. Biological sensing elements (enzymes, DNA, drugs, antibodies, microorganisms) can face challenges in terms of stability, potential interference, and optimal working conditions, but specificity and selectivity It has the advantage that there is room for improvement in terms of specificity and selectivity.

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