

# **Use of Biosensors in Heavy Metal Monitoring in Wastewater**

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## **ABSTRACT**

Living organisms require very small amounts of heavy metals like Cd, As, Hg, Zn, Tl to carry out the cell metabolism but large doses of heavy metals can also be fatal to the living things and the environment. Human activities are contributing to the release of these heavy metals into the environment leading to the increase in their concentration in air, water, and soil. Heavy metal monitoring plays an important role in determining the concentration of heavy metals in the environment. Various heavy metal monitoring techniques like mass spectrometry; voltammetry; microprobes, etc. are being designed and applied over the past few decades. In the last decade, Biosensors are found to have the potential for continuous and in situ heavy metal monitoring. They can be constructed from a wide array of immunochemicals and even genetically engineered microorganisms, and they can be configured to be reversible. Some of the recent advances in biosensors in the field of heavy metal monitoring in wastewater are reviewed. What are heavy metals, various sources of heavy metals, their harmful effects, what are biosensors, types of biosensors, basic construction and operating principle of biosensors and advantages of biosensors over other classical methods are also included.

## **KEYWORDS**

Heavy metals, monitoring, bioaccumulation, biosensors, biological material, transducer, operation, capacitive biosensor, catalytic DNA biosensor.

## **INTRODUCTION**

Some of the heavy metals are the natural constituents of earth crust like mercury (Hg), cadmium (Cd), arsenic (As), chromium (Cr), thallium (Tl) and lead (Pb). Unlike organic pollutants that are degraded or destroyed physically, chemically or biologically with time, heavy metals can only change their forms in chemical compounds, which may be more or less toxic and remain in the environment forever. Considering the harmful effects of heavy metals and importance of their trace level determination that has been discussed later in this term paper, various techniques have been developed to monitor their concentration in the environment. However, most of these techniques require sophisticated instrumentation and are very expensive. Biosensors are found to be useful cost effective devices in this respect. This term paper will mainly summarize the advantages of using biosensors over other techniques and will include a review of two newly developed biosensors, (1) Synthetic Phytochelatin-based Capacitive Biosensor and (2) Catalytic DNA biosensors used for heavy metal monitoring in wastewater.

## **HEAVY METAL CONTAMINANTS**

### **Definiton and Sources**

Metallic chemical elements that have a high relative density and are toxic at very low concentrations are referred to as heavy metals. The human body requires very small amounts of a few heavy metals, e.g. copper, selenium, and zinc, to maintain the metabolism. However, at higher concentrations they can lead to poisoning and other harmful effects on human health. Nowadays, human activities have drastically altered the biochemical and geochemical cycles and the balance of some heavy metals. Some of the major heavy metal pollutants like, Mercury, Lead, Cadmium, Arsenic and their organic and inorganic compounds are released into the atmosphere from a variety of anthropogenic sources like, industrial point sources, including present and former mining activities, foundries and smelters, and diffuse sources such as piping, constituents of products, combustion by-products, traffic, contaminated runoff, etc. Relatively volatile heavy metals and those