CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

Sandeep Kambhampati

Project Number

S1115

Project Title

A Novel DNA Electrochemical Biosensor for the Detection of Heavy Metals in Aquatic Ecosystems

Abstract

Objectives/Goals

The goal of this project is to develop a DNA electrochemical biosensor for the detection of lead nitrate in aquatic ecosystems. First, lead nitrate is studied through electrochemical methods to determine if it causes damage to DNA. If so, then this correlation is used in a biosensor and the DNA immobilization process is optimized to create a cheap and effective method of detection.

Methods/Materials

The major reagents used were 100 Grams Fish Sperm DNA, thiol modified DNA, 60 Grams Lead Nitrate, and 100 mL Buffer Solution of pH 4 and pH 10, and silanizing solution. ~50 Graphite working electrodes, a silver chloride reference electrode, and a copper counter electrode were used, in addition to materials for the transducer circuit. The working, counter, and reference electrodes were connected to the potentiostat, and voltammetry was run. After a clear correlation between lead nitrate and DNA oxidation was established, the various trials were run with the modifications (thin, thick and multi layer; various pH's; and physical vs. chemical adsorption primarily) placed onto the working electrode. The computer interface outputted a graph plotting measured current vs. applied voltage, revealing oxidation peaks that indicated if DNA damage occurred.

Results

The oxidation peak of the control was compared to the oxidation peak of a trial with lead nitrate and significant difference (more voltage and lower current at oxidation peak) was confirmation of DNA damage. The graphs revealed that guanine indeed was irreversibly oxidized. The quality of the output and was primarily used to determine which method of immobilization was most effective. The hypothesis was proved false regarding the technique of immobilization and thin-layer proved to be most effective. The hypothesis regarding the environment (acidic pH) of immobilization and method (chemisorption) was proved true.

Conclusions/Discussion

This experiment confirmed the hypothesis that lead nitrate is indeed much more harmful than previous thought. The pollution from industrial runoff of this heavy metal is a severe issue that must be dealt with immediately. This project developed an effective, optimized biosensor that has significant potential as it can help curb ever increasing cancer rates in modern society and hopefully aid developing nations by providing a cheap alternative to standard expensive, time-consuming laboratory tests.

Summary Statement

My project establishes a link between lead and DNA damage, and uses this correlation to create and optimize a biosensor that can detect lead pollution in the field.

Help Received

Mr. Hartwig provided a data acquisition device necessary for building the biosensor, and Dr. Malini Vasishta helped acquire materials and ensure that proper safety regulations were met.