CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)
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Project Number
S0514

Project Title
Oxidation of Dopamine by High-Valent Manganese: A Link to Neurodegenerative Disorders?

Abstract

Objectives/Goals
The goal of this project is to determine whether high-valent manganese compounds readily oxidize dopamine, a neurotransmitter. It also examines whether cysteine (a sulfur containing amino acid) interferes with this oxidation.

Methods/Materials
The oxidation of dopamine by compounds containing manganese in various oxidation states (+2, +3, +4) were followed spectrophotometrically. In a typical experiment, a batch of ~10mg of the manganese compound was added to a solution of dopamine in DI water or phosphate buffer (pH 7.4) and the oxidation products were analyzed by monitoring the electronic absorption spectra. The courses of the same reactions after the addition of cysteine were also monitored in a similar fashion. The mechanism of the oxidation was explored by intervening the oxidation reactions at various intervals and identifying the products at selected times by various spectroscopic techniques as well as measuring the pH of the reaction mixtures.

Results
High-valent (+3, +4) manganese compounds promote rapid oxidation of dopamine to aminochrome and neuromelanin. In presence of cysteine, the potent neurotoxins DHBTs are produced. Coordination of the catecholate moiety of dopamine to the metal center and subsequent electron transfer result in such oxdation .

Conclusions/Discussion
The results correlate well with the conditions observed in the basal ganglia and other affected areas in the brains of Manganism patients. Manganism is similar to Parkinson's Disease and is found in welders and miners. Loss of dopamine and sulfur-containing molecules like cysteine, the presence of dopamine-derived neurotoxins and enhanced oxidatitve damage have all been linked to neurodegenerative diseases like Manganism.

Summary Statement
My project focuses on the mechanism of oxidaion of dopamine by high-valent manganese compounds.

Help Received
My dad, Pradip Mascharak, provided the chemicals and the instrumental facilities. Two UCSC graduate students, Alegra Eroy-Reveles and Raman Afshar supervised the use of the instruments. Dr. Koushik Ghosh helped with the fluorescence measurements.