CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

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Project Number

S0503

Project Title

A Novel Approach to Combating Brain Tumors Using Hyperpolarized Carbon 13 NMR

Abstract

Objectives/Goals

The purpose of this research is to study how tumor cell growth can be stopped through inhibition of key energy producing pathways, such as Glutaminolysis. A new method to inhibit Glutaminolysis by hyperpolarizing Glutamine using Dynamic Nuclear Polarization (DNP) in C13 NMR is proposed. This method also has applications to Glycolosis, as well as to all cancer cells.

Methods/Materials

DNP is a form of hyperpolarization used in NMR which spin polarizes both the nucleus and electrons of an atom. Spin polarizing the electrons leads to a violation of the Pauli Exclusion Principle, which causes Glutamine to lose its ability to react chemically with other molecules. The first step of Glutaminolysis, which triggers the entire process, is the conversion of Glutamine to Glutamate. However, since the hyperpolarized Glutamine can no longer react chemically, Glutamate cannot be produced, and Glutaminolysis is inhibited. In order to maximize the rate and effectiveness of the inhibition of Glutaminolysis, the optimal conditions for DNP to occur were determined through investigation of the effect of pH on the rate of magnetization transfer in the sample and the spin lattice relaxation time (T1).

Results

It was found experimentally that the pH is directly proportional to the rate of transfer of magnetization and inversely proportional to T1. Glutamine was also magnetized, and it was found that the magnetized Glutamine had a much higher pH, which allows for a faster transfer of magnetization in the sample, enhancing the effects of DNP and allowing for highly effective inhibition of Glutaminolysis.

Conclusions/Discussion

My new method ultimately provides effective inhibition of Glutaminolysis in tumor cells, thus cutting off the cells' energy supply and killing them. I also observed that the pH of a sample is directly proportional to the rate of transfer of magnetization and inversely proportional to T1 of that sample, and that when magnetized, the pH of Glutamine rose, allowing for effective inhibition of Glutaminolysis. My new method also applies to Glycolosis, the other main energy-producing pathway in tumor cells, as well as to all cancer cells in general.

Summary Statement

In this study, I propose a new method to inhibit Glutaminolysis using DNP in C13 NMR to ultimately kill tumor cells.

Help Received

My faculty mentor at school advised me on some of the technical aspects of my study.