CALIFORNIA STATE SCIENCE FAIR
2007 PROJECT SUMMARY

Name(s)
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Project Number
S0512

Project Title
Surface Plasmon Resonance: Using Surface Plasmons to Detect Chemical Changes

Abstract

Objectives/Goals
The goal of my project was to investigate how surface plasmon resonance (SPR) can be used to detect and measure changes in chemical solutions and protein-protein interactions. My hypothesis was that the SPR phenomenon could be used to observe (1) the kinetics of a simple chemical reaction, and (2) binding between daclizumab (a protein drug) and daclizumab-specific anti-drug antibodies.

Methods/Materials
SPR is an oscillating wave of electrons that results from the interaction between the photons of a laser beam and the electrons in a thin metal layer. SPR occurs only at a very specific angle of incidence, and that angle is affected by the substance placed in contact with the metal layer. I constructed an SPR spectrometer using a small laser pointer, a photodetector, a semicircular prism, and other spare optical components on loan from IBM Almaden Research Center. In my preliminary experiment, I used the spectrometer to determine the relationship between the SPR angle of several sucrose solutions of varying concentration. I also used my SPR spectrometer to observe the kinetics of a reaction between glycerol and HCl. To validate that the SPR phenomenon could be used to detect the interaction between daclizumab affixed to the metal surface and its ADAb, I attempted to generate a standard curve showing a dose-response relationship between ADAb concentration and SPR angle shift.

Results
By plotting the shift in SPR angle, I was able to observe a positive correlation between increasing sucrose concentration and the SPR angle. I was also able to estimate the rate of the chemical reaction between glycerol and HCl. I was initially able to detect a shift in SPR angle that was proportional to the concentration of ADAb in the sample, which was the desired result. However, after additional experimentation, I was unable to attribute this shift to specific binding between daclizumab and its ADAb.

Conclusions/Discussion
My preliminary experiments confirmed my hypothesis. SPR angle shifts were proportional to changes in sucrose concentration and could be used to follow the progress of a chemical reaction. However, the primary experiment was inconclusive. Although the initial protein-binding results were inconclusive, I hope to be able to repeat the experiment in the future using improved sample handling techniques, and to extend this project to more detailed investigations of the daclizumab-ADAb interaction.

Summary Statement
I built a surface plasmon resonance (SPR) spectrometer and explored how SPR can be used to detect protein binding and other chemical changes.

Help Received
Felix Guzman provided HCl and Glycerol; Used lab equipment from IBM Almaden Research Center; Michael Jefferson provided lab space and guidance; Steve Keller of PDL BioPharma provided lab space and materials