CALIFORNIA STATE SCIENCE FAIR
2008 PROJECT SUMMARY

Name(s)
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Project Number
S0519

Project Title
The Synthesis of Silicon Nanoparticles for Macrophage Cellular Imaging in Atherosclerosis

Abstract

Objectives/Goals
Currently, angiography is the primary method in imaging plaques, but it is an invasive technique and cannot determine the plaque#s vulnerability to rupture. As heart diseases are the number of cause of death in America, it is crucial to develop a non-toxic biomarker that could be safely injected into human patients in order to detect and image plaques that cause atherosclerosis.

Methods/Materials
For a biomarker, silicon nanoparticles are optimal due to our ability to synthesize sufficient quantities necessary for clinical applications as well as surface modification of the particles for the attachment of biomolecules for disease detections. The synthesis of the silicon nanoparticles is consistent of a reaction consisting of NaSi with the solvent dimethylformamide. The reaction is kept under reflux temperature for three days before propargylamine was added to coat particles with amine groups. Maleyl groups were then attached to purified silicon nanoparticles to create a negatively charged surface to bind to the scavenger receptor on the surface of macrophages. Macrophages were incubated with the maleylated silicon nanoparticles for confocal microscopy imaging.

Results
Our results show that the silicon nanoparticles show very promising qualities as an inert biomarker to imaging vulnerable plaques. Cell toxicity analysis shows that about 95% of the cells are still viable after 4 hours of incubation. And, imaging studies show that there is successful uptake of the silicon nanoparticles in macrophages, proving that these biomarkers could indeed be used to target vulnerable plaques.

Conclusions/Discussion
My results provide the first evidence showing that the targeted maleylated silicon nanoparticles can be used for in vivo diagnosis and assist with treatment of humans with atherosclerosis. The biomarkers are bio-compatible and inert even in high concentrations. For future work, once the silicon nanoparticles are verified to be a successful biomarker on the cellular level, it is important to test them in animal studies. For this we use mice and rats with damaged carotid arteries. We are currently synthesizing Mn doped silicon nanoparticles, a multimodal contrasting agent that could use fluorescence and MRI imaging to verify the clinical utility. Lastly, high quantities could be produced for clinical utility. Hopefully, an Investigational New Drug application will be submitted to the FDA within the next year.

Summary Statement
Synthesizing a non-toxic biomarker that could image plaques in the blood stream that cause heart diseases and strokes.

Help Received
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