James & Esther King Biomedical Research Program

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Department of Surgery, Surgical Oncology — *2006 Program*
University of Florida — *New Investigator (3-year project)*

Project Title: Metabolically Targeted Nanoshells for High Resolution In Vivo Imaging of Cancer with Finite Element Based Photoacoustic Tomography

Project Summary: Cancer remains a leading cause of smoking-related morbidity and mortality in the United States. New techniques for the early diagnosis of cancer as well as new techniques for the non-invasive treatment of cancer are needed. The overall goal of this project is to study a new, multidisciplinary, nanotechnology based paradigm for cancer imaging and therapeutics.

Nanotechnology is the exciting multidisciplinary field involving the design and engineering of nano-objects or nanoparticles less than 500 nanometers in size. "Nano" refers to the scale of objects measured in nanometers (nm) (i.e. one billionth of a meter). Cancer nanotechnology seeks to characterize the interaction of nano-scale devices with cellular and molecular components specifically related to cancer diagnosis and therapy. The potential of cancer nanotechnology lies in the ability to engineer vehicles with unique therapeutic properties that because of their small size can deeply penetrate tumors with a high-level specificity. The National Cancer Institute has recognized this and has documented that nanotechnology offers an "unprecedented and paradigm-changing opportunity" to make significant breakthroughs in cancer diagnosis and treatment.

Nanoshells are a type of multifunctional biocompatible nanoparticle that because of their unique properties have tremendous potential for improving the early diagnosis and noninvasive treatment of cancer. Specifically, nanoshells have potential as contrast agents for novel imaging of cancer, as highly specific drug delivery vehicles, and as mediators of local thermal ablation of tumors. In order for nanoshells to be effective in a living organism, they must be preferentially delivered to cancer cells. This project proposes to metabolically target nanoshells to cancer cells in a living organism. Cancer cells have increased glucose metabolism and increased iron metabolism compared to non-cancerous cells. As part of this project, nanoshells that are linked to 2-deoxy-glucose and to transferrin will be constructed and characterized. It is hypothesizes that this type of metabolic targeting will allow them to be preferentially delivered to cancer cells in a living organism.

Photoacoustic tomography is a new imaging modality that uses pulsed light and ultrasound to generate images. Photoacoustic tomography creates high-resolution images without the use of ionizing radiation. To date, photoacoustic tomography has not been used to image cancer in a living organism. Nanoshells, because of their inherent physical properties, are an attractive contrast agent for imaging with photoacoustic tomography. This project proposes to image cancer in a living organism using photoacoustic tomography with the metabolically targeted nanoshells as a contrast agent. As part of this project, a photoacoustic tomography system that utilizes a pulsed, near infrared laser with the ability to deeply and harmlessly penetrate biologic tissues will be constructed and characterized.

The ability to preferentially target nanoshells to cancer cells in a living organism using metabolic pathways combined with the ability to image them using photoacoustic tomography represents a new and exciting paradigm for cancer diagnostics and therapeutics. It is anticipated that the findings of this study would be widely applicable to many tobacco related malignancies.