Biomedical Optics: In Vivo Imaging and Microfluidics

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This talk will describe four research areas involving in vivo imaging or microfluidics.

Analysis of Circulating Tumor Cells

We are developing droplet microfluidic methods for analysis of circulating tumor cells. Laser heating is used to perform polymerase chain reaction amplification of DNA or RNA from cells in nanoliter volumes in as little as 6 minutes. Cell analysis can be performed in situ on the capture surface without having to remove cells to a separate analysis platform. We have used this method to analyze methylated and unmethylated BRCA1 promoters at the single cell level.

In Vivo Optical Imaging of Wound Healing

We are applying infrared optical molecular imaging to wound healing in animal models. Contrast comes from the activity of the transglutaminase enzyme, which aids wound healing through creation of a provisional extracellular matrix. Injection of fluorescently-labeled substrates for the transglutaminase enzyme results in covalent labeling of the matrix. We are using this method to study stability of the extracellular matrix in chronic wounds.

In Vivo Optical Imaging of Breast Cancer

We are applying infrared transillumination in conjunction with carbogen inhalation for imaging breast cancer. The carbogen produces unusual changes in vasodilation/vasoconstriction and hemoglobin oxygenation, which we attribute to the atypical vasculature produced by tumor angiogenesis. Analyzing the temporal variation in these images provides a rich array of signatures associated with breast lesions.

Artificial Bilayers

We are using droplet microfluidic methods to produce artificial bilayers. The bilayers are created using water droplets in mineral oil. When two lipid-containing droplets are moved together under laser control, a bilayer is produced where the droplets touch. The bilayers are quite stable and easy to prepare. We have demonstrated measurement of osmotic water flow through the bilayer using this method. Ultimately this method may prove useful for high throughput studies of transmembrane proteins.

Dr. Gregory W. Faris is a Program Manager in the Discovery Technologies Laboratory at SRI International.  He has thirty-five years of experience with optics, lasers, spectroscopy, laser instrumentation, nonlinear optics, laser and optical sensors, and optical imaging.  He has specialized in biomedical optics for the last 21 years, including work on in vivo imaging, microscopy, microfluidics, and optical label development. Dr. Faris received his Ph.D. from Stanford University in Applied Physics in 1987 and a B.S.E. (summa cum laude) from Princeton University in 1980.   Dr. Faris has over 60 publications in refereed journals and holds 15 patents.  He was the founding editor of the Virtual Journal for Biomedical Optics and was deputy editor of Biomedical Optics Express.