Faculty Profile

Mentor: Michael Nichols  
Department: Physics / Biophysics / Medical Physics  
Research Area: Development of laser-based imaging techniques to assess and monitor cellular metabolism during disease progression

Dr. Nichols leads the Biological Optics Research Group (BORG) which is generally interested in the development and application of novel laser-based techniques for diagnostic and therapeutic application in medicine and biology. Ever since the discovery and application of x-rays by Roentgen at the turn of the 20th century, the ability to develop new medical approaches to effectively treat disease has relied heavily on our ability to see what is going on inside the patient. This has led to the development of current state-of-the-art techniques such as computed tomography, positron emission tomography, magnetic resonance imaging, and ultrasound. In the BORG, we are working to develop new, non-invasive techniques that use visible and near-infrared laser light, avoiding the harmful side effects of ionizing radiation while providing both very high spatial resolution and sensitivity to fundamental biochemical and biophysical processes. Current projects in our group include imaging cellular metabolism using endogenous reporter molecules such as NAD(P)H and flavoproteins, determination of oxygen availability by phosphorescence quenching, measurement of changes in cellular elasticity in response to anti-cancer drugs, and the targeted release of drug compounds following the application of laser light.

Keywords (Research Topics)  
Lasers  
Microscopy  
Cellular energy metabolism  
Mitochondria  
Cancer  
Fluorescence  
Phosphorescence  
Time Correlated Single Photon Counting  
Lifetime and phasor analysis

Keywords (skills/techniques learned when conducting research)  
Sterile cell and tissue culture • cell growth assays • preparation of solutions and media for experimental control of cellular metabolism • confocal and two-photon microscopy • linear and non-linear excitation mechanisms • optical design • live animal imaging • measurement of laser light • laser safety • UV/VIS/Near IR fluorescence, phosphorescence and absorbance measurements • tissue optics • electronics • device fabrication • image analysis and quantification • programming in Python