Synergy: Unpacking my Research Experience in the Schenkman Lab

My work on my bioengineering senior capstone project in the Schenkman lab is much more than completing a departmental requirement for graduation—rather, it is a synergistic experience that combines my bioengineering coursework, my interest in translational research, my independent drive, and my future as a pediatric physician. I am learning to creatively problem solve, apply my classroom knowledge to new situations, explore many avenues for necessary resources, and persevere in the face of unexpected challenges. Furthermore, because of my research with the Schenkman lab, my education extends beyond the classroom and outside of the laboratory, into the real-world realm of clinical trials and daily use of medical technology. I find myself fed by the energy of working on my own project. I am motivated day after day by the unveiled discoveries, new solutions waiting to be found, and ways in which I know that my research experience is shaping both my collegiate years and my future in medicine.

The Schenkman lab is poised at the brink of forming a commercial startup; because of this, I am witnessing the translation of innovative research into a commercial application. This is what initially drew me to the field of bioengineering: a problem-solving, engineering approach to medicine, where discoveries have a direct impact on a person's life, not just the advancement of knowledge. I will be watching first-hand as these discoveries come to fruition this winter, when our lab debuts our cellular oximeter in a clinical trial at Harborview Medical Center. Our oximeter provides a window into the cellular level of systemic perfusion, allowing for accurate assessment of oxygen delivery and the non-invasive quantification of shock severity in real-time. Engaging in this clinical trial, I will be collecting spectral measurements of cellular oxygenation from trauma patients as they arrive in the Emergency Department and recover in the Intensive Care Unit. In these fast-paced, hectic environments, I will be standing at the premiere interface of bioengineering research and its medical applications. I know that helping with our clinical trial will be an invaluable experience for me, and one that I would not be able to have without having done my capstone project in the Schenkman lab. Furthermore, watching the preparations for the clinical trial has been extremely educational in my understanding of the regulations, review process, and ethical considerations for a clinical trial in an emergency situation. I eagerly anticipate witnessing this critical translation step from bench-top to bedside and approaching the challenges that this first trial will unveil.

My capstone project will aid in the refinement of the design of our spectroscopic oximeter device by determining the optimal separation of optical probes for photon penetration into muscle. Within our optical probe, optical fibers at the skin surface transmit light through the skin, fat and muscle (Figure 1). Due to the scattering properties of tissue, some of this light is reflected to nearby optical fibers which transmit the light to a photodetector. Since a necessary condition of our cellular oximeter is that the photons reach a muscle depth, my project investigates photon penetration in tissues (using a tissue phantom) and their path from the light source to the light detector. Specifically, my capstone project seeks to determine the most probable penetration depth that both near-infrared and visible-range photons reach when travelling from the surface source, through tissue, and to the surface detector. Moreover, the system that I design will allow me to determine depth of visible and near-infrared (535nm to 800nm) photon penetration as well as the 3D path of travel that is most probable during their migration through tissues in reflectance spectroscopy applications.

In order to map out the most probable 3D photon migration path, I am designing a system that couples spectroscopic measurements with a precise, micro-motion stage. I have programmed the micro-motion system to move a black, plastic, light-absorbing sphere (~2mm diameter) to various 3D coordinate locations throughout a tissue phantom (fat emulsion) that mimics the light-scattering properties of tissue. The volume through which the absorbing sphere passes is the area between the source optical fiber and the detector optical fiber—that is, the area where the photons travel in their migration from the source fiber, through the tissue phantom, and to the detector fiber. With each positioning of the light-absorbing sphere, my program tells the spectroscopy system to measure absorbance. The absorbance measurement taken for each xyz coordinate location indicates the probability that photons pass through that xyz coordinate point. Therefore, plotting the absorbance measurements with their respective coordinate location yields a 3D map of the probable paths that photons take through the tissue phantom.

This summer I began the preliminary design work, programming, and integration of the spectroscopic system with the micro-motion system. My preliminary data, shown in Figure 2, proves that my system can effectively map the 3D probable photon paths. Further work remains to investigate how the photon paths change with: the distance separating the source and detector fibers, variations in the scattering and absorbance properties of the tissue phantom, and the wavelength of travelling light. Furthermore, since visible-range photon penetration in tissues has not been extensively studied, a summary of my methods, results and conclusions may be publishable in a biomedical optics journal. Undoubtedly, this would be a valuable achievement for me as an undergraduate and a testament of my commitment to the project.

My bioengineering capstone project is multi-disciplinary, requiring me to utilize my knowledge from previous courses in circuitry, mechanics, physics, programming, physiology and instrumentation. As the only undergraduate student in the intimate, three-person Schenkman lab, I receive personalized guidance and encouragement from all three professionals, whom I meet with twice weekly. They generously provide not only a desk, workbench and research-grade spectroscopy system for my own use, but also an upbeat, humorous environment that is fun to work in. While I have the spectroscopy expertise of my colleagues easily at my disposal, the challenge of my capstone project is in its interdisciplinary nature, requiring both creativity and persistence on my part to find appropriate resources and solutions for each problem I face. However, this challenge is well suited to my independent and driven character, as I find joy in discovering solutions from unlikely sources.

As Dr. Ken Schenkman's student, I have the fortune of receiving his expert guidance and support with my capstone project as well as shadowing him in the Pediatric Intensive Care Unit (PICU) at Seattle Children's Hospital. This allows me to fully appreciate the role of medical technology in a clinical setting. My shadowing experience has helped me understand the unmet challenges, needs, and opportunities for bioengineering contributions to improve health care. Moreover, it has opened my eyes to the fact that medical technology is only a small part of the medical care-giving process. In the PICU, it is only through the melding of compassion and medical knowledge, along with incredible communication and orchestration, that children receive quality care. For this reason, my shadowing experience is a meaningful part of my education as it has confirmed my interest in pediatrics and my ambition to be a pediatrician.

Due to my research in the Schenkman lab, I now am gaining knowledge and experiences that have not only greatly enhanced my undergraduate years, but will carry with me to my medical education and eventual clinical practice. I could never place a monetary value on the numerous benefits associated with my involvement in the Schenkman lab, nor could I engage myself as deeply were I to work part-time to finance my education. For this reason, I respectfully ask consideration for the support of the Mary Gates Endowment. I know that I am being transformed because of my synergistic research experience, and I am grateful.

Supplementary Figures

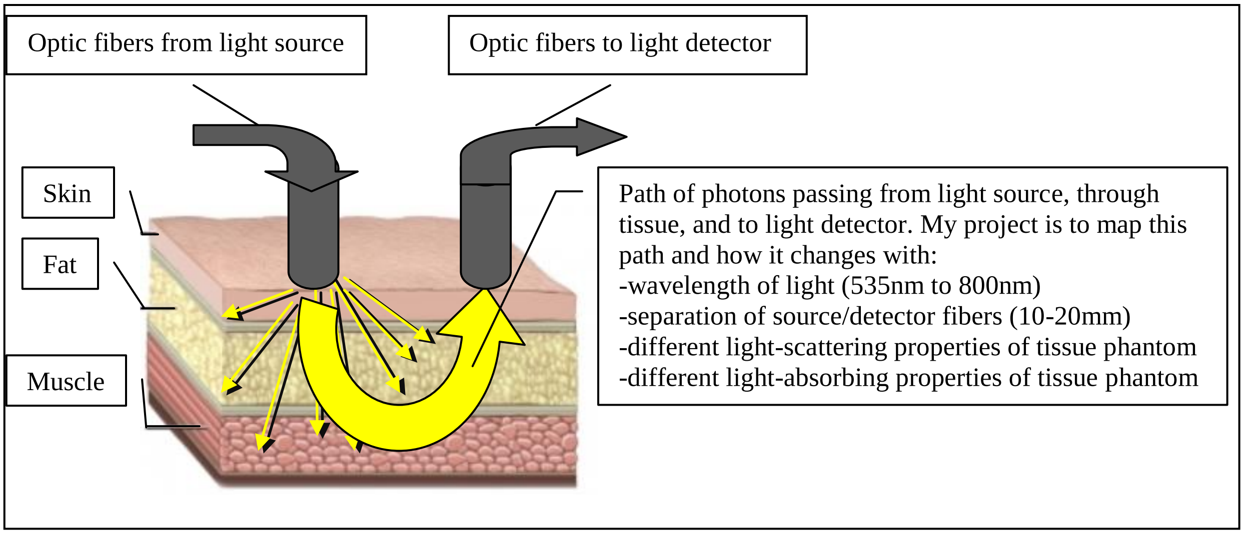

Figure 1 – Skin Layers & Reflectance Spectroscopy
Original illustration of layered skin, fat & muscle borrowed from
http://www.aurorahealthcare.org/healthgate/images/si55551758eb.jpg

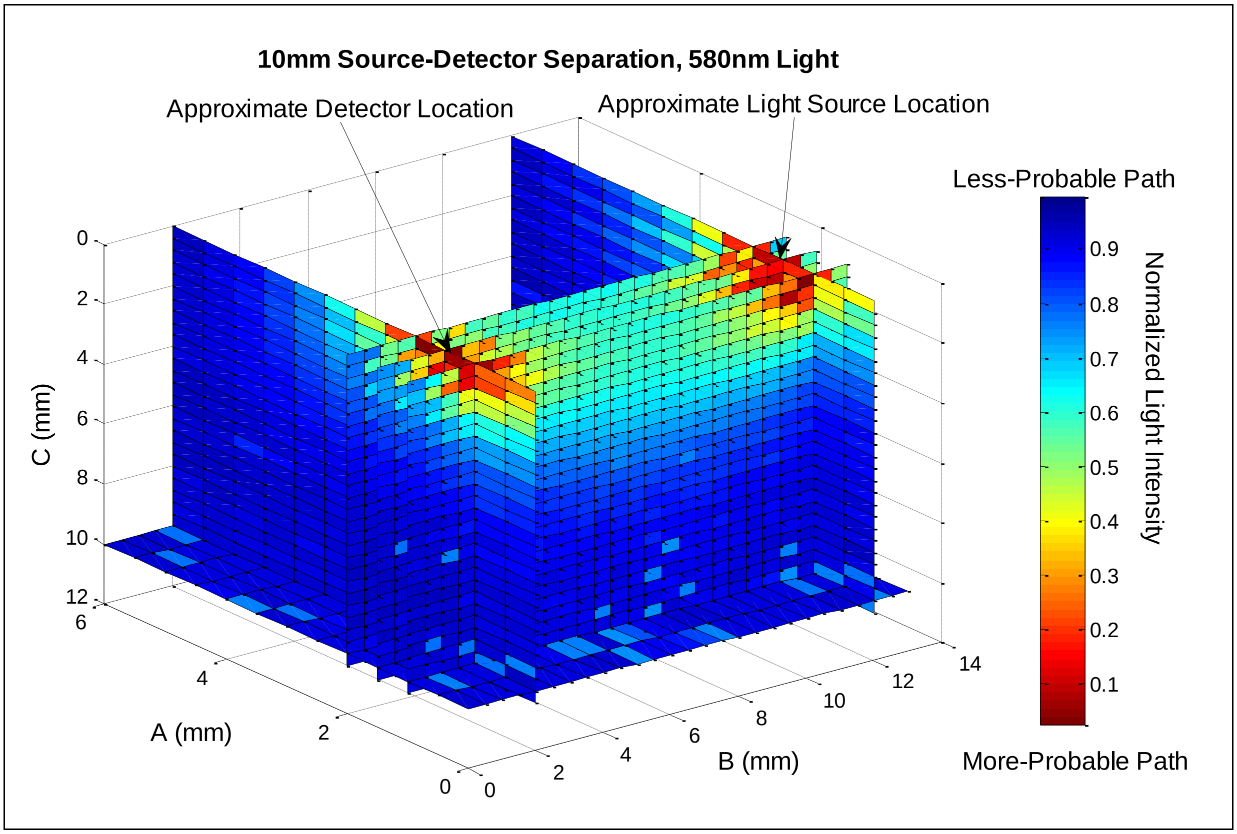

Figure 2- Slices of preliminary volumetric data. The color of a point indicates the normalized intensity of 580nm light reaching the detector when the absorbing sphere is positioned at that point. Since a lower detected light intensity corresponds to the absorbance of more photons, a lower intensity indicates a higher probability that photons pass through that location.