Sebaceous glands, which secrete the lipid-rich sebum that moisturizes and protects skin, play an important role in the pathogenesis of acne vulgaris. The glands are comprised of cells known as sebocytes, which synthesize, store, and finally release sebum into hair shafts. Pharmaceutical interventions for acne improve symptoms by altering the chemical or physical nature of the glands. Interestingly, lipid-rich cells such as sebocytes have long been observed to be particularly sensitive to cold-induced injury. This cold treatment approach has recently been demonstrated to damage sebaceous glands by selectively killing subcutaneous fat cells through a process known as cryolysis. As in pharmaceutical interventions, cryolysis triggers a host of changes to sebaceous glands, which undergo dynamic changes over the course of just minutes to weeks. As cryolysis represents a potential therapy for acne, there is a need to understand the fundamental mechanisms that lead to improved therapy.

Coherent Raman imaging is a non-destructive, non-perturbative imaging technique that makes use of a pair of laser pulses to “tune” into molecular vibrations and illuminate chemical species. With four orders of magnitude signal improvement over traditional Raman tools, coherent Raman technologies enable chemically-specific imaging at video-rate speeds in tissues. Coherent anti-Stokes Raman scattering (CARS) microscopy, a coherent Raman technique, has been found especially potent for imaging skin, revealing the distribution of lipids as well as uptake of pharmaceutical compounds in both animal models and humans.

Using CARS microscopy, we have non-invasively tracked and monitored the damage and subsequent recovery of individual sebaceous glands in living mice from the first minutes following intervention to weeks following cold treatment. As CARS imaging does not require animal sacrifice, fixation, or any tissue processing, this study was able to follow unique sebaceous glands and track their microscale response to treatment. Imaging experiments have revealed dynamic morphological changes in glands throughout the recovery process, including a reduction in sebum content during the weeks following treatment. We have additionally observed heterogeneity in the response of sebaceous glands, which is currently under study. Current studies are focused on tracking the chemical alterations underlying sebocyte cold treatment and long-term response using CARS and fluorescence microscopy along with Raman spectroscopy.