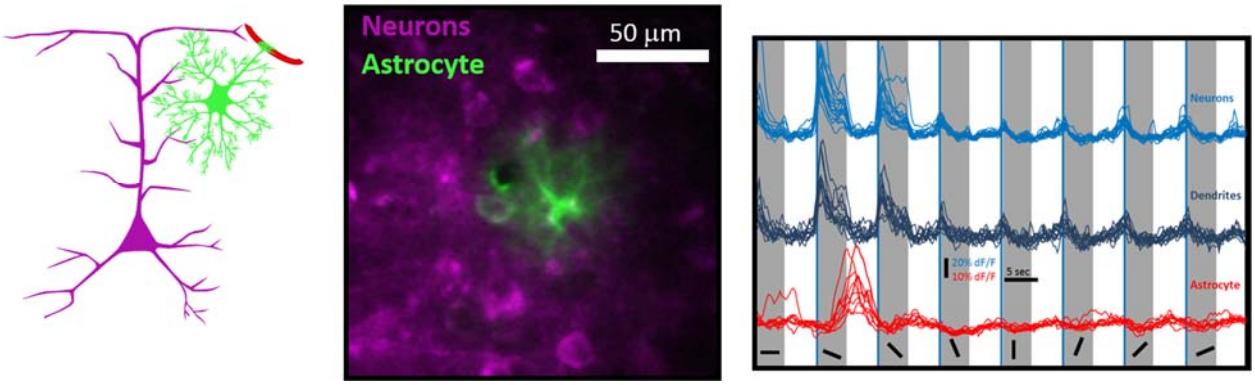
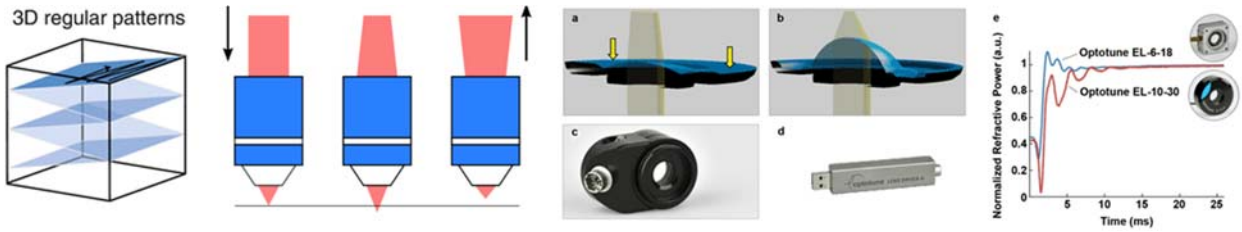
Project title: **Functional interactions between different cell types in the brain.**

The brain consists of many cell types, the most prominent among them are neurons and astrocytes. Neurons are responsible for fast electrical signaling for information processing. The role of astrocytes is less clear, but they are hypothesized to modulate neuronal activity via slow chemical signaling. Through a combination of in vivo high-resolution imaging (see Figure), and computational models, we are testing several hypotheses about these interactions between neurons and astrocytes. Students on this project will assist with data collection using two-photon calcium imaging of the visual cortex of the brain *in vivo*, perform data analysis of these data, and run and test simulations of neurons and astrocytes in the Matlab environment. These aspects will contribute greatly to the lab's work to unravel the mystery of astrocyte function.



Project title: **Imaging more neurons faster in the living brain**

Information processing in neural circuits depends on the coordinated activity of large populations of neurons. We study how information processing in the visual cortex of the brain gives rise to visual perception by imaging the activity of large populations of neurons in the visual cortex *in vivo*. One of the critical constraints on these measurements is the number of neurons we can image simultaneously, and the speed at which we can record their activity. Students will be involved in implementing modifications to our existing microscope to incorporate electrically-tunable lenses, which enable fast, inertia-free changes in focal plane (see Figure). This will enhance the number of neurons we can image at high speed, making use of optical and electrical design and testing to enable 3-dimensional scanning paradigms.



Project title: **Building lightweight, head-mounted fluorescence microscopes**

Measuring the activity of neurons during natural behavior is important for understanding how brain activity relates to cognitive function. However, most microscopes capable of imaging brain activity are too large to facilitate these types of measurements. With the recent advent of open-source, miniaturized, lightweight, 3D-printed microscope bodies, the ability to measure the activity of populations of cells in freely-moving animals is now a possibility (see Figure). We plan to adapt this technology to our experimental paradigm, which requires modifications of existing drawings and electronics to suit our particular needs. Students will make new 3D mechanical designs for prototyping and testing by 3D printing, and incorporate different optical configurations for multi-color imaging. Students will have the chance to test different microscope designs both on the benchtop and in animal testing as well.