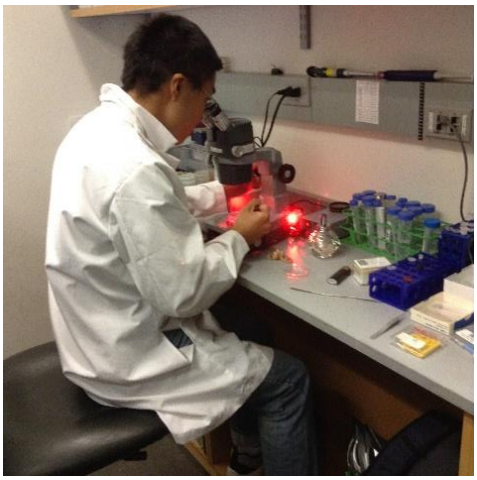

Multiple Oscillators Drive Forward Locomotion in C. elegans
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Forward locomotion in many complex organisms, such as the hind-limb movement of humans, is controlled by rhythmic signals created by "random pattern generator" (RPG) cells in the neuronal circuitry. In humans, there are at least two RPG cells or oscillators that are each capable of creating unique rhythmic signals, but these usually work in unison to control forward locomotion.

The nematode C. elegans relies on a strikingly similar "multi-oscillator" neuronal strategy for its forward swimming and crawling oscillations. Explaining how multi-oscillator models function in simple organisms like C. elegans will allow us to apply that knowledge to more complex organisms. My project seeks to expand our understanding of the multi-oscillator model for locomotion in C. elegans, in the hopes that this information may one day be used to find solutions to neurodegenerative diseases that affect human locomotion (ALS, multiple sclerosis, etc.)

The locomotory circuit of C. elegans is composed of many different sets of neurons, and the current literature has not precisely defined which of these neurons act as the oscillators for forward locomotion. Prior to 2012, the accepted model for the forward locomotory circuit consisted of only a single, primary oscillator in the head. Upon finding evidence that a secondary oscillator existed, my mentor Anthony Fouad began work on identifying where other oscillators may be located.

The majority of my project this summer consisted of testing the motor neuron sets in C. elegans (A, B, D) and also different command interneurons associated with the motor neuron sets for possible secondary oscillators. My project's experiments systematically ruled out the command interneurons, the A-types, and the D-type motor neurons as possible candidates for the second oscillator. The experiments relied on disabling the neuron set to be tested, and then applying optogenetic treatments to see if the worm still demonstrated behavior consistent with a multi-oscillator model. Many of the worm strains had been genetically modified to have their neurons or muscles paralyze when exposed to green/yellow light, and be excited by blue light. While working on this project, I learned a great deal about how to integrate optogenetic trans-genes into worm strains, as well as how to operate a complex laser targeting system unique to the Fang-Yen Lab.

Further work involved creating strains of C. elegans whose neurons could be killed optogenetically, and using these strains to remove B-type neurons in different regions of the worm and narrow down the secondary oscillator's location. Post experimentation, I wrote a Matlab program that performed logistic regression analysis on the results. The output from the Matlab program implied that C. elegans is most likely to exhibit multi-oscillator behavior if neurons in the posterior region are ablated, and that the oscillator could be located as far back as 90% through the worm's body length. I had no coding experience prior to this summer, and working on this Matlab project and others greatly expanded my skillset as an engineer. Additional experiments are ongoing to determine if the oscillator lies in the dorsal or ventral B-type neurons.