

Experiential Neurophysiology for Biomedical Engineering Students

The undergraduate engineering curriculum generally consists of a significant amount of theory and mathematics that are deemed necessary to solve problems in the real world. For biomedical engineering undergraduates this often results in limited hands-on experiences with live tissue samples and biological experimental techniques. In the Biomedical Engineering Program at the University of Rhode Island, this issue is addressed to some extent by implementing an experiential

electrophysiology laboratory. The two-semester project course exposes the students to laboratory skills in dissection, instrumentation and physiological measurements.

A Tale of Two Snails

Well, actually one snail and one slug. Both are from the phylum MOLLUSCA, and class GASTROPODA, but one is a fresh water snail, *Lymnaea stagnalis*, and the other a saltwater slug, *Aplysia californica*.

The invertebrate central nervous system is ideally suited for the study of neurophysiology, as the comparative size of the individual neuron is rather large; on the order of 20 to 200 microns. Intracellular recordings of these cells are accomplished with a modicum of difficulty to an investigator familiar with the anatomy of the specified invertebrate.



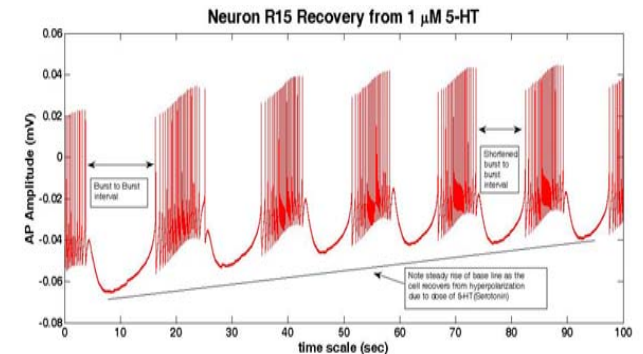
Aplysia californica



Lymnaea stagnalis

Undergraduate Research

The dissection is only the beginning. As engineers, we're interested in the machinations of, well, everything. That is, we want to know what makes things tick. The true educational experience lies not in the learning but rather in the discovery. The Biomedical Engineering Program here at URI offers undergraduates the opportunity to conduct research and present the findings at student and professional conferences in the region.



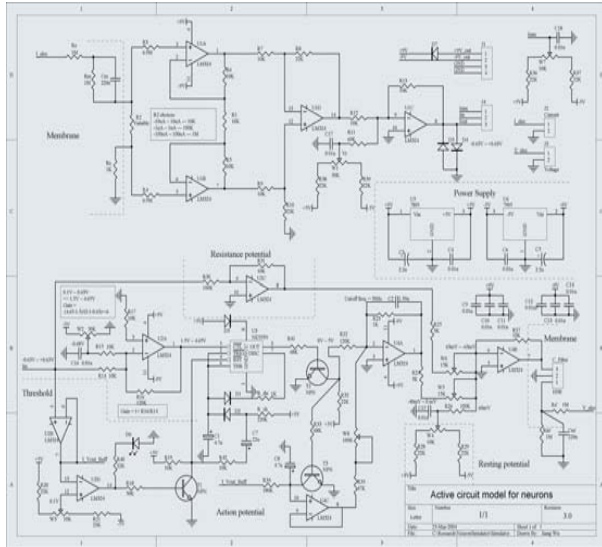
Neuronal action potentials from *Aplysia californica* (Probably saying "Get this microelectrode out of my brain!")

Mother Invention

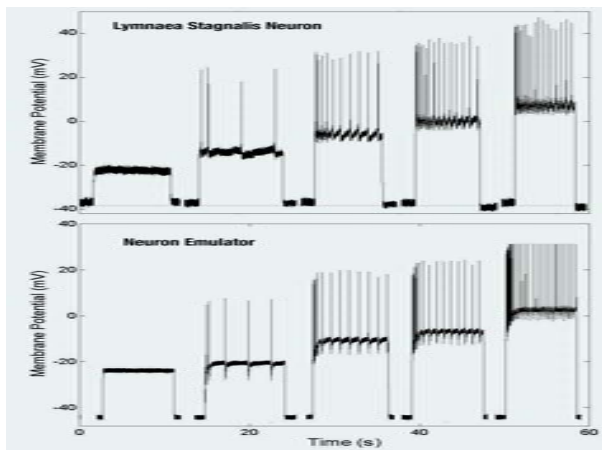
This all sounds wonderful, I know, but where is the engineering you ask? It's everywhere! We can use electrical engineering techniques to analyze the signals, we can use the biology of the animal to model electrical circuits, or help physiologists record signals by building a better mouse, err, *Aplysia* trap. The possibilities are endless.

In the Spring of 2004, the students of the Neurophysiology course designed, built and were granted a US provisional patent for a device that models the neuronal output of the pond snail *Lymnaea stagnalis*. It was then presented to biologists from across the nation at the Northeast Nerve Net meeting at the Marine Biological

Laboratories (MBL) in Woods Hole, MA. The device, called the Neuron Emulator, is in its second generation of design. The device will be made available to other research institutions for education and equipment evaluation purposes.



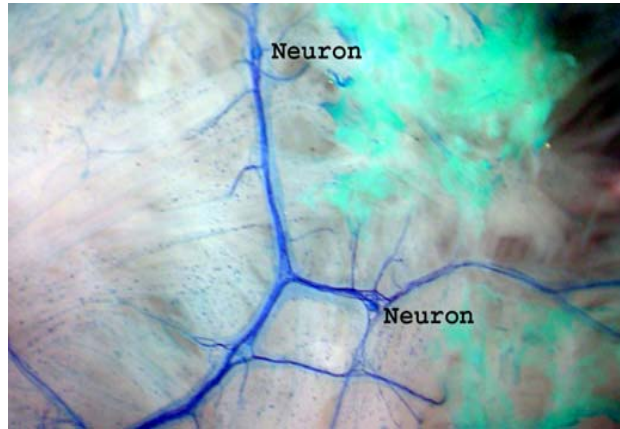
Schematic of Neuron Emulator



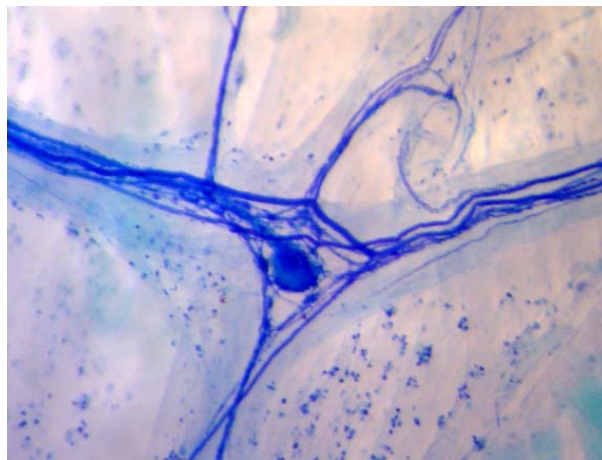
Is it live or is it Emulator?

Got Lobstah?

Snails aren't the only animals we'll plunge an electrode into. Just to keep things interesting, we like to add another dissection to list from time to time. A student body favorite is the American lobster, *Homerus americanus*, since they have rather large neurons in their hearts. What happens to the rest of the lobster? Let's just say some of our Biomedical Engineering students eat very well.



Cardiac trunk of the American lobster, *Homerus americanus*.



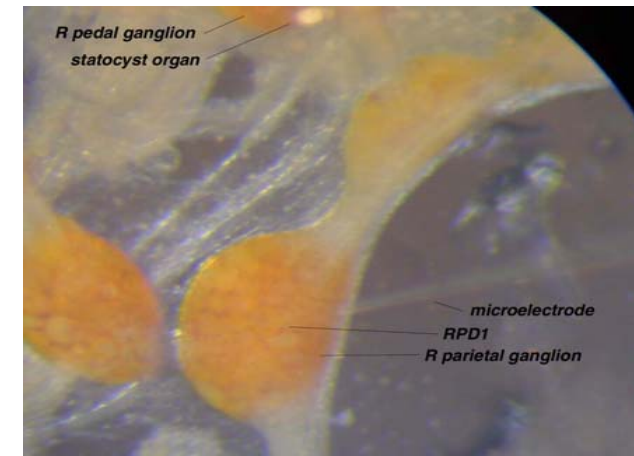
Close up of a neuron in the cardiac trunk.

Visiting Distinguished Researchers

Over the past couple years, the BME Program has been privileged to host several distinguished professors of Neurobiology to complement our own outstanding researchers. This exposure gives students a sense of research taking place in other parts of the world and helps them better understand the dynamics of the global research community. These researchers include Dr. Leon Collis, of the MBL, Woods Hole, MA, Dr. Tim Fort of the Institute of Neurobiology, University of Puerto Rico, Dr. Ken Lukowiac of the University of Calgary and Dr. Kiyooki Kuwasawa of the Univeristy of Science, Okayama, Japan.

Further Information

By now, you are abuzz with questions and interest regarding the wonderful world of neuroscience. Dissections and experiments occur on a regular basis. If you are interested in seeing a demonstration of what we do, please contact Professor Ying Sun by phone at 401 874-2515 or John DiCecco by phone at 401 874-5870. You may also send email correspondence to sun@ele.uri.edu or dicecco@ele.uri.edu.



CNS of the pond snail *Lymnaea stagnalis*