

# *Experiential Learning in Neurophysiology for Undergraduate Biomedical Engineering Students*

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# *Overview*

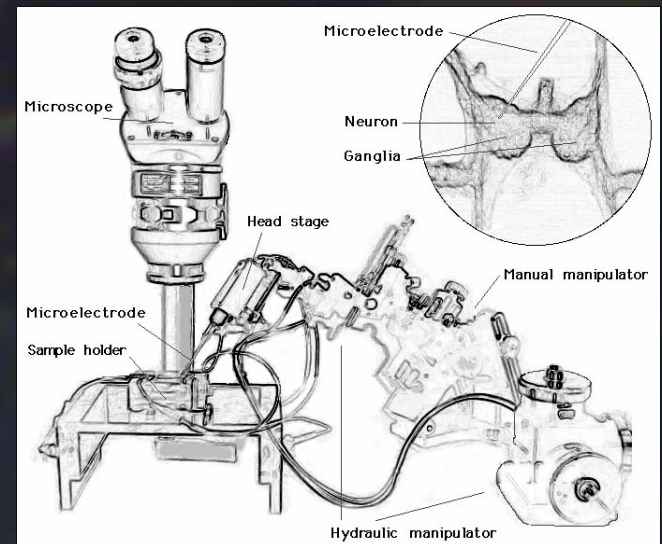
- *Background*
- *Experiments*
- *Objectives*
- *Results*
- *Future Biomedical Live Tissue Experimentation*
- *Discussion*

# *Background*

- *Began as physiology lab replacement*
- *Four all day experiments per semester vs. fifteen several hour experiments*
- *Experiments to include electrical engineering application to satisfy curriculum*
- *Small class structure – 5 students*

# *Experiments- L. stagnalis*

- *Microelectrode recording from Left Pedal ganglia neuron, LPD-1*
- *Resistance in microelectrodes off scale, so noise shielding is critical*
- *Turns out snails have a favorite cocktail- snail saline*
- *Once microelectrode is inserted into the cell,  $Na^+$  influx and  $K^+$  efflux create a small current across a large resistance, yielding spontaneous action potentials*



# *L. stagnalis*



No magnification

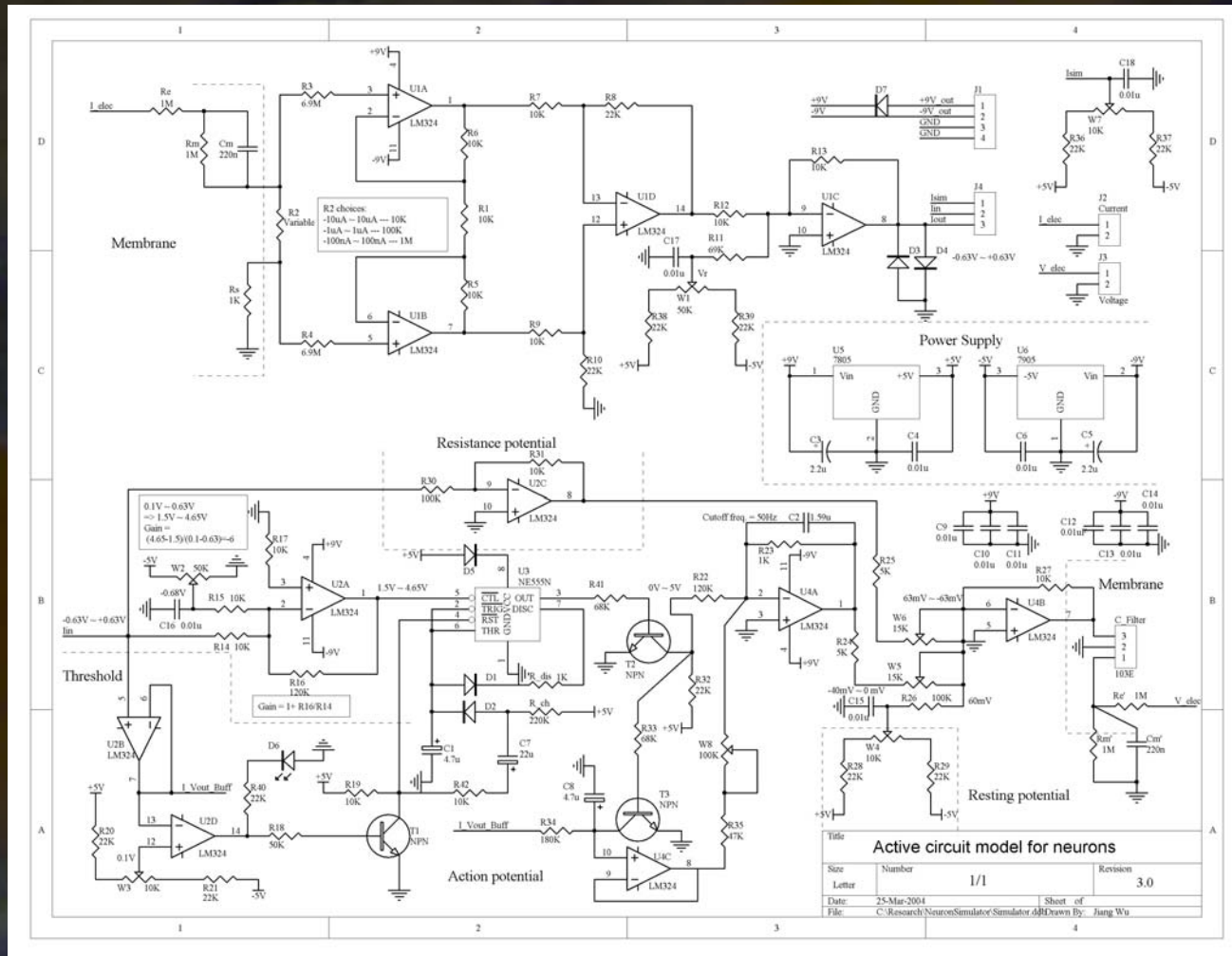


20 times magnification



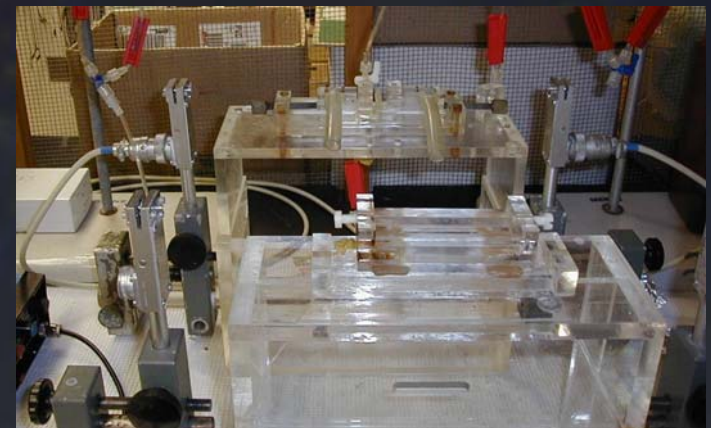
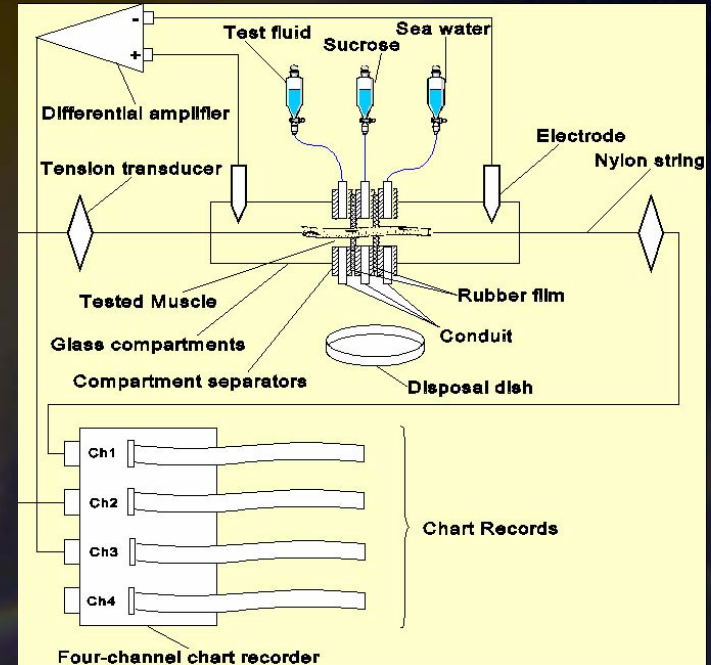
500 times magnification. Microelectrode is inserted from the right of this preparation.

# Electrical Engineering



# Experiments- *B. canaliculatum*

- *Dissect radula protractor muscles from the proboscis*
- *Double sucrose gap methodology*
- *Isolates membrane via control of ion flow to allow recording of change in membrane potential*
- *KCl, Sea Water and Sucrose are used to isolate preparation*
- *Tension transducers record contractility of muscle*



# *B. canaliculatum*

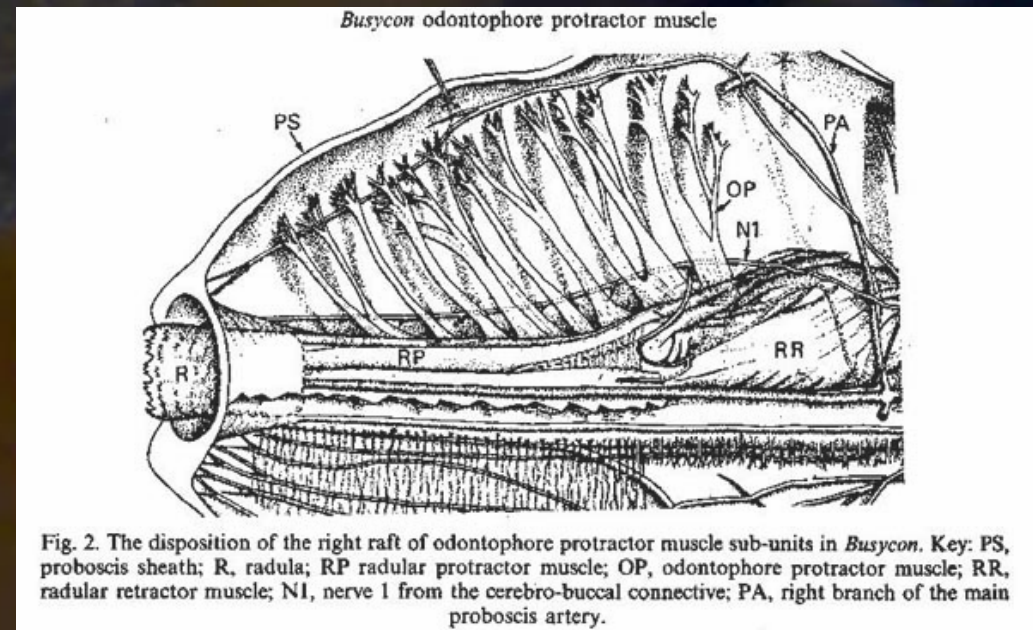


Fig. 2. The disposition of the right raft of odontophore protractor muscle sub-units in *Busycon*. Key: PS, proboscis sheath; R, radula; RP radular protractor muscle; OP, odontophore protractor muscle; RR, radular retractor muscle; N1, nerve 1 from the cerebro-buccal connective; PA, right branch of the main proboscis artery.

**Huddart, et al.** Electrical and Mechanical Responses of the Odonophore Protractor Muscle of *B. Canaliculatum*: A Sucrose Gap Voltage Clamp Study. *Comparative Biochemistry and Physiology*, Vol 102C pp. 149-158, 1992.

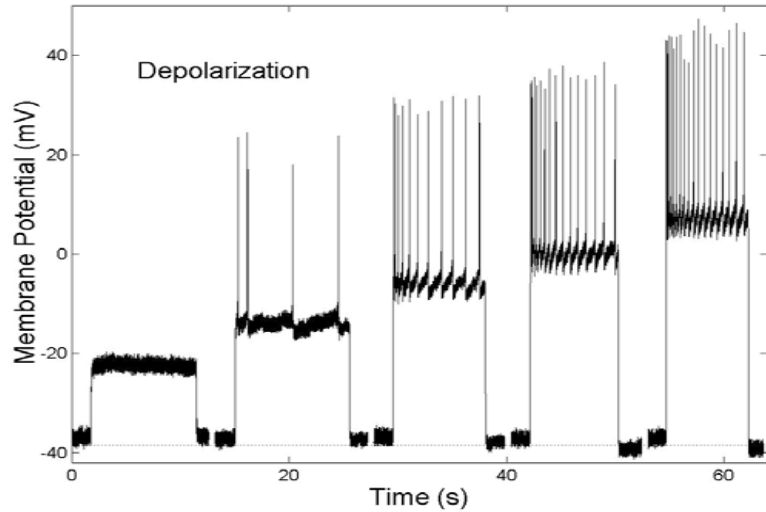


# *Objectives*

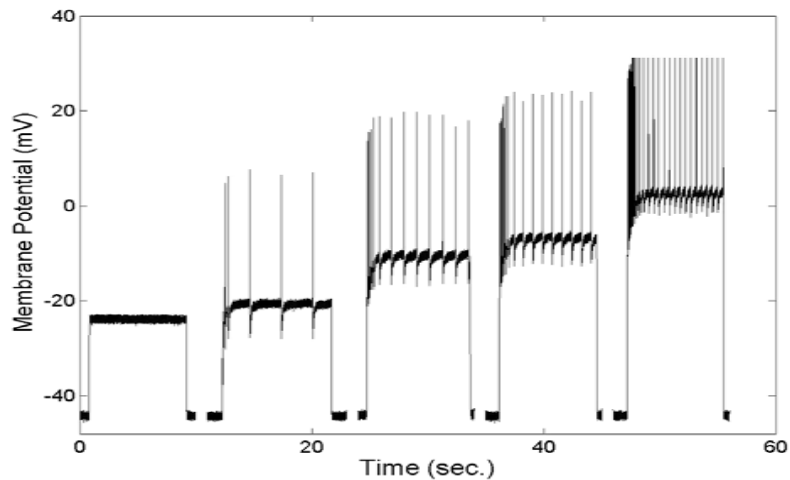
- *Experiential learning using live tissue experimentation*
- *Understand physiological signals to facilitate an electrical analog*
- *Gain knowledge of multiple preparations*
- *Develop necessary laboratory and dissection skills*

# Testing Results – *L. stagnalis*

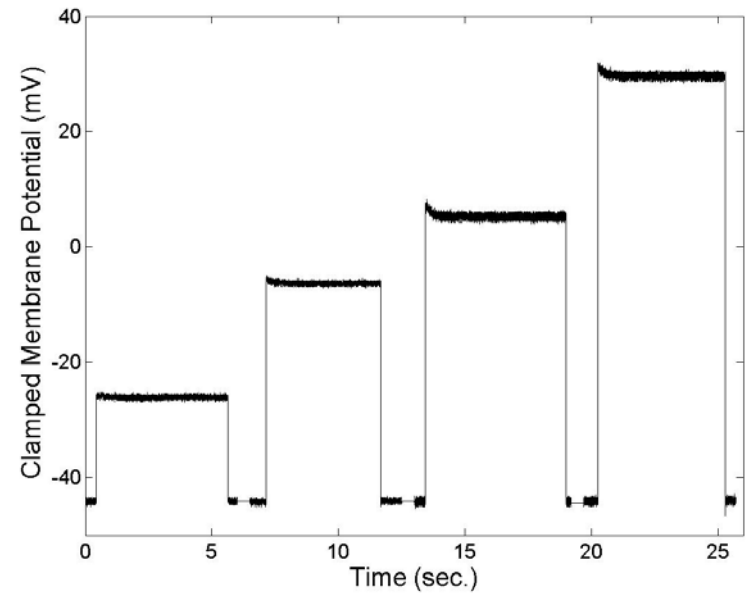
*Real Neuron Result*



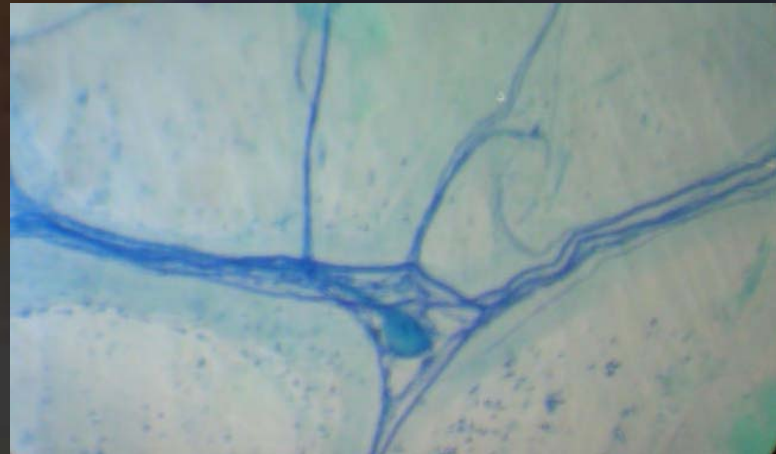
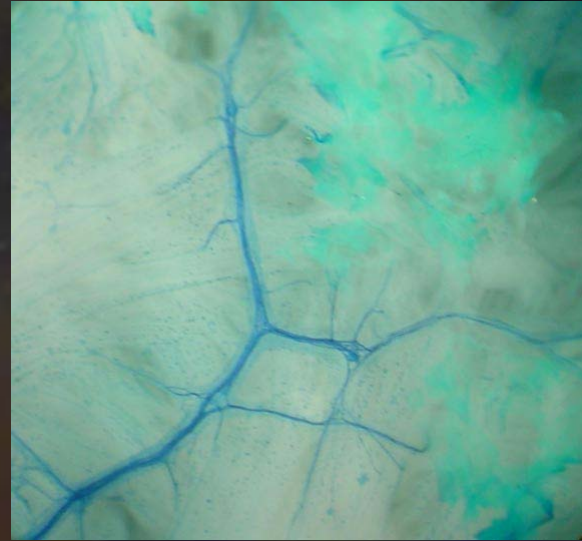
*Model Result*



*Voltage Clamped Model Result  
by GeneClamp*



# *Future Tissue Preparations*



# *Discussion*

- *Poster presentation East Coast Nerve Net, Woods Hole Marine Biological Laboratory, Woods Hole, MA*
- *Submission of work to the journal Advances in Physiology Education*
- *Continue to develop this course and incorporate in Biomedical Engineering curriculum*

# *Special Thanks*

- *Professor Kiyooki Kuwasawa for his expert guidance in the *L. stagnalis* preparation, as well as the *H. americanus* (Lobster) preparation, and for helping us develop a functional electrophysiology laboratory*
- *Professor Robert Hill for his expert understanding of physiological processes, including, but by no means limited to, the intricate mechanisms of spontaneous action potentials*
- *Professor Ying Sun for his ability to model anything electrical*
- *The University of Rhode Island, specifically the Department of Electrical, Computer, and Biomedical Engineering and the Department of Biological Sciences*
- *Western New England College for graciously hosting the 30<sup>th</sup> Annual Bioengineering Conference*