**VR Project 10-Week Plan**

Implementing Virtual Reality in an Introductory Neurobiology Class

**BIOL 373 Units**: underlined units will be accompanied by VR simulations.

Equilibrium Potentials I & II: covered by Nernst simulator.

Passive Membrane Properties: covered by Passive membrane simulator and videos, but can be improved.

* The goal is to go from physical ions, membranes, and ion channels to the electrically equivalent circuit.
* Concepts: ions moving through channels; positive and negative ions moving along an electric gradient; membrane capacitance.

Action Potentials I, II, III, IV, & V: Current Clamp; Voltage Clamp; Patch Clamp; Multiple Conductances.

* I - Positive feedback sequence for sodium ions and repolarization by potassium ions - covered in a video, but no visual simulation. Sequence of m, n, and h gates during an action potential - currently covered by Figure 2 in AP I.
* II - Voltage clamp: currently covered by a video. Hodgkin Huxley experiments: choline, TTX, TEA. Gating probability.
* III - Sodium Current: doesn’t seem to be a priority for animating. Patch clamp: technique could be animated.
* IV - HH Equations; Sag; Calcium; Calcium Dependent Potassium; Persistent Sodium; Fast Potassium

Cable Properties I, II, & III: Passive Cable Simulation

* Hose-Cable Analogy covered by Figure and Video. Cylinder and space constant. Spherical cell and time constant.
* Conduction velocity and myelination.

Synaptic Physiology I & II

Synaptic Plasticity I, II, & III

Novel Transmitters I & II

Sensory Neurons

Neuromuscular Models

Reflex Loop

Central Pattern Generators I, II, & III

**Simulation Descriptions**

1. Passive Membrane Simulation: movie sequence of a patch clamp tip lowering and patching onto a section of an axon. Then the interactive component begins; click patch clamp tip to send stimulation pulse; toggle voltage representations, ions, and electric field lines; V vs. t curves displayed. **Note to Team**: No parameter options/sliders since the patch clamp simulation will go through this; control with the cardboard button would be tedious.
2. Action Potential Simulation: movie sequence of action potentials from a simple sodium/potassium feedback mechanism; m, n, and h gates are introduced and the animation focuses on the gates and pauses at the ‘checkpoints’ of the action potential. **Note to Team**: define the checkpoints later.
3. Cable Properties Simulation: Hose-Cable animations of capacitance, cable flux, and channel flux. Interaction with transient pulse in a cable section with first and second order neighboring recording electrodes to illustrate the space constant. Spherical cell and time constant. Myelination and conduction velocity will also be illustrated.

**Biweekly Calendar**

June 12 - Weeks 1 & 2: Passive Membrane

* Updating voltage maps in 3D; electric field lines representing current flow.
* Representation of the membrane and a patch clamp tip.

June 26 - Weeks 3 & 4: Passive Membrane

* Ion interactions: equations of motion for ions; ion and voltage map coordination; capacitance.
* Combine visual objects and physics to simulate a passive membrane. Try to have a patch clamp current injection sequence.

July 10 - Weeks 5 & 6:

* Create movies for sodium/potassium feedback mechanisms and m, n, and h gates. Build in sodium and potassium currents and a current clamp (should extend from the passive membrane simulation). If time permits, create a voltage clamp simulation.

July 31 - Week 8 (team busy for the 7th week in with NeuroInspire):

* Patch Clamp and other conductances animation if time permits. If the team is behind or would like to move on, it would be better to use this week to catch up or get ahead on higher priority simulations.

August 7 - Weeks 9 to 11

* Build Cable Properties Simulation with multiple recording locations and proper spread of voltage. If the Passive Membrane Simulation was built properly, then this should be a simple extension of that simulation.
* Build in myelination and a truly conducting neuron illustrating the conduction of the signal down the cable.
* Build Spherical simulation to illustrate the time constant.