January 26, 2015

Introduction to Neuron Models, Extracellular Recording Technique

Simulations
Capture and reproduce screen shots to illustrate particular simulations that address the questions you are answering. Initials on assignment file!

Keep in mind: Class participation important- Bonus Points
Expect assignments on time
Review Course policies on Blackboard and Web site
Review “Expectations”

Aspects of electrical activity in a neuron explained by understanding some very basic electrical concepts

1. Voltage attenuation from a source of current injection
2. Distortion of voltage with distance and time
3. Greater AP conduction speed of large axons
4. Greater AP conduction speed of myelinated axons
5. Repolarization of APs at nodes of Ranvier without IK
6. Synaptic Integration- Why we can think!

What are the biological representations of the relevant electrical parameters of a neuronal membrane?

Current across membrane with hyperpolarizations

\[ I_{Na} = I_{K} + I_{C} \]

Steady-state Vm determined by Rm.

How do resistance add in series?- cells connected by electrical junctions
How do they add in parallel?? – ion channels in a neuronal membrane
How do we categorize ion channels?  
What open or closes them?  
What is their selectivity?

What other important properties can differentiate channels that have the same activators?

Other important properties that differentiate channels.  
Inactivation kinetics  
Activation kinetics  
Opening probability  
All can be changed by neuromodulators

Once a channel is open, what Law does it obey?

Only a few equations needed in Neurobiology.  
The separation of unlike charge results in a tendency for an electrical current flow.  
The extent of current flow depends on the conductance (or its reciprocal, resistance) of the medium separating the charges.  

What law is this?
Ohm’s Law

\[ V = IR \]

The separation of unlike charge results in a tendency for an electrical current flow. The extent of current flow depends on the conductance (or its reciprocal, resistance) of the medium separating the charges.

\[
\begin{align*}
I &= V / R \\
V &= I / G \\
R &= V / I \\
I &= V \times G \\
G &= I / V
\end{align*}
\]

How does a separation of specific types of charges occur across a cell membrane?

Membrane Cm

What is capacitance?
\[ C = Q / V \]

What makes a capacitor stronger or weaker?

How does capacitance affect a voltage change?

How does capacitance add in series and in parallel?

How is capacitance relevant to Neurobiology?
Cm on voltage change across the membrane

This week
First Lab: Model Neuron: Membrane resistance, Oscilloscope primer, Time constant, A/D software tutorial- Introduction to Lab Chart

First Lab: Model Neuron
Membrane resistance

Effect of circuit resistances on membrane voltage spread

What do the resistances represent?

First Lab: Model Neuron
Membrane capacitance

Simple RC circuit: Effect of capacitance on membrane voltage

Describe how membrane capacitance alters the time course of a voltage change?

RC circuit- short, consecutive inputs- What happens?
First Lab: Due Thursday, February 5

No formal write-up; Answer questions posed in the lab exercise and for LabChart exercise.

Show example figures of your results: resistor ladder voltage graphs, RC circuit responses, signal conditioning and sampling

Background readings for first week’s lab:
Website: Week 1
222 Passive Properties
Electrical Terminology
Axon Guide