**Neurons in Action WORKSHEET – WEEK 3**

**Name Section# Group#**

**Work through each NiA tutorial as instructed** then answer *the following questions*, adding screenshots of any NiA plots that you refer to. Include relevant plots, with axes and scales, and figure legends if necessary; include other panels only if there are many changes from default values.

Add your answers into this Word document, copying in relevant screen captures, then save as a pdf. You may discuss the problems with your team, but **complete and submit the worksheet independently**.

**1. The Membrane Tutorial**

**1a.** For a pure lipid bilayer (given area 0.0001cm2), change the membrane capacitance to (i) 0.7F/cm2 and (ii) 1.4F/cm2. *For each value,* ***plot*** *the membrane potential during a current pulse of default (2 nA) amplitude, and* ***calculate*** *the rate of change of voltage (dV/dt).*

Use the ”Keep Lines” and “View=Plot” options to display both traces and use the cursor to read out voltage values. Check your result with the equation relating capacitance, voltage change and current. *What is the effect of doubling the membrane capacitance?*

**1b.** *What would be the effect of doubling the area of the membrane patch on (i) the capacitance and (ii) dV/dt, for a 2 nA stimulus current?* (prediction only: you cannot change patch size in NiA)

**1c***. Show* (use Keep Lines) *and explain the difference between the capacitive current density plots with and without leak channels: when leak channels are present, why does a capacitive current flow in the reverse direction after the stimulus current has ended?*

**1d.** Set up a membrane with both a Na/K pump and leak channels. Set the membrane capacitance to 0.5 F/cm2,the leak conductance to 0.0005 S/cm2, and inject 2 nA current (IClamp, default value) for long enough for the membrane potential to approach a plateau.***Calculate*** *the time constant from the plot, and compare it to the theoretical value.*

**1e. *Predict*** *the leak conductance value needed to make the time constant = 10 ms.*

**1f.** *In an excitable membrane, with voltage-sensitive channels, what is the effect of setting the leakage potential to -40mV or above? What type of neuron or excitable cell might show this behavior?*

**2. Threshold: to fire or not to fire**

**2a.** *Is there a “threshold” value for membrane voltage?*

**2b.** *If not, how is threshold best defined?*

**2c.** *What minimum total charge did you use to elicit two action potentials in 20ms? Give the current pulse duration and amplitude, and any other settings that were changed from default.*

**3. The Passive Axon**

**3a.** *What is your estimated* ***length constant*** *for a default (10 m diameter) axon and for a 50 m diameter axon? Include the voltage values that you used to make the calculations.*

|  |  |  |
| --- | --- | --- |
| Axon diameter (microm) | **10** | **50** |
| Voltage value at point 1 (mV) |  |  |
| Distance at point 1 (microm) |  |  |
| V2 = V1 x 1/e (= 0.3679) |  |  |
| Distance at which Vm = V2 (microm) |  |  |
| Length constant (mm) |  |  |

**3b***. When you changed the axon diameter, did this affect the plateau* ***amplitude*** *of the voltage change, the* ***rate*** *at which the voltage changed (time constant), or* ***both****? Describe the effect of the change in diameter at points close to and distant from the site of current injection.*

**4. The Unmyelinated Axon**

**4a.** *Why is so much more stimulus current needed to depolarize the squid axon than the membrane patch in the Introduction or the Membrane Tutorial?*

**4b.** *What is the conduction velocity of the action potential in the model squid axon at the default temperature (6.3oC)? Include the time interval and distance you used to make this calculation.*

**4c.** *What is the conduction velocity in the smaller-diameter axon?*

**4d.** *What other changes do you see in the 10-fold reduced diameter axon, compared to the “squid” axon?*

**4e.** *How does the action potential change at increased temperature?*

**5. Modeling your earthworm giant fiber experiment**

**5a.** *What diameter(s) did you choose to model the earthworm giant fiber(s)? What other parameters were changed?*

**5b.** *Were the predicted velocities consistent with your experimental findings?*

**5c.** *What other parameters or conditions differ between this simulation and the experimental preparation? Which of these could affect conduction velocity?*

**By submitting this assignment, you affirm that the analyses and interpretations presented are your own independent work.**

**ALSO:** develop **Experimental Plans** for next week: team members should cooperate on this, and submit a single experimental plan for the team, 24 hours before the week 4 lab session.