Simulation Exercises – Action Potentials: Part 2

The Ion Channel Olympics!   Your groups will compete in two events.

Event Number 1 – Dynamic Range.   Run SimCC and load the parameter file Cell_challenge1.cc5
This cell begins with the basic Na$^+$ current and K$^+$ current you have already used in previous simulations. In this event, **the challenge is to choose the combination of additional ion conductances to create a cell that has the best possible dynamic range**. That is, the firing rate keeps increasing over the biggest range of spike frequencies and stimulus intensities. The evidence of your success is the F-I plot of your best neuron. An action potential must cross -10 mV to be counted.

To add or change conductances: go to menu Parameters | Conductances.   To increase or decrease the stimulation current, go to menu Parameters | Protocol and change "Injected Current". You must provide data to document your success!   Use the Excel spreadsheet F-I_plots.xlsx to help you plot your data (found on the course website). Feel free to modify the graph or spreadsheet if needed.

To get the full benefit from this exercise, you'll need to monitor the conductances and currents that you are relying on to shape the firing pattern you want. Use the menus in the upper right box to graph all of the currents you are using to understand how they interrelate. **Style points** come from being able to explain why your neuron works the way it does!

Event number 2 – Spike frequency adaptation. Run SimCC and load the parameter file Cell_challenge2.cc5   This cell also begins with the basic Na$^+$ current and K$^+$ current you have already used in previous simulations. In this event, the challenge is to choose the combination of additional ion conductances to create a cell that has the best spike frequency adaptation. That is, the firing rate starts off fast then slows progressively as the burst of action potentials progresses. The evidence of your success is the plot of ISI by spike number for your best neuron. An action potential must cross -10 mV to be counted. Three ways to win: 1) smooth and slow – where your cell slows its firing rate slowly but steadily, 2) run then stop – where your cell starts off fast, then slows abruptly 3) Fast then slow – where your cell fires rapidly at first, then moves to a slower rate.

Use the excel spreadsheet ISI_plots.xlsx to help you plot your data (found on the course website). Feel free to modify the graph or spreadsheet to serve you better.

In this event it will also be essential to monitor the conductances and currents that you are relying on to shape the firing pattern you want. You will probably also need to understand how calcium channels are producing the output you see. For calcium, you will need to monitor its conductance, current, and intracellular concentration.   Use the menus in the upper right box to graph all of the currents, conductances, and ion concentrations that you are using to understand how they interrelate. **Style points** come from being able to explain why your neuron works the way it does!

Homework 5 Assignment: Answer these questions and submit to the appropriate Dropbox:
For the *Dynamic Range* Event:
1. (1 point) The figure that shows your best product
2. (0.5 point) Describe the particular combination of ion conductances you used
3. (3 **style points**) - Explain why the combination of conductances that you chose worked
4. (3 **style points**) – Use more figures from your simulations to support your answer to #3

For the *Spike Frequency Adaptation* Event:
1. (1 point) The figure that shows your best product
2. (0.5 point) Describe the particular combination of ion conductances you used
3. (3 **style points**) - Explain why the combination of conductances that you chose worked
4. (3 **style points**) – Use more figures from your simulations to support your answer to #3