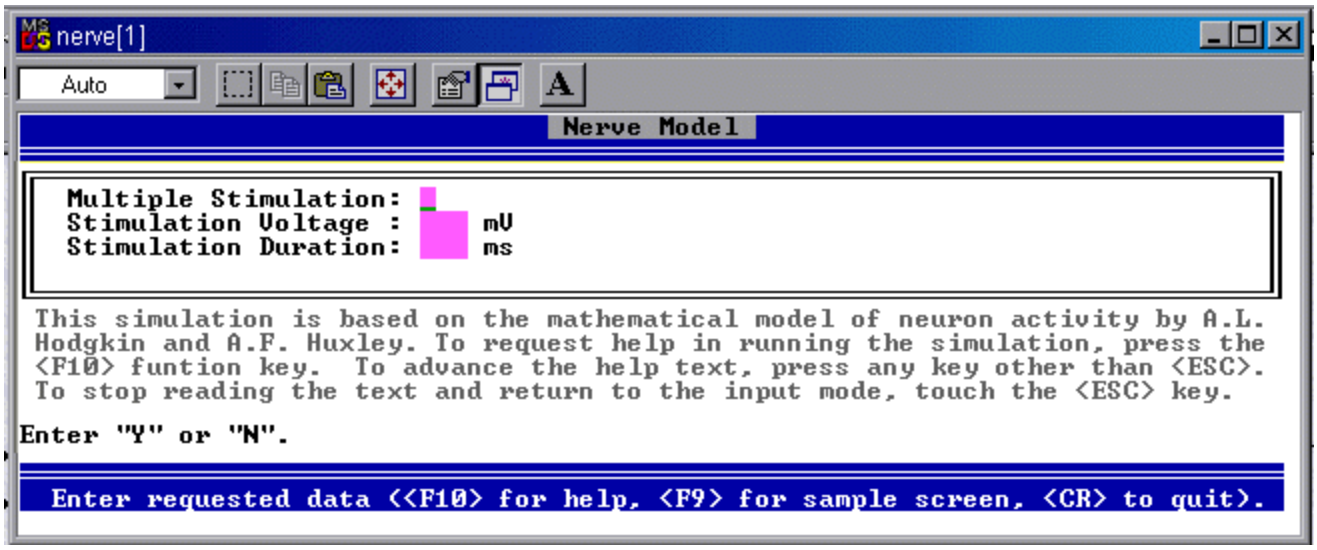
Bill's Nerve Simulation



NOTE: This simulation is a DOS simulation, not a windows program. It will run in a DOS window as shown above. When it displays an action potential, the screen will switch to full-screen mode. I am working on a windows version. This figure shows the setup for the nerve simulation. Background information on the application can be read by pressing F10, an explanatory picture is at F9.

This simulation will allow you to explore the effects of stimulus voltage, duration and frequency on a model nerve cell. If this is your first time using the simulation, press the <F10> function key for help or ask your instructor for assistance. Otherwise, provide inputs for questions in the above menu.

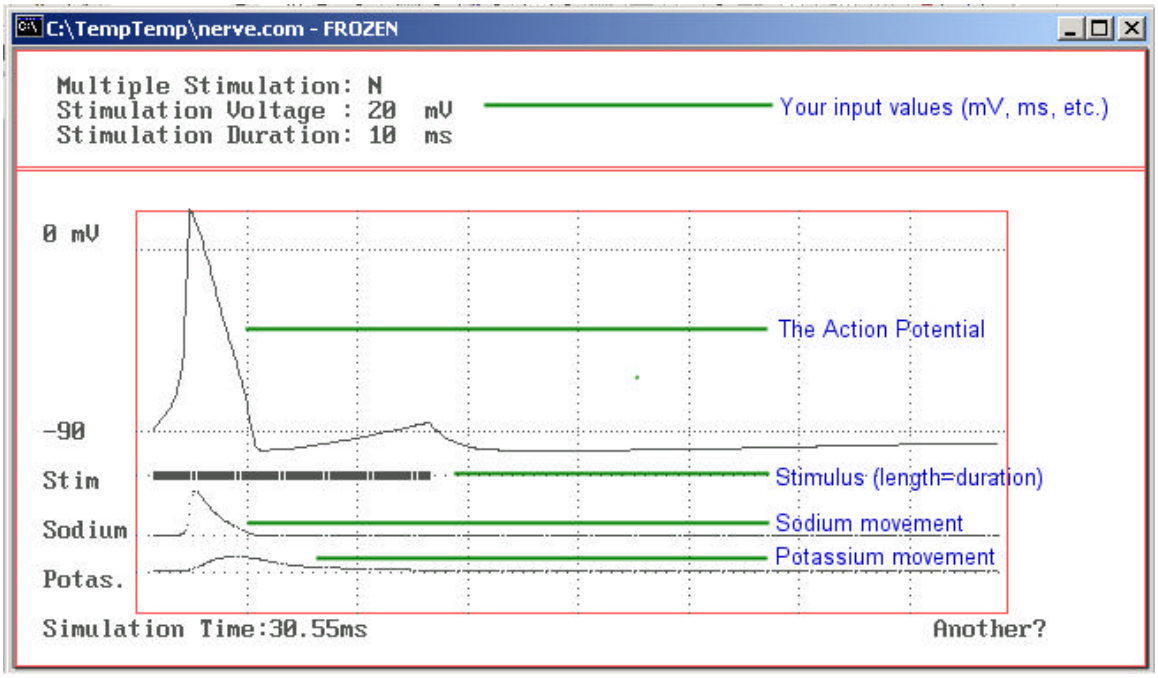
You must first choose either the multiple stimulation mode or the single stimulus mode. The single stimulus mode produces a voltage pulse that like this:" ", while the multiple stimulus mode produces a chain of pulses:" ". In either mode, you can adjust the stimulus intensity in millivolts (mV): Small stimulus: " " or large stimulus: " ".You can also adjust the stimulus duration in milliseconds (ms): Short duration: " " or a longer duration: " ".

The multiple stimulus mode also allows you to vary the frequency:

Low frequency: High Frequency:

_____How to begin_____

If this is your first time using the program, begin with the single stimulus mode (answer "N" to the first question. Then begin with 20 mV stimulus amplitude at .5 ms stimulus duration. Enter "N" to the next question (you don't want to enter a second stimulus). The screen will then switch to a display similar to the following:



1. Determine what a normal action potential looks like, and what stimuli arerequired to produce an action potential. (Start with 20 mV at 0.4 ms).
2. Experiment with varying the stimulus amplitude while holding the duration constant (keep the duration at 0.4 ms and try a lower voltage (like 10 mV). Does the nerve still respond with an action potential? Decrease the stimulus amplitude and determine the threshold voltage for a 0.4 ms duration stimulus. Try increasing the stimulus voltage above 20 mV. Does the resulting action potential look more-or-less the same?
3. Next vary the stimulus duration. Start with a stimulus amplitude near,but below threshold (as determined in (2)) and step up the stimulus duration. Does an increase in stimulus duration allow an action potential to occur for what was previously a sub-threshold stimulus? The remaining experiments rely on the use of the dual stimulus mode and multiple stimulus modes.
4. Demonstration of Absolute and Relative refractory periods. To demonstrate the absolute refractory period, choose the single stimulus mode and enter a stimulus at or near threshold (say, 20 mV at 0.4 ms). Then indicate that you need to enter another stimulus. Enter your second stimulus parameters (for example, 20 mV at .4 ms) with an interpulse interval of only 3.0 ms or so). Since the second stimulus arrives during the active phase of the action potential, the nerve does not respond to the stimulus. Increase the amplitude of the second stimulus by an order of magnitude (keep the first stimulus as 20 mV for 0.4 ms and allow the second amplitude to be 200 mV). Note that the nerve still does not respond indicating that you are attempting to stimulate it during the absolute refractory period. Increase the interpulse interval until you can get a response to the second 200 mV stimulus. If the cell does not respond to a 20 mV stimulus for those conditions, then you have demonstrated the relative refractory period.
5. Next use the multiple stimulus mode to demonstrate the effects of stimulus frequency on the nerve impulse. Choose a subthreshold condition (such as 5 mV at .4 ms) and change the interpulse duration (shorter durations result in higher frequencies).

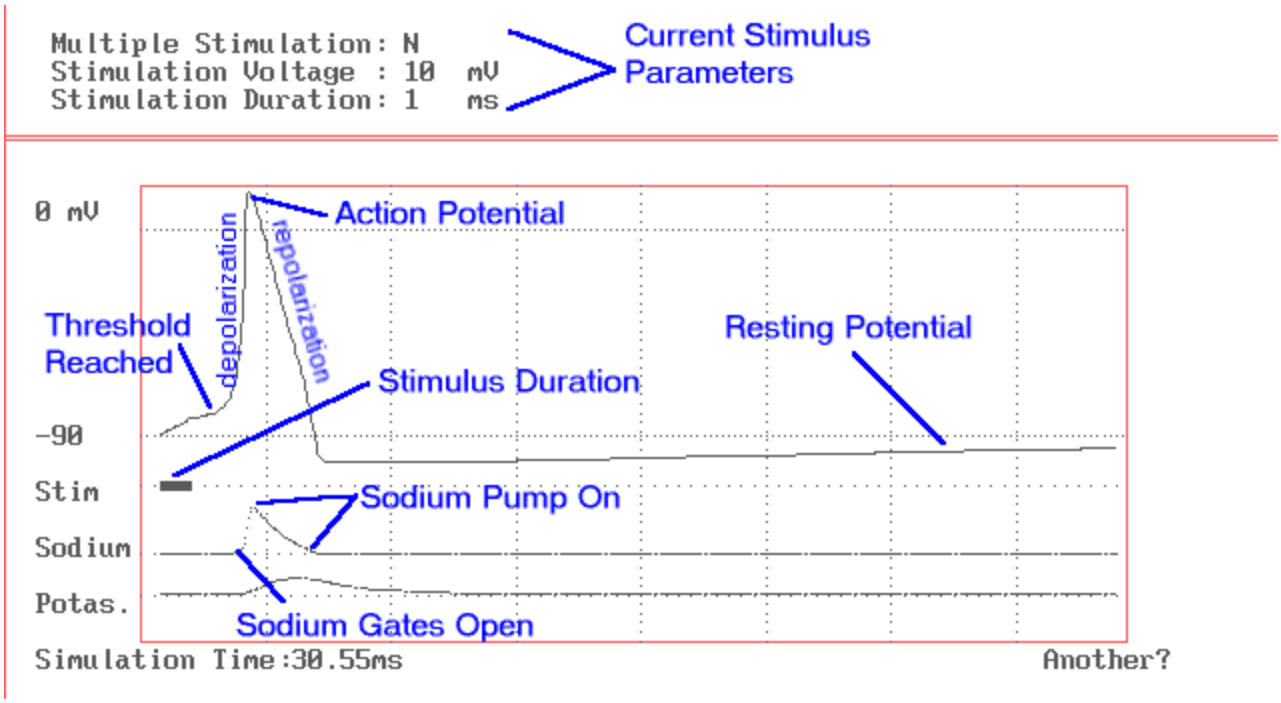
```
Multiple Stimulation: Y
Stimulation Voltage : 10  mV
Stimulation Duration: 1   ms
Interpulse Interval : 1   ms
```

Here, a multiple stimulus simulation is selected.

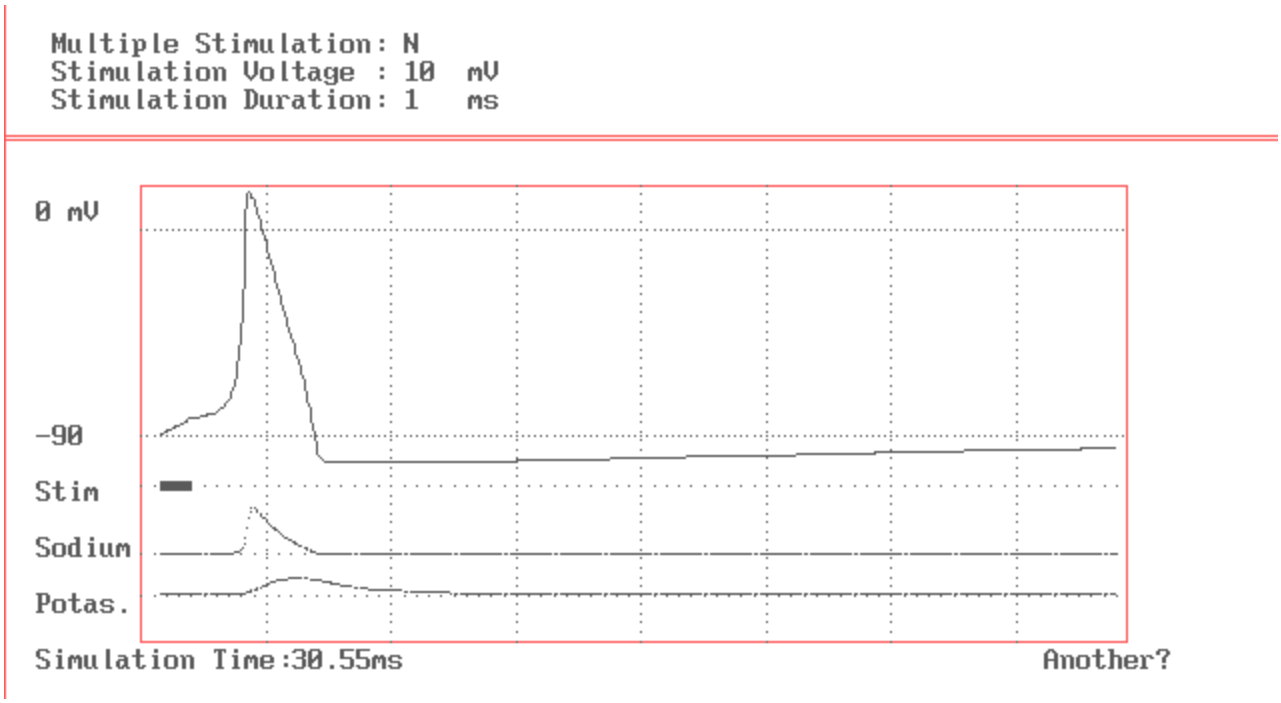
```
Multiple Stimulation: N
Stimulation Voltage : 10  mV
Stimulation Duration: 1   ms
Second Stimulus     : Y

Stimulation Voltage : 10  mV
Stimulation Duration: 1   ms
Interpulse Interval : 1   ms
```

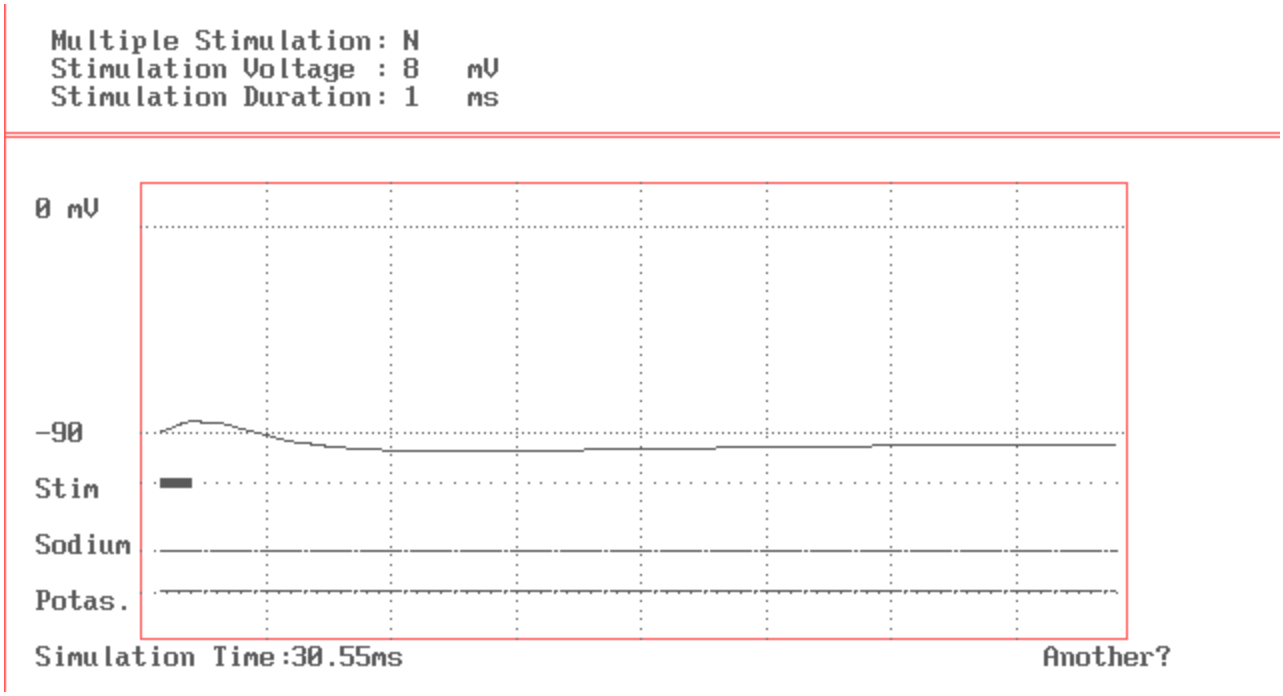
Two stimuli are selected here.



This figure shows the components of an action potential and portions of the screen.

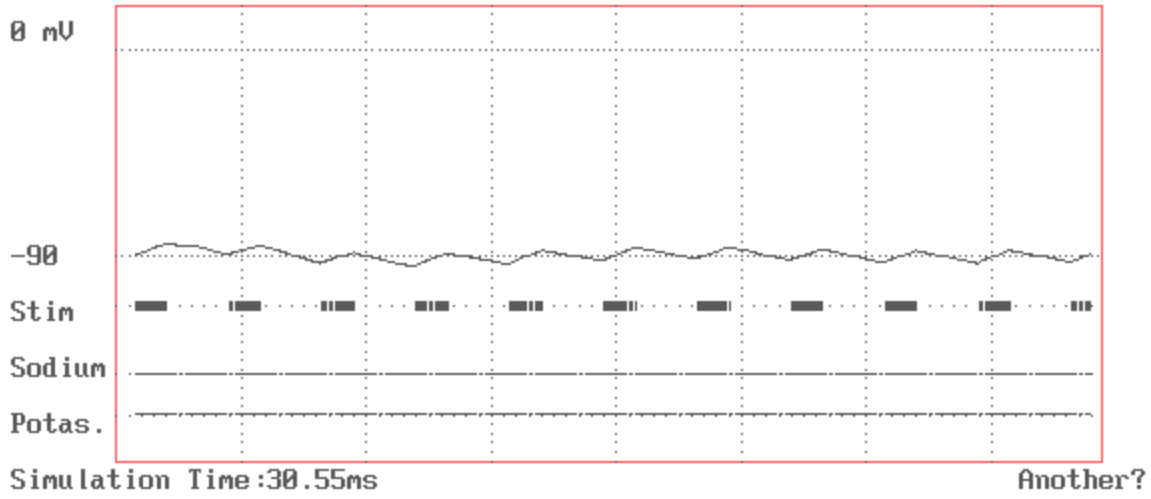


Here are the results of a single stimulus of 10 mV for a 1 mV duration. Try decreasing the stimulus duration while holding the voltage constant until you no longer get an action potential. At that point, increase the stiumus voltage.



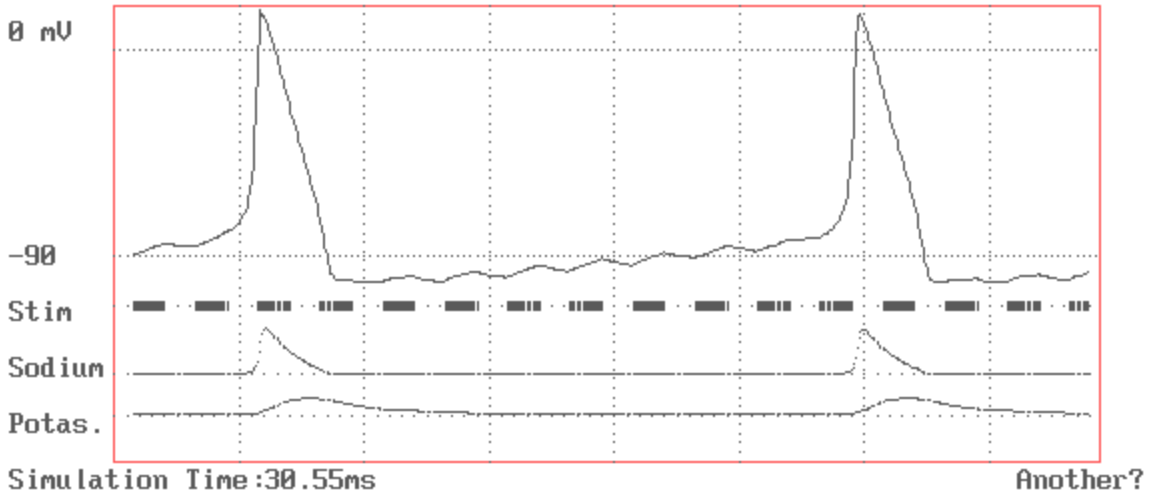
By only slightly reducing the input voltage to 8 mV, the nerve cell never reaches threshold. Increase the stimulus duration until you get an action potential (leave the voltage at 8 mV)

Stimulation Voltage : 8 mV
Stimulation Duration: 1 ms
Interpulse Interval : 2 ms

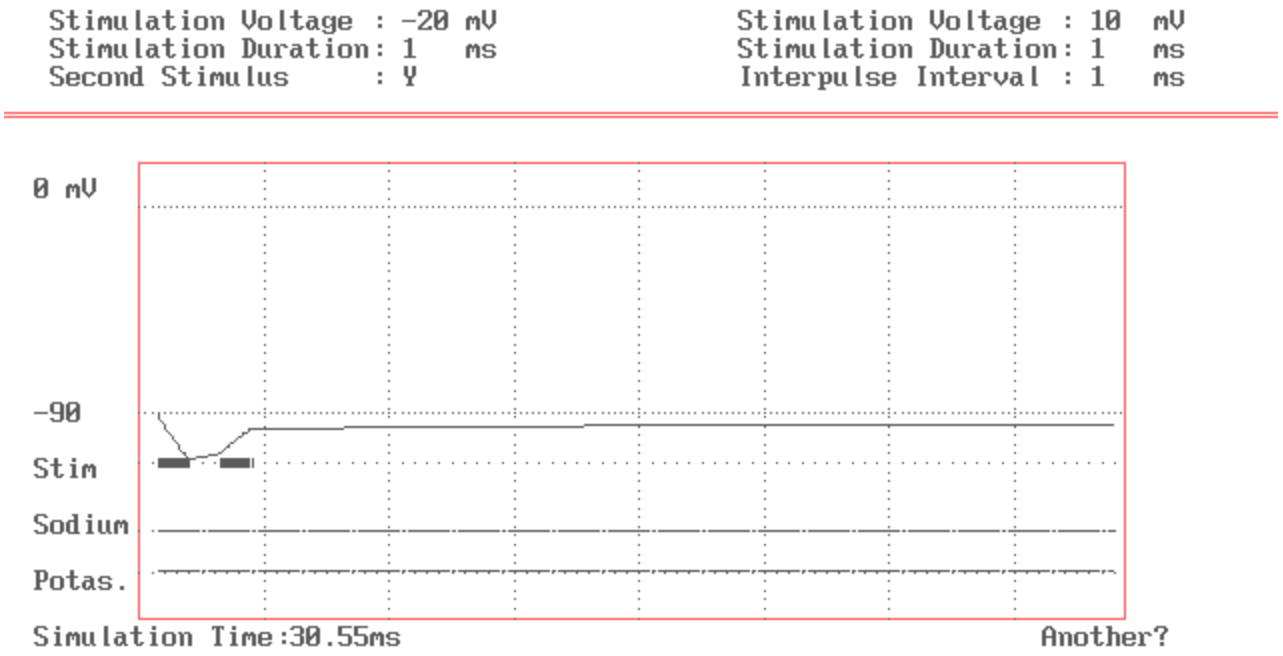


In multiple stimulus mode, an 8 mV stimulus applied at 2 ms intervals never results in an action potential.

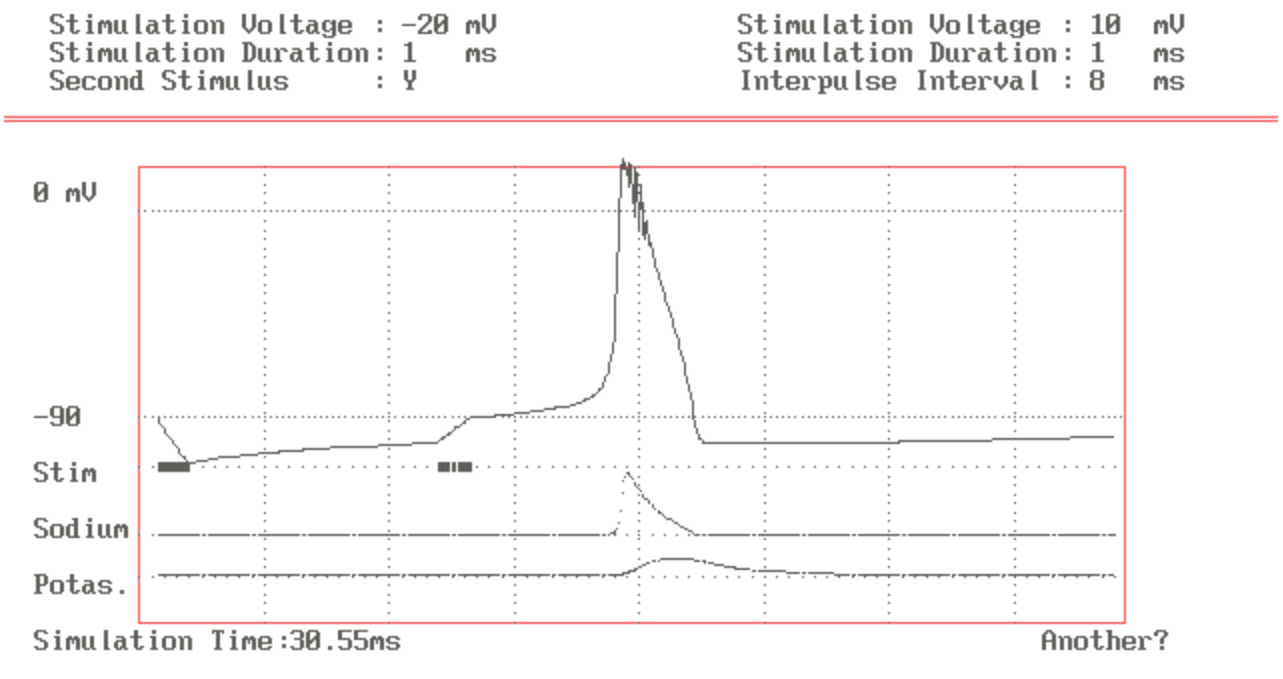
Stimulation Voltage : 8 mV
Stimulation Duration: 1 ms
Interpulse Interval : 1 ms



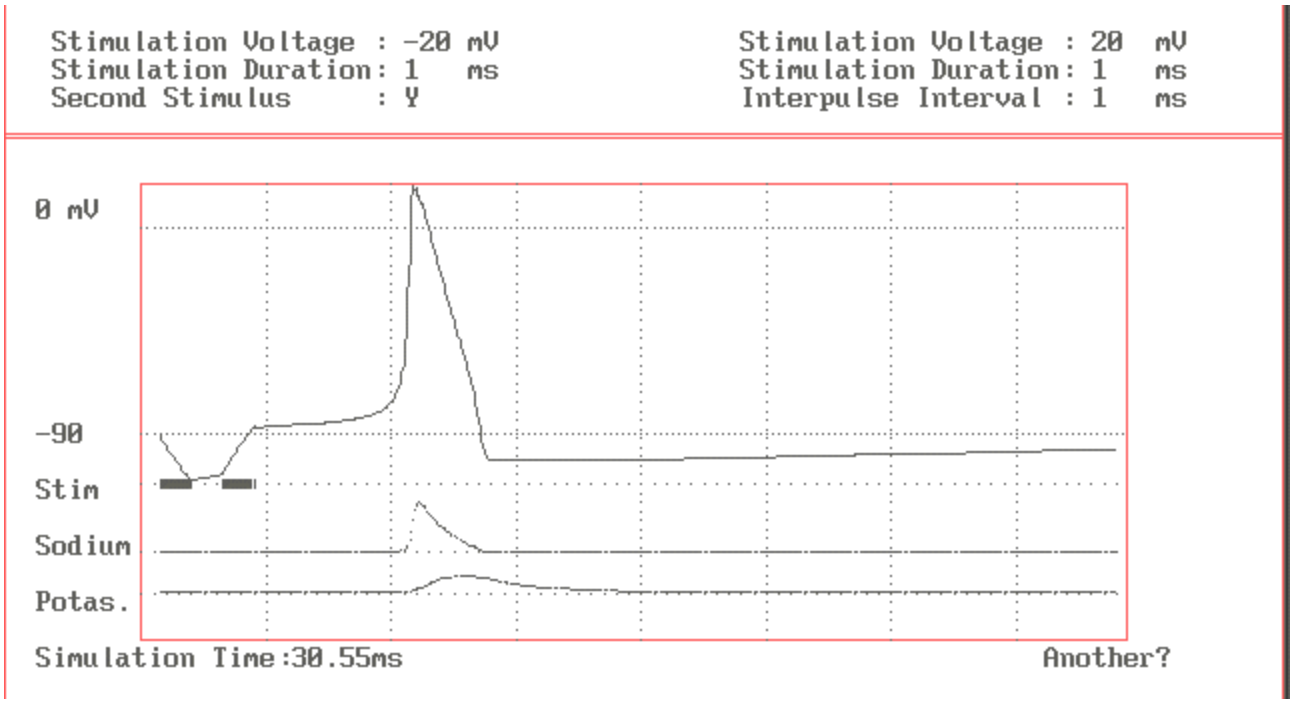
Decreasing the pulse interval while holding the voltage at 8mV will produce action potentials. Increase the pulse interval to 1.5 ms. Explore what happens if you increase the stimulus voltage. What happens if you decrease the pulse interval?



Effects of inhibition on nerve cell function. In this simulation, an inhibitory impuse (-20 mV) is followed by a previously successful 10mV, 1ms stimulus. No action potential is seen.



An action potential is not seen until you allow an 8 ms interval between the inhibitory pulse and the 10 mV, 1 ms stimulus.



A stronger stimulus will permit an action potential.