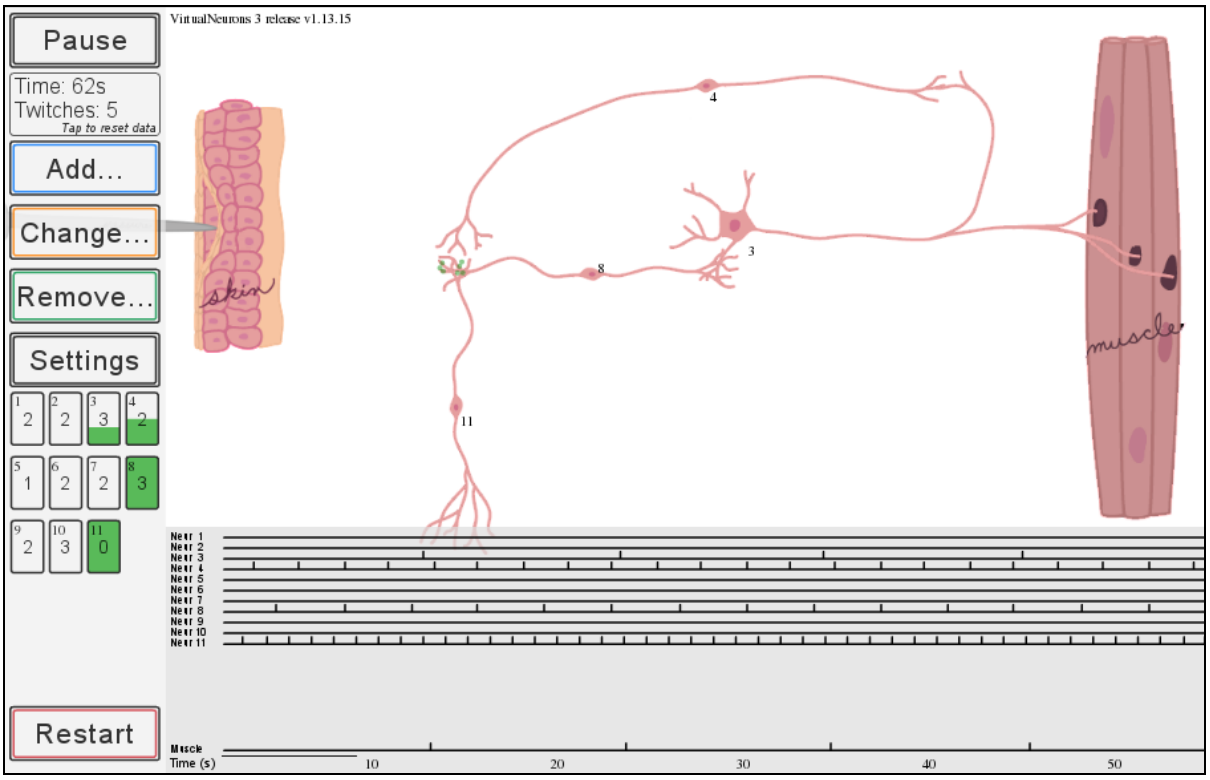
Teacher Note
Homeostatic Circuit with Virtual Neurons

The following set of circuit examples assumes you know how to operate the Virtual Neurons program and understand the use of threshold bars, neuron shape changes, and the principals of excitation, inhibition, and feedback.

Make a block diagram of a homeostatic system. Include the following components: Set Point, Input, Output, Feedback, Comparator, and System to respond to differences.

Construct the series of circuits shown in the examples below. Operate them. Calculate the firing rates for the individual neurons and the muscle contraction. Be able to explain what is going on. As you examine them, identify components analogous to Set Point, Input, Output, Feedback, Comparator, and System to respond to differences.

A circuit that activates muscle contraction from a pacemaker interneuron (neuron 11) with negative feedback (neuron 4)



The negative feedback forms the basis for comparing the actual performance of the muscle with the pacemaker input, as would occur in a homeostatic system.

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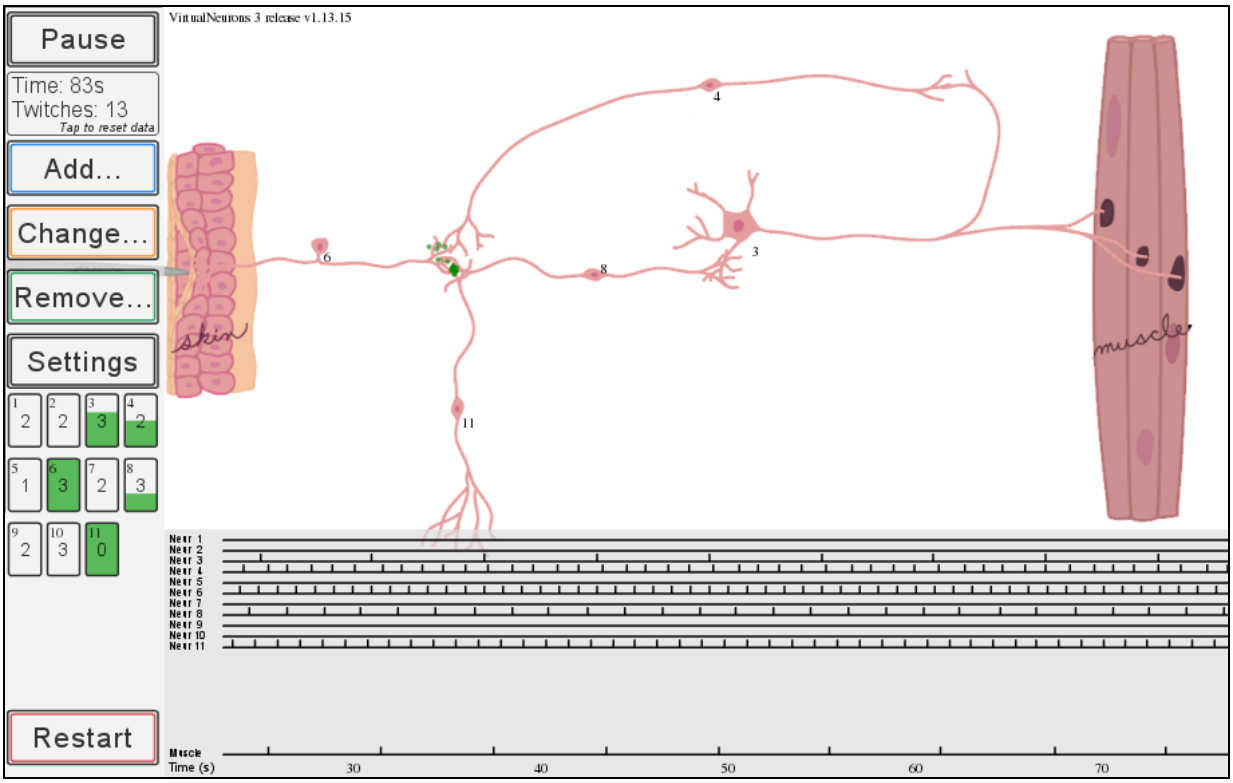
The same circuit as on the previous page plus sensory input

Neuron 8 compares all 3 inputs before causing the muscle to contract.



The addition of another interneuron (neuron 7) in parallel to neuron 5, but with a higher threshold, drives muscle contractions faster only when the input (neuron 6) is higher. Compare above with the next 2 circuits.

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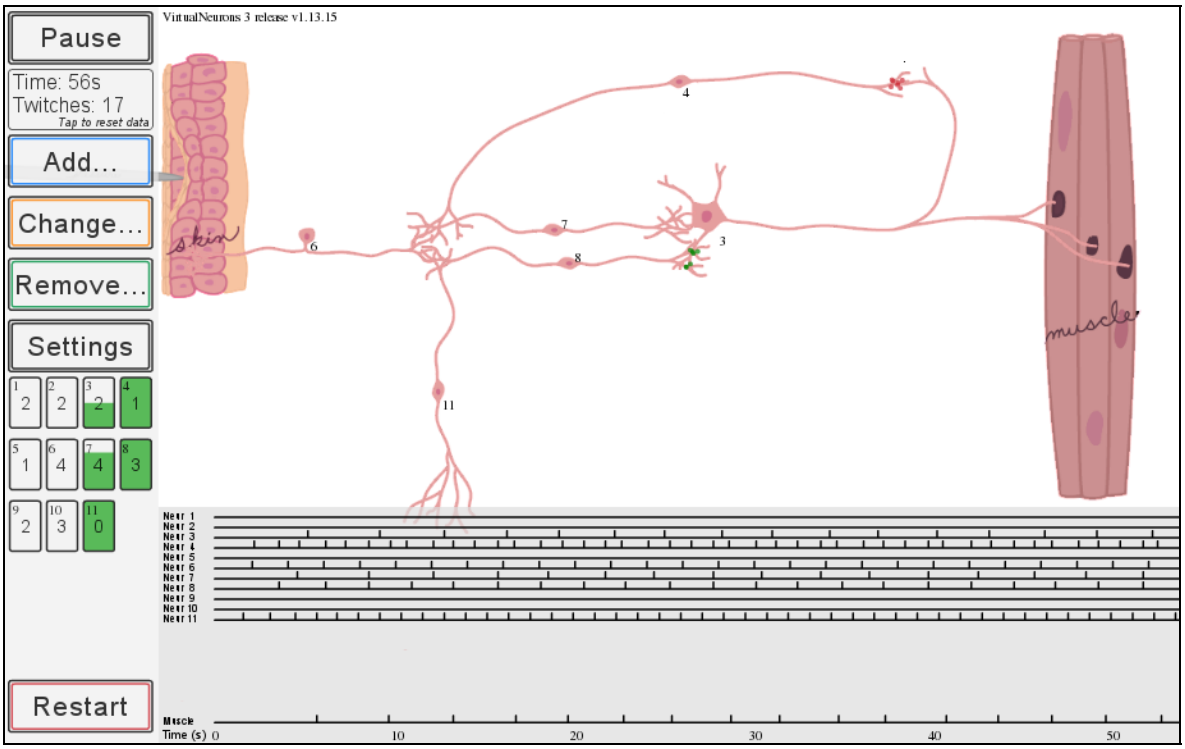

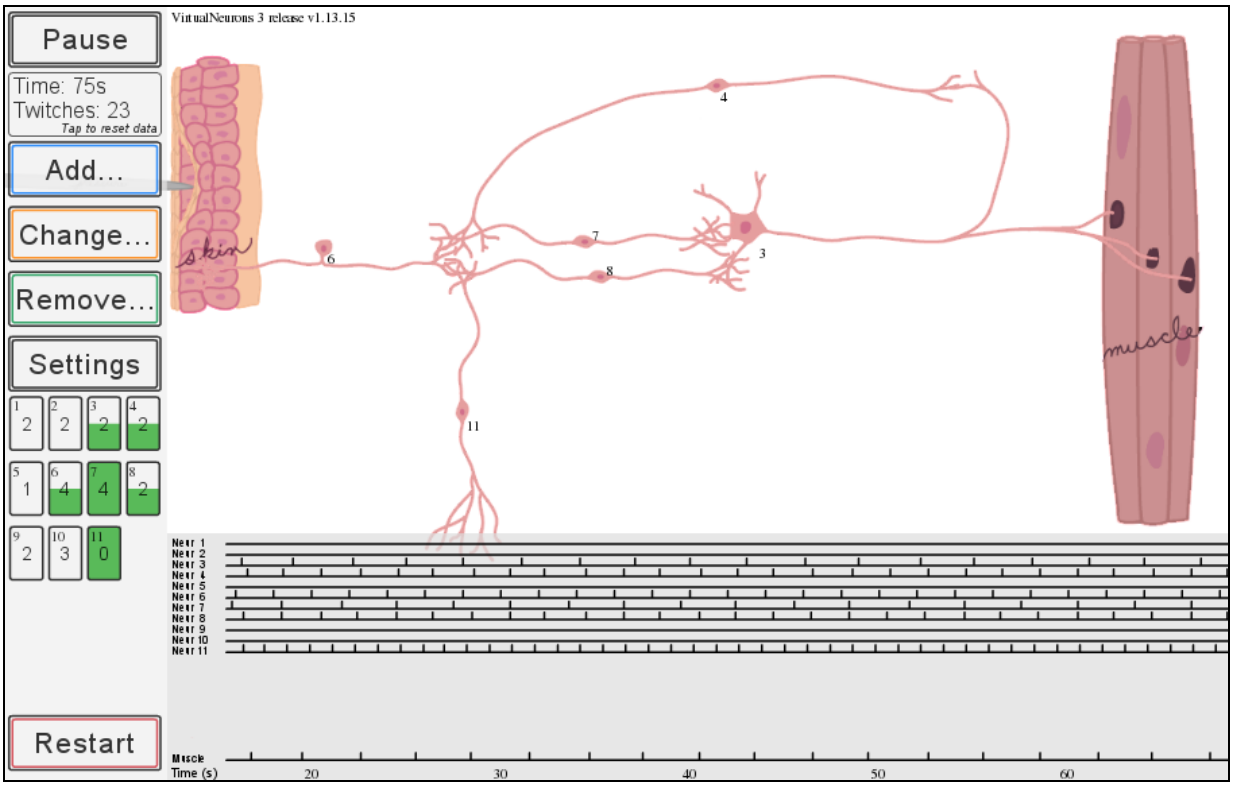

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So having multiple interneurons in parallel in this feedback loop circuit allows it to respond to the differences detected among the various inputs. This is an example of a system that responds in a homeostatic manner. Raising the threshold of the motor neuron (3) will give the system a greater dynamic range over which to detect changes in inputs.

Note the program has a very limited range of input firing rates for the sensory neurons. These can be varied by using the following conditions: spontaneous (zero threshold, no need to touch the skin), maximum when placed on the skin across from the pin, half maximum when moved away from the pin, or modulated slighty by changing the threshold when the neuron is on the skin. Some of these input rates are subtle. So you must calculate the rates of firing to be able to see the differences in both input rates and muscle contraction rates.

Play with changing the threshold on neuron 3. What happens?

Then vary the thresholds on neurons 7 and 8.

Add another excitatory interneuron with a third threshold level. What happens now?

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