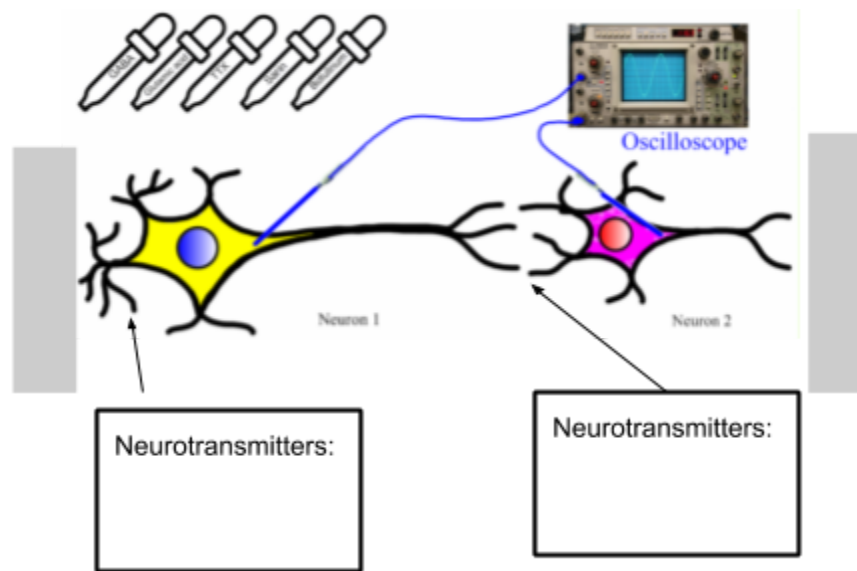


# Experiments in Information Processing and Neurophysiology

Virtual Lab at [jondarkow.com](http://jondarkow.com)



## Experiment 1: Information Processing

Neurons modify signals by receiving neurotransmitters from multiple neurons. Some can be inhibitory, others excitatory. Assume the neurons in the simulation originate in the sacral region of the spinal cord (Neuron 1), and innervate the *rectus femoris* muscle (Neuron 2). When Neuron 2 sends a signal to the *rectus femoris* muscle, the muscle contracts extending the leg at the knee.

Using the simulation determine which neurotransmitter is excitatory, and which is inhibitory, GABA or glutamic acid. The dependent variable in the simulation is the membrane potential of Neuron 1 and Neuron 2. The membrane potential is measured at the axon hillock of each neuron (units are in millivolts.)

1. Answer the following questions about this simulation. **[3 points]**
  - a. In this simulation, from where does Neuron 1 originate?
  - b. What neurotransmitters bind to the dendrites of N1? What do they do?
  - c. Where does Neuron 1 end?
  - d. What neurotransmitter does N1 release?
  - e. Where does N2 begin?
  - f. What is the purpose of N2?
  - g. Double click on the image above and label the organ/cell type that belongs in the boxes before N1 and after N2.
  - h. Label the Neurotransmitters used in each space pictured above.
- 2.
3. **Record** your data in the [Class Data Table](#), sheet 1. Because the simulation allows for randomness, be sure to run each condition 5 times, and calculate the mean, and 2SEM values. Be sure you record **2 data samples**.
4. **Insert** an appropriately labeled graph illustrating how each neurotransmitter affects the depolarization of the neurons. Include 2 SE<sub>x</sub> (95%CI) error bars. **[2 points]**
5. Which neurotransmitter is excitatory, and which is inhibitory? **Justify** your claim with evidence. **[2 points]**
6. Determine the minimal dosage necessary for the neurotransmitter to activate the neurons in this pathway (threshold). **Justify** your answer with data by inserting a screenshot of the data to show how you arrived at this dosage. You should include a screenshot *before* and *after* the minimal dosage is administered. **[2 points]**

7. **Explain** why having a higher concentration of this neurotransmitter does not impact the response of these neurons. **[1 point]**
8. **Explain** which neurotransmitter would be released to flex (contract) a muscle. **[0.5 points]**
9. **Explain** which neurotransmitter would be released to relax a muscle at this neural pathway. **[0.5 points]**

## Experiment 2: Neurotoxins

Neurotoxins interfere with neuronal function. Like any toxin though, dosage matters. The EPA sets limits on the acceptable amounts of different toxins that humans can be exposed to in the environment. In this simulation you will work with each of the neurotoxins and determine the following:

- how the neurotoxin impacts these neurons,
- the biochemical explanation of the impact described, and
- the maximal allowable dosage to which humans can be exposed.

Set GABA to 0, and glutamic acid to 60.

Use the background information at the *Explore Model* tab to learn more about each neurotoxin.

### TTX

8. a. Where is this neurotoxin found? **[0.5 points]**  
b. What does it do? **[0.5 points]**
9. **Predict** how **TTX** will impact the action potentials of N1 and N2. **[1 point]**
10. Run the simulation and determine the impact of TTX on N1 and N2 in this circuit. **Insert and image** representative of the results of one trial. **[1 point]**
11. **Explain** why these results occurred. Provide reasoning to support these results and any differences between these results and your predictions. **[1 point]**
12. Living things can generally tolerate some level of exposure to a toxin. Using the simulation determine the maximum allowable dosage of TTX that humans can be exposed to without disrupting the action potential? **Justify** your answer with data by *inserting a screenshot of the data to show how you arrived at this dosage*. You should include a screenshot *before* and *after* the maximal dosage is administered and be sure **that the screenshot includes the dosage administered**. **[1 point]**

### Sarin

13. a. How is this neurotoxin used? **[0.5 points]**  
b. What does this neurotoxin do? **[0.5 points]**
14. **Predict** how **Sarin** will impact the action potentials of N1 and N2. **[1 point]**
15. Run the simulation and determine the impact of Sarin on N1 and N2 in this circuit. **Insert and image** representative of the results of one trial. **[1 point]**

16. **Explain** why these results occurred. Provide reasoning to support these results and any differences between these results and your predictions. **[1 point]**
- 17.
18. Living things can generally tolerate some level of exposure to a toxin. Using the simulation determine the maximum allowable dosage of Sarin that humans can be exposed to? **Justify** your answer with data by *inserting a screenshot of the data to show how you arrived at this dosage*. You should include a screenshot *before* and *after* the maximal dosage is administered and be sure **that the screenshot includes the dosage administered**. **[1 point]**

### Botulinum

19. a. Where is this neurotoxin found? (You will have to do a Google search to learn where it is found?) **[0.5 points]**
- b. What does it do? **[0.5 points]**
20. **Predict** how **botulinum** will impact the action potentials of N1 and N2. (1 point)
21. Run the simulation and determine the impact of BTX on N1 and N2 in this circuit. **Insert and image** representative of the results of one trial. **[1 point]**
22. **Explain** why these results occurred. Provide reasoning to support these results and any differences between these results and your predictions. **[1 point]**
23. Living things can generally tolerate some level of exposure to a toxin. Using the simulation determine the maximum allowable dosage of BTX that humans can be exposed to? **Justify** your answer with data by inserting a screenshot of the data to show how you arrived at this dosage. You should include a screenshot *before* and *after* the maximal dosage is administered. **[1 point]**
24. a. What are botox injections used for? **[0.5 points]**
- b. How do they work? (i.e., Explain the physiology the underlies the reason(s) for which they are used.) **[0.5 points]**