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Experiment: Record and Manipulate Live Neurons!

Did you just get a SpikerBox, and are wondering how to use it? In this lesson, you will listen to action potentials and view "spikes" in real time. This is an excellent starting point for your SpikerBox. This is a great nervous system lab for students as young as middle school! See live action potentials in an engaging lab activity!

Time 30 Minutes

Difficulty Beginner

What will you learn?

This is a great introductory experiment to get you started with spikes! By the end of this experiment, you will understand what neurons are, how they communicate, and how to record spikes using a SpikerBox!

Prerequisite Labs

None

Equipment

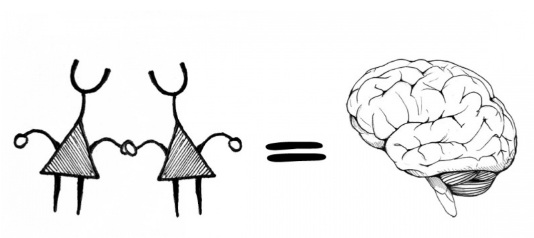
SpikerBox (/products/spikerbox)

Cable: Laptop (/products/laptopcable) Phone (/products/smartphonecable)

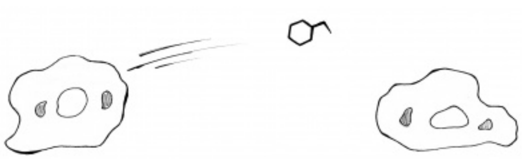
Cockroaches (/products/cockroaches)

Introduction

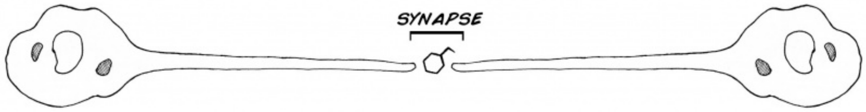
Your brain uses a combination of chemicals and electricity to operate. Brain cells (neurons) communicate with each other to control your body. A brain with only 1 neuron is not a brain.



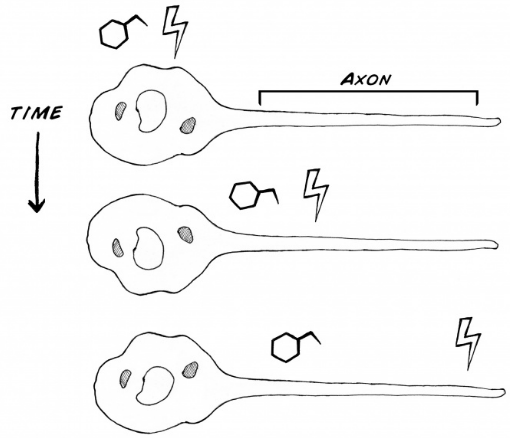
A brain is a network (friendship) of neurons. Your brain has and uses around one hundred billion neurons! But how do all of these neurons talk to each other? One of the the first ways cells used to network was chemical communication.



Bacteria use this method. It works well, but is limited by diffusion. For example, when you release an odor on one side of the room, how long does it take for someone on the edge of the room to smell it? There should be a faster way. One way is to bring cells closer together through stretching.

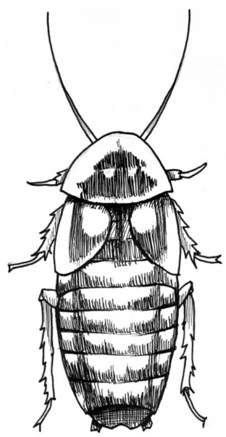


But there is still a problem. The signal still needs to travel a long way through the cell. Is there a way to make this faster? What is very fast & important today?

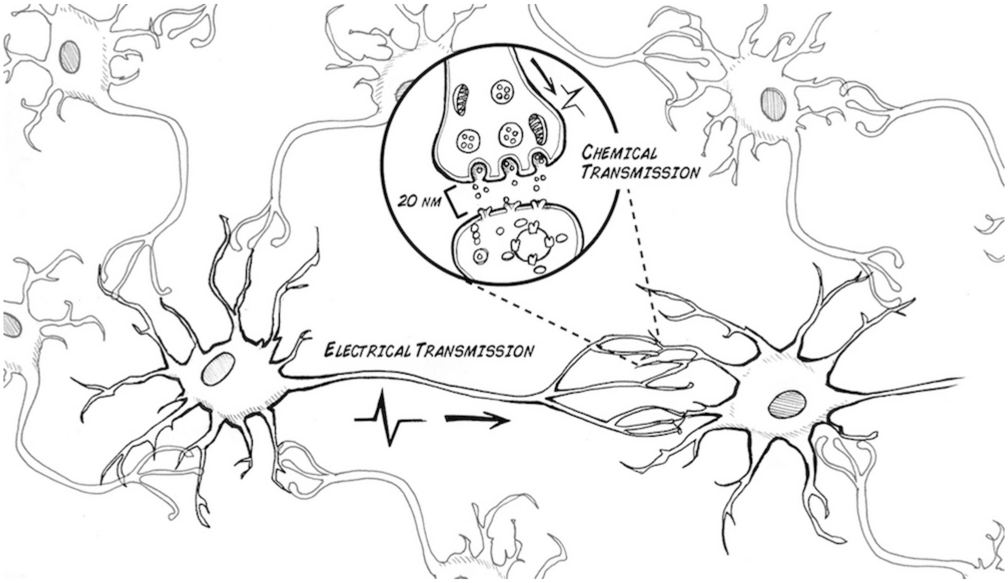


Electricity! Notice how fast the lights in your house turn on when you flick the switch. Neurons use electricity as well; electrical pulses travel down the neurons This pulse is called the:

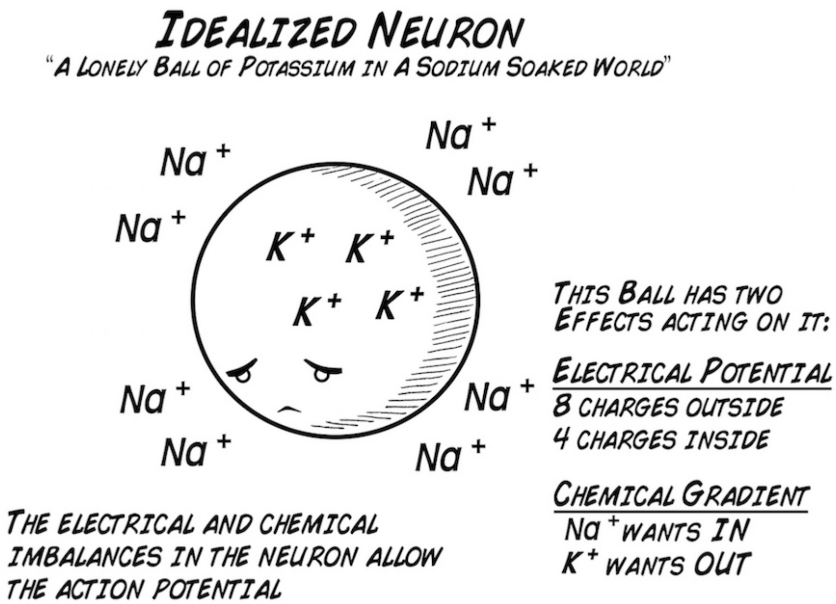
We at Backyard Brains have dedicated our lives to studying spikes, and you can too! What shall we use to study neurons? 380 million years of evolution bring you the cockroach. We will use the Discoid cockroach (*Blaberus discoidalis*), or false death's head. They live in the Amazon rainforest of South America under the bark of rotting trees.



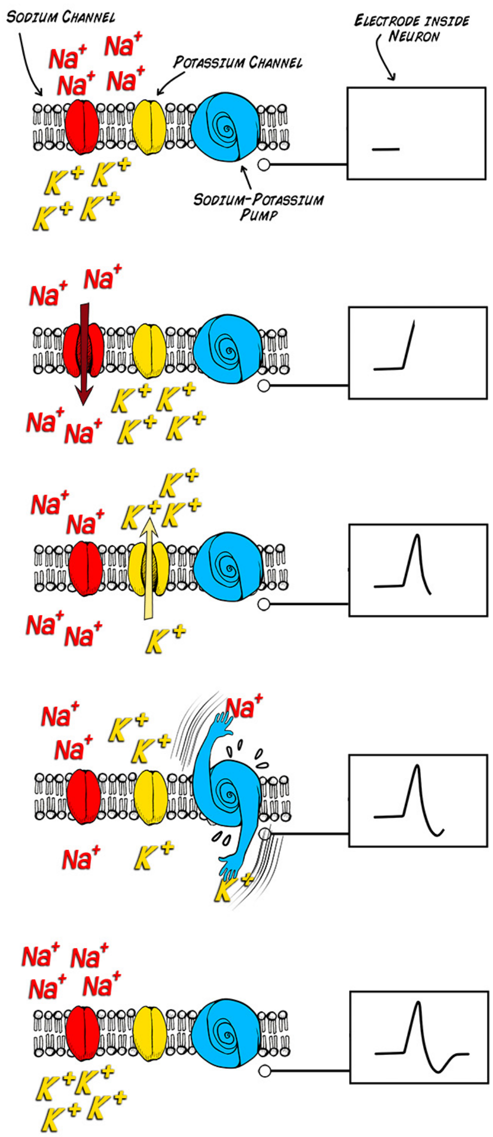
Like most multicellular animals (beyond creatures like sea sponges), cockroaches' bodies are filled with nerves (which are bundles of neurons) to control movement & sensation. As said above, neurons use a combination of electrical and chemical signaling to function.



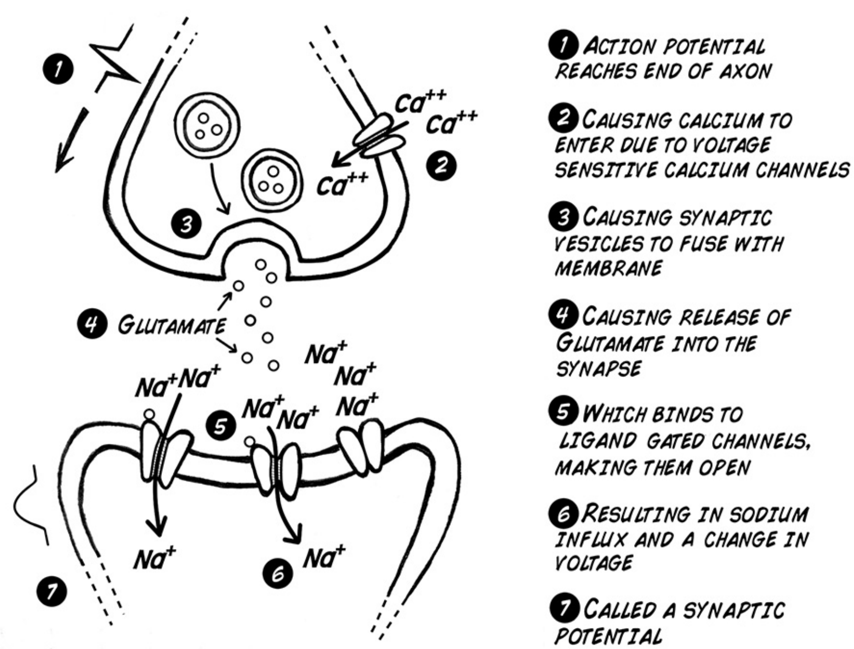
How does the Neuron generate the electrical impulse? It is due to to both a chemical and electrical difference across the inside and outside of the neural membrane.



The movement of sodium and potassium across the neural membrane causes the momentary change in voltage called the action potential or "spike".



What happens when the Spike reaches the end of the axon? It causes the release of neurotransmitter across the synapse, when can change the electrical properties of the next neuron.

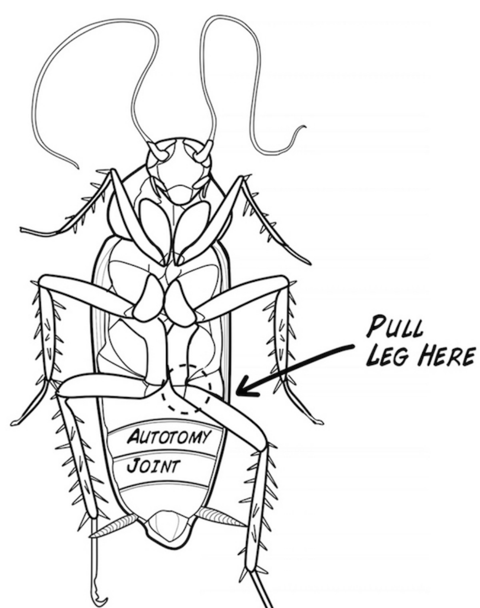


But enough theory, let's see this spike for real!

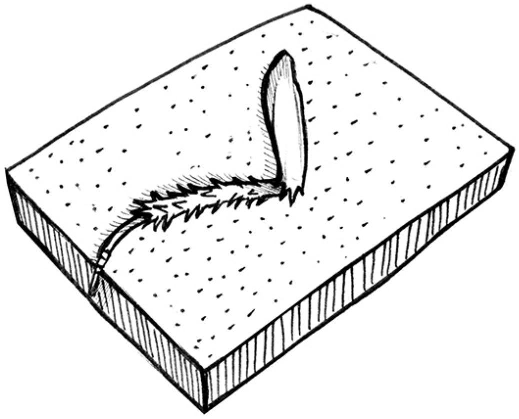
Procedures

1. Take a cockroach & put it in a jar of ice water. Wait a few minutes until it stops moving.

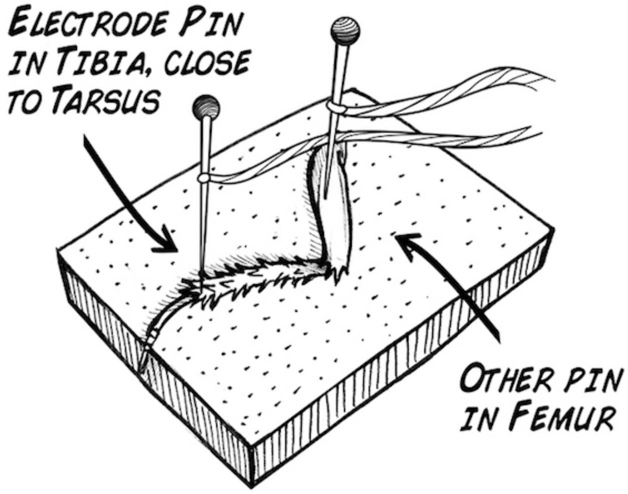
2. Remove the cockroach, and with a tug on the femur, pull off one of his legs near the body. Don't worry, the leg is designed to break easily at this joint (like the tail of a lizard) and will grow back to full size within 125 days (http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0146778). Note: we used to say "cut the leg" but have since found pulling the leg makes the cockroach regenerate the leg faster.



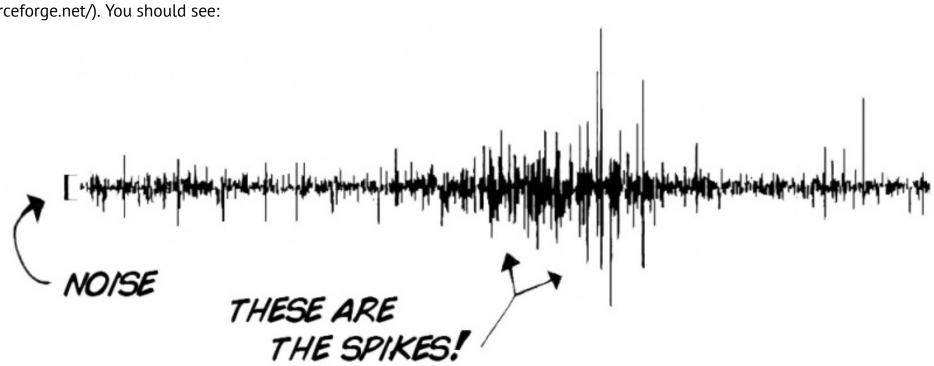
3. Return the cockroach to its house. It'll be fine, the leg will grow back if the cockroach is not a full grown adult yet (Adults have wings, nymphs don't).
4. Place the leg on the cork of your SpikerBox.



5. And put the two electrodes in:



6. Turn your SpikerBox on! If you hear a popcorn sound, congratulations, you have just heard your first neurons! Now let's see what the electrical discharge looks like. Plug your sound cable from the SpikerBox into your smartphone or into the microphone input of your computer.Turn on our free "Backyard Brains" app (Android (https://play.google.com/store/apps/details?id=com.backyardbrains) or iPhone (https://itunes.apple.com/gb/app/backyard-brains/id367151200?mt=8)) on your mobile device, or, if on a laptop, our Backyard Brains computer app (/products/spikerecorder) or Audacity (http://audacity.sourceforge.net/). You should see:



7. Zoom in, & the spikes look like:

This is due to ion channels opening and closing in the neurons, causing the pulse.

Note: You can also do this experiment on crickets if you do not have access to cockroaches. You can usually buy crickets at local pet stores. See video:

Science Fair Project Ideas

- You are doing extracellular recordings, that is, your electrode is placed outside the cell. How would the recordings differ if you were recording inside the cell? Would the amplitude of the spikes be the same or different? Would the positive and negatively charged portions of the recording look the same or different? (Hint: you may want to review the electrophysiology section to refresh yourself on the differences between the two types of recordings.)
- What causes the spikes that you saw? Specifically, what is occurring when the spike is positive? What is occurring when the spike is negative? Keep in mind you are doing extracellular recordings, which record the change in voltage in the area just outside the cell membrane.
- Why does lowering the temperature of the cockroach make it stop moving? What are other ways you could anesthetize it?
- Based upon your initial results, are you primarily listening to spikes coming from motor neurons (neurons that tell muscles to contract) or to sensory neurons (neurons that send information from the periphery into the brain). Why?
- What changes would you see in your recordings if you were to blow on the cockroach? Would the changes caused by blowing be the result of activity in sensory neurons or motor neurons?