Spring Brain Conference

Neuroscience Teaching Team

Electrical Model of Neuron

SBC OUTREACH PROGRAM
Demo Outline

This packet contains the teaching points and figures necessary to explain the electrical model of the neuron. This demonstration has two components – a single neuron and a neural network – that can be done together or separately. This demonstration takes 10-15 minutes and can be expanded using the optional information on action potentials for a classroom setting or condensed as needed for more informal, one-on-one teaching.

ELECTRICAL MODEL OF A SINGLE NEURON

In this module students will learn about the cells that make up the nervous system – neurons

I. Our bodies are made up of cells
   a. Elicit students' current knowledge of cells (size, shape, components, ect)

II. Neurons are the cells in our brain
   a. They have special jobs so they have special parts

III. Neurons have three parts (Fig 1):
   a. SOMA – large, circular, "computer center" with all the components other cells have like a nucleus, mitochondria
   b. DENDRITES – "input" center for neuron, many branches reaching all over (like Medussa hair) to collect information
   c. AXON – single "output" part of the cell, long and tail like
   d. Have the students find each of these components on the mode;

IV. Let's see how the neuron works
   a. Each student takes a light box (DENDRITE) that will be receiving information from that student. When you say "GO" they decide which way the switch should be (on or off).
   b. One student (or parents or teacher) controls the light switch on the SOMA. Instruct this participant to only flip their switch *if more than half of the lights are turned on.* Demonstrate that when the SOMA turns "on" the AXON light bulb turns on to send the signal onto the next cell.
   c. Say "GO" – pause to explain what happened (either threshold was reached or not)
   d. Keep saying "GO" – getting faster and faster for about a minute until the SOMA cannot keep up.

V. Summarize
   a. SOMA integrates incoming signals from dendrites using a THRESHOLD
      i. Neurons are binary – either on or off
      ii. Threshold means must have minimum input to pass signal on
   b. DENDRITES receive incoming information
   c. AXON is a single output
   d. Neurons work REALLY fast

VI. Questions

OPTIONAL ADDITION ON ACTION POTENTIALS

For older students and/or classroom settings

I. Neurons are actually electrical – they use movement of charged ions to send their signals

II. These signals are called ACTION POTENTIALS
   a. The action potential looks like this (Fig 2)
   b. Over time (x axis) the membrane potential (or charge – that's the electrical part) on the cell changes. It gets more positive when GO signals come in from the DENDRITES.
   c. Point out THRESHOLD – this is when enough positive signals comes in for the SOMA to "decide" to send a signal down the axon.

- Note, if you have the background, you can also explain concepts such as:
  - Voltage gated ion channels
  - Myelin sheath
  - Sodium and Potassium Gradient

However, the basic concept of an electrical signal that must reach a certain level to be passed on does NOT require explanation of these concepts.

ELECTRICAL MODEL OF A NEURAL NETWORK

In this module students will learn about how multiple neurons communicate with each other

I. Here I have three neurons, each neuron has a SOMA, a DENDRITE and an AXON
   a. Point out components
   b. Explain that for this model we are just looking at a single dendrite, and that in the brain different types of neurons have different numbers of dendrites – and axons!

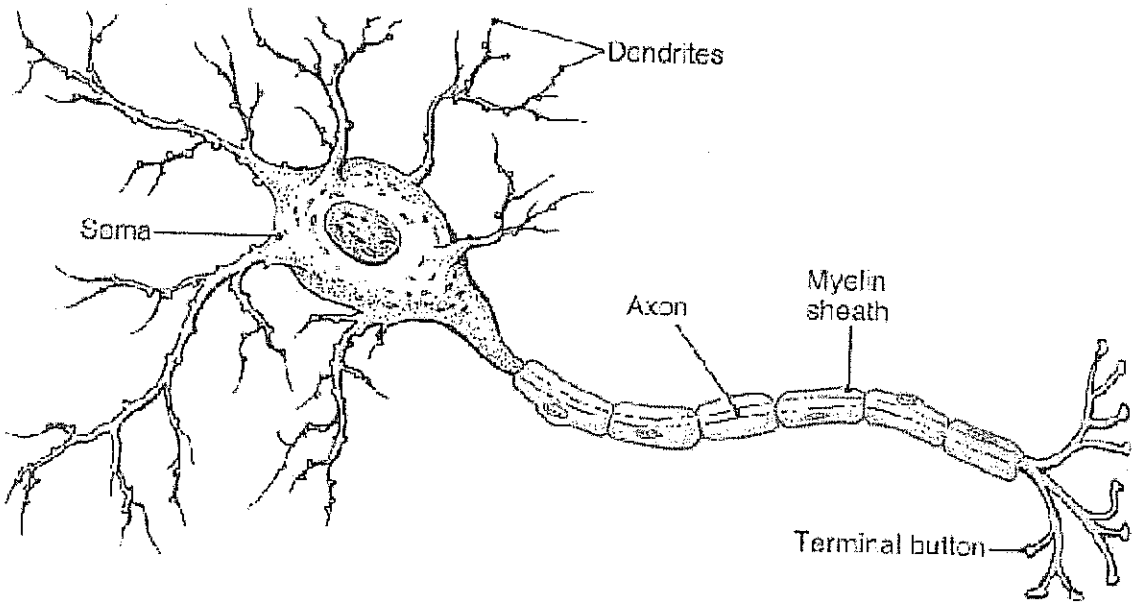
II. Neurons communicate by changing ELECTRICAL signals into CHEMICAL signals and then back again.

III. Let's see how this works:
   a. Give the first student a few pieces of small candy like m&ms – this is the go signal.
   b. That student then is signaled to turn on their light box. The chemical (candy) signal is now electrical. The signal goes through the soma and turns on the light bulb at the AXON.
   c. A student watching the light bulb SEES the light and pushes Neurotransmitter (candy) across the SYNAPSE (a gap). The student at the next dendrite eats the candy which causes him or her to turn on his light switch.
   d. This repeats for all three neurons.
   e. Give candy to the "pre-synaptic" volunteers so they don't feel left out

IV. DISCUSS
   a. Signal was both electrical (light switch) and chemical (candy)
   b. It takes almost no time for the electrical signal, but there was a delay with the candy – relate this to an actual neuron
   c. The signal got all the way around the table – just as signals go all around the brain

V. QUESTIONS

Figure 1



http://www2.cedarcrest.edu/academic/bio/hale/bioT_EID/lectures/tetanus-neuron.gif

Figure 2
(From Wikipedia)