Funatomy & Easyology

Time for a NAP: Neuronal Action Potential

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Purpose: The purpose of this lab is to teach students the mechanisms of nerve action.
Materials: 3x5 cards
Markers
Nerf balls
Masking tape
Preparation: Prior to teaching this lab, a series of cards may be made and laminated that may be used for years to come. There will be two sets of cards.

Set One: For each group of 25 students, label the following 3x5 cards:
Cell body (1)
Pre-synaptic knob (1)
Dendrites (3)
Na+ (9)
K+ (9)
Ca+2 (2)
Set Two: Cut 30 3x5 cards in half and divide into 3 stacks of 20 each. On each card write small voltage changes of +5mV, +10 mV, +15 mV, -5mV, -10mV, -15 mV, etc., until all cards are marked. On at least one card in each stack write the words "Action Potential". To make sorting them easier, the stacks could be made in different colors.
On the day of the lab, take a full roll of masking tape to a large flat surface, such as a hall floor, a gym floor, etc. (Or use chalk on a sidewalk or parking lot.) Tape off a model of a neuron with at least three dendritic extensions. Make the axon as long as necessary to accommodate the size of the class. Have students pull a card indicating their role in neuronal action potential. Position students along the axon as indicated below.

Use video, lectures, or diagrams to introduce to students the roles of each of the components listed in conducting a nerve impulse. Explain to the dendrites that they will be bringing in messages to the cell body, either EPSP's (excitatory post-synaptic potentials) or IPSP's(inhibitory post-synaptic potentials). The role of the cell body is to tally up the incoming potentials to see if a message will be conducted along the nerve. The cell body maintains a resting membrane potential of -70 mV. When the tally of all incoming inputs take the resting potential up to a -55 mV, the membrane can become depolarized, and an action potential can occur. That is, sodium ions flow in, and potassium ions flow out. This wave of depolarization moves down the axon to the pre-synaptic knob. When the change of polarization reaches it, calcium channels open, causing vesicles filled with neurotransmitters to move to the membrane, releasing them(neurotransmitters) across the synapse.

After introducing students to the basics, put them into position on the taped neuron. Explain to each of the dendrites that his/her job is to bring inputs (IPSP's or EPSP's) to the cell body. The cell body will have to add together the inputs to see if the total added to his resting -70 mV is at least -55 mV. If the cumulative tally is that positive, the cell body shouts "Action Potential", at which point the first sodium ion (closest to the cell body) jumps into the membrane. When his/her feet touch the ground, the adjacent potassium ion jumps out, and the chain continues down the axon to the calcium ions. The calcium channels tag the vesicle in the pre-synaptic knob, and he throws his neurotransmitter (ball) across the synapse to start the next reaction. It is easy to use a garbage can, or any receptacle, to act as the target receptors for the next cell.

If the sum total of neuronal inputs doesn't tally up to at least -55 mV, the dendrite runners return to the stack of cards which should be left at the end of each dendrite, face down.

On completing an action potential, the students should trade cards with other parts of the nerve to learn the actions of all parts. After running through the role play once, allow a student to manage it. After students are comfortable, have them return to their seats and write a paragraph on how neuron action potentials work.

Helpful hints:

The teacher facilitates the action with a "1,2,3,GO!"

The first cell body should be a student who thinks quickly on his/her feet.

Each student should hear the instructions given to all others, so they can adapt to new jobs easily.

In a large class, this works well as a competitive game, using two neurons taped/drawn out on the floor. If the post-synaptic membrane receptors (the receptacles for the balls) are placed a reasonable distance away, the game becomes a shoot-out by the best vesicle to place it's neurotransmitter at the post-synaptic receptor.