Generation of action potentials essay sample

PREDICTIONS

1. Exceeding the threshold depolarization at the trigger zone DECREASES the likelihood of generation of action potential.

2. Action potential amplitude: DOES NOT CHANGE with distance

3. Increasing frequency of stimulation to the trigger zone: DOES NOT increase the production of action potentials.

MATERIALS AND METHODS

Experiment 1: Effect of Stimulus Strength on Action Potential Generation

1. Dependent Variable

Membrane potential

2. Independent Variable

Stimulus strength (voltage)

3. Controlled Variables

Frequency of stimulation

Type of neuron

Experiment 2: Effect of Frequency of Stimulation on Action Potential Generation

1. Dependent Variable

Membrane potential

2. Independent Variable

Frequency of stimulation

3. Controlled Variables

Type of neuron

Stimulus Strength (voltage)

4. Which part of the neuron was stimulated? Action potential is first generated in the dendrites of the neuron, or where the neuron receives the action potential of other neurons.

5. Where was membrane potential measured?

6. What was used to measure membrane potential?

RESULTS

See Table 3: Membrane Potentials at Different Stimulation Voltages, by Location See Graph 1: Maximal depolarization of membrane potential at axon hillock and axon after different stimulation voltages.

1. What was the resting membrane potential (no stimulation) recorded in Table 3? The Resting Membrane Potential Voltage =-70 mV

2. At which stimulation voltage(s) did you see decrimental conduction of graded potential from axon hillock to axon? At 2V the graded potential went from 64. 8 – 73. 8

3. At what stimulus voltage(s) did an action potential occur? Action potential occurred at 6V

4. What was the membrane potential at the axon hillock when the action potential was generated? The membrane potential was 30. 2 at the axon hillock at 6V when action potential was generated.

5. For each of the stimulation voltages, indicate whether it was sub-threshold, threshold, or suprathreshold. 2 V Subthreshold

4 V Subthreshold

6 V Threshold

8 V Threshold

See Table 4: Effect of Supra-Threshold Stimulation Frequency on Action Potential Generation. See Graph 2: Number of action potentials generated at different times between simulations.

6. State the amount of time between stimulations for each frequency of stimulation. 25 Hz 40 msecs

50 Hz 20 msecs

100 Hz 10 msecs

200 Hz 5 msecs

400 Hz 2. 5 msecs

7. For each frequency of stimulation, indicate whether the period between stimulation is longer or shorter than the length of an action potential. Length of action potential in pyramidal neuron is about 15-20 milliseconds (msec) 25 Hz longer

50 Hz same

100 Hz shorter

200 Hz shorter

400 Hz shorter

8. Estimate the length of the refractory period for the pyramidal neuron.

The length of refactory period was approximately 10 msecs between the 15-20 increasing the action potentials almost doubling them from 3 to 5.

DISCUSSION

1. In Experiment 1, discuss why the amplitude of the action potential did not increase as stimulation voltage increased above threshold. All-or-nothing theory….. Once the threshold is met, a refactory period is needed. All and then nothing, repeat…..

2. In Experiment 1, explain why the membrane potential between the axon hillock and axon either changed or did not change with subthreshold stimulus. Differences of 1. 0 mV or less are not significant. It did not change. Unless the depolarization occurs, the sodium ions cannot enter created change. This only happens at the threshold.

3. In Experiment 2, explain why the membrane potential between the axon hillock and axon either changed or did not change with threshold stimulus. Differences of 1. 0 mV or less are not significant. . It did not change. Unless the depolarization occurs, the sodium ions cannot enter created change. This only happens at the threshold.

4. In Experiment 2, explain why the number of action potentials generated varied with increased stimulation frequency. Action potentials can occur

more frequently as long there is a continued source of stimulation, as long as the relative refractory period has been reached, which in experiment 2 the refractory period was complete.

5. Restate your predictions that were correct and give the data from your experiment that supports them. Restate your predictions that were not correct and correct them, giving the data from your experiment that supports the correction. 1) Exceeding threshold depolarization does not change the likelihood of an action potential being produced, Due to the need for a refractory period this is (all or nothing) In the experiment from 6V-8V in the axon hillock the difference in amplitude went from 30. 2 to 30. 9 (not a remarkable increase) 2) Amplitude does not change with distance. . From the experiment, the action potential amplitude does NOT change as it propagates down the axon. (The change was small at 0. 4, 0. 2) 3) Increasing frequency of stimulation of the trigger zone does not increases the production of the action potentials. This goes back to the threshold All or nothing theory.

APPLICATION

1. ECF potassium levels affect resting membrane potential. Hyperkalemia (excessive levels of potassium in the blood) and hypokalemia (abnormally low blood potassium levels) both affect the function of nerves and muscles.

Explain how hyperkalemia will initially affect the resting membrane potential and the generation of an action potential. Hyperkalemia depolarizes muscle cells, reducing the membrane potential from –90 mV to approximately –80 mV. This brings the membrane potential closer to the threshold for

generation of an action potential. Hyperkalemia will initially increase excitability, since a lesser depolarizing stimulus is required to generate an action potential. But then due to the decrease in K+ fatigue and less excitability set it in the nerves and the muscles.

Explain how hypokalemia will initially affect the resting membrane potential and the generation of an action potential. Hypokalemia hyperpolarizes the muscle cells. This brings the membrane potential further from the threshold and initially causes fatigue then goes on to making muscles spasm and nerves are over fire.

2. Tetrodotoxin, a toxin found in puffer fish, acts by inhibiting voltage-gated sodium channels. Eating improperly prepared puffer fish sushi can be fatal because of interference with action potential generation. Explain how tetrodotoxin interferes with action potential generation. TTX is a poison because it blocks voltage-gated sodium channels in nerve membranes by binding to a peptide group at the opening of the channel. This means that sodium ions cannot enter the cell, so that the nerves do not fire and signals are not transmitted.