Name_____Period_____Assignment #_____

Data Analysis: Why Frat Boys Need Anatomy and Physiology

Necessary background information

1) Hypotonic solutions and Osmosis (Osmosis lab, Notes Question #11 How do substances that are permeable to the plasma membrane get into and out of cells?)
2) Action potential propagation (Notes Question #42: How do neurons "talk" to each other?)
3) Voltage-gated ion channels (Notes Question #42)
4) Refractory period (Notes Question #42)
5) Role of sodium ions (Na^+) and potassium ions (K^+) in membrane potential (Question #42)

A tragic consequence of hazing

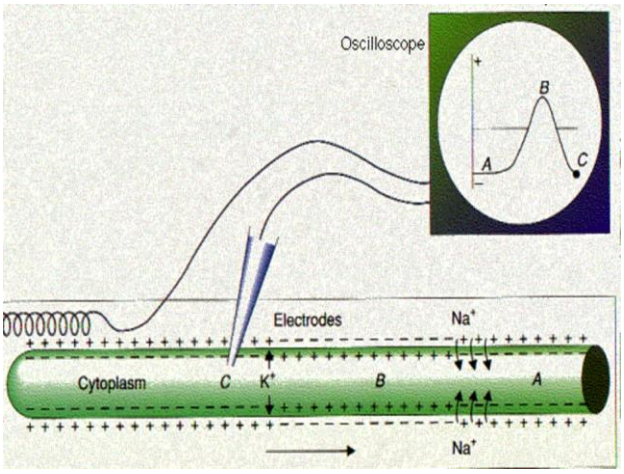
"There were forced pushups and trivia quizzes. Through it all, Carrington and Quintana were ordered to drink from a five-gallon jug of water, which was filled over and over. Fans blasted icy air on their wet bodies. They urinated and vomited on themselves. Then, according to DA Ramsey, something went terribly wrong.

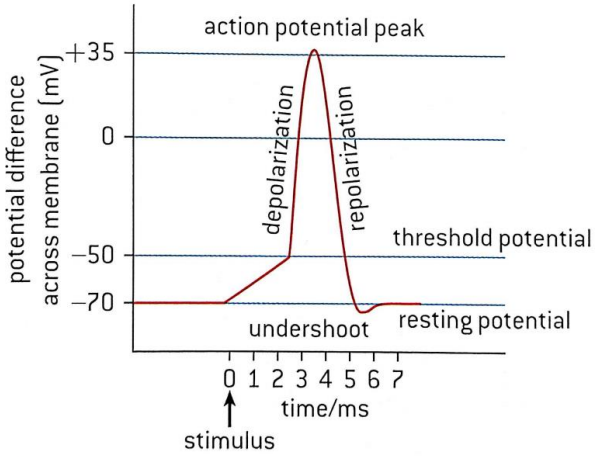
Carrington collapsed and started a seizure. Fraternity members didn't initially call an ambulance. By the time they did, it was too late. Carrington was taken to Enloe Medical Center, where his heart stopped. At about 5 a.m. he was pronounced dead from water intoxication." Read the whole story at
http://www.npr.org/templates/story/story.php?storyId=5012154

Analysis of oscilloscope traces showing resting potentials and action potentials

Membrane potentials in neurons can be measured by placing electrodes on each side of the membrane. The potentials can be displayed using an oscilloscope. The display is similar to a graph with time on the x-axis and the membrane potential on the y-axis. If there is a resting potential, a horizontal line appears on the oscilloscope screen at a level of -70 mV, assuming that this is the resting potential of the neuron.

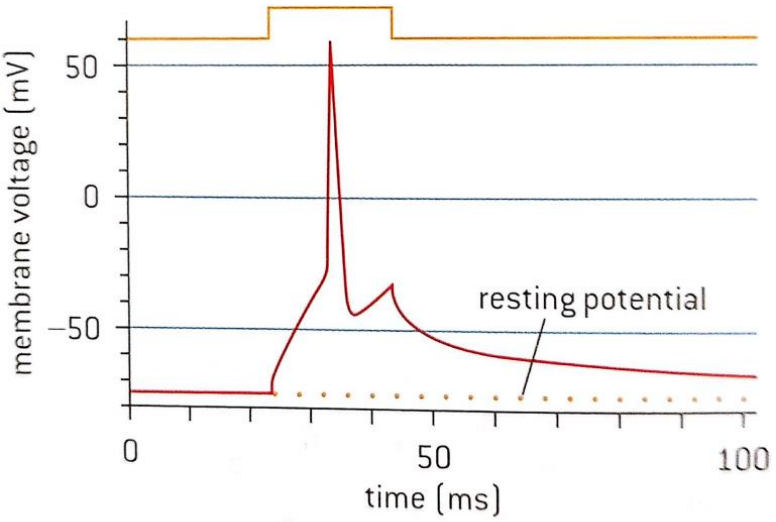
If an action potential occurs, a narrow spike is seen, with the rising and falling phases showing the depolarization and repolarization (see figure 11). The oscilloscope trace may also show the potential rising before the depolarization until the threshold potential is reached. The repolarization does not usually return the membrane potential to -70 mV immediately and there is a phase in which the potential changes gradually until the resting potential is reached.



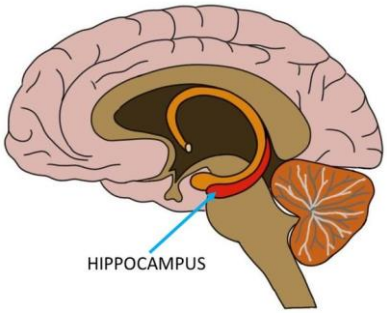


▲ Figure 11 Changes in membrane polarity during an action potential

The oscilloscope trace in figure 12 was taken from a digital oscilloscope. It shows an action potential in a mouse hippocampal pyramidal neuron that happened after the neuron was stimulated with a pulse of current.



▲ Figure 12



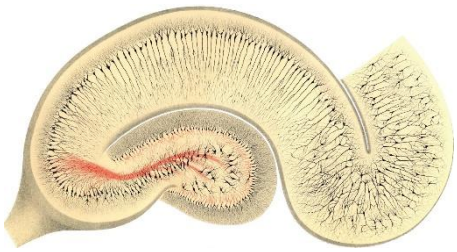


Figure 1 Pyramidal Cells of the Hippocampus

1) State the resting potential of the mouse hippocampal pyramidal neuron.

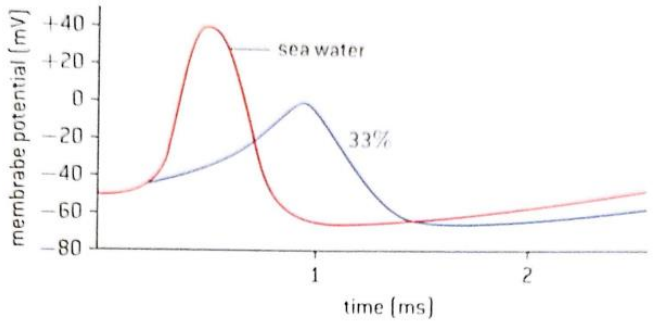
2) Deduce with a reason the threshold potential needed to open voltage-gated sodium channels in this neuron.

3) Estimate the time taken for the depolarization, and the repolarization. Reference specific numbers from the graph and **show your work**.

4) Predict the time taken from the end of the depolarization for the resting potential to be regained. Reference specific numbers from the graph and **show your work**.

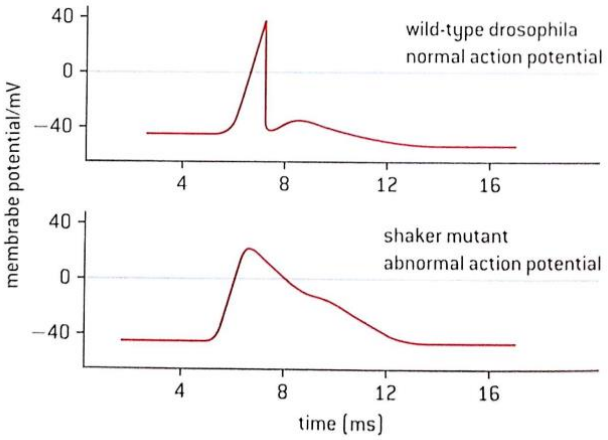
5) Think about how an oscilloscope works. Suggest a reason for the membrane potential rising briefly at the end of the repolarization.

The action potential of a squid axon was recorded, with the axon in normal sea water. The axon was then placed in water with a Na^+ concentration of one-third that of sea water. The action potential was recorded again. Figure 16 shows these recordings.



▲ Figure 16

Geneticists discovered a mutant variety of fruit fly that shakes vigorously when anaesthetized with ether. Studies have shown that the shaker mutant has K^+ channels that do not function properly. Figure 17 shows action potentials in normal fruit flies and in shaker mutants.



▲ Figure 17

6) Using only the data in figure 16, outline the effect of reduced Na^+ concentration on:
   a. The magnitude of depolarization

   b. The duration of the action potential.

7) Explain the effects of reduced Na^+ concentration on the action potential.

8) Discuss the effect of reduced Na^+ concentration on the time taken to return to the resting potential.

9) Compare the action potentials of shaker and normal fruit flies.

10) Explain the differences between the action potentials.

over

11) Explain how drinking a lot of water affected Carrington (the fraternity pledge). Your explanation must include the following terms: osmosis, hypotonic, concentration, sodium (Na^+) ions, sodium ion channels, depolarization, action potential, and nervous system.