

7.29 Midterm

Answer **Question 1** and **four of the five others**. Each answer is worth 20 points. If you answer all six questions the first five will be graded.

No books, no notes, no cooperation permitted. Calculators are allowed.

All lettered subsections of a question have equal point value unless otherwise specified.

All questions have specific answers. It is to your advantage to be brief.

You may use telegraphic rather than grammatical English if you wish, so long as your reasoning is made clear.

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Question 1.

Identify the following terms and indicate how they relate to the course: (2 points each)

- a) A bacterial channel
- b) Saltatory
- c) Tetanus toxin
- d) Nicotine
- e) An antibody
- f) Atropine
- g,h) Eserine (or Neostigmine) – two uses
- i,j) Tetrodotoxin –two uses

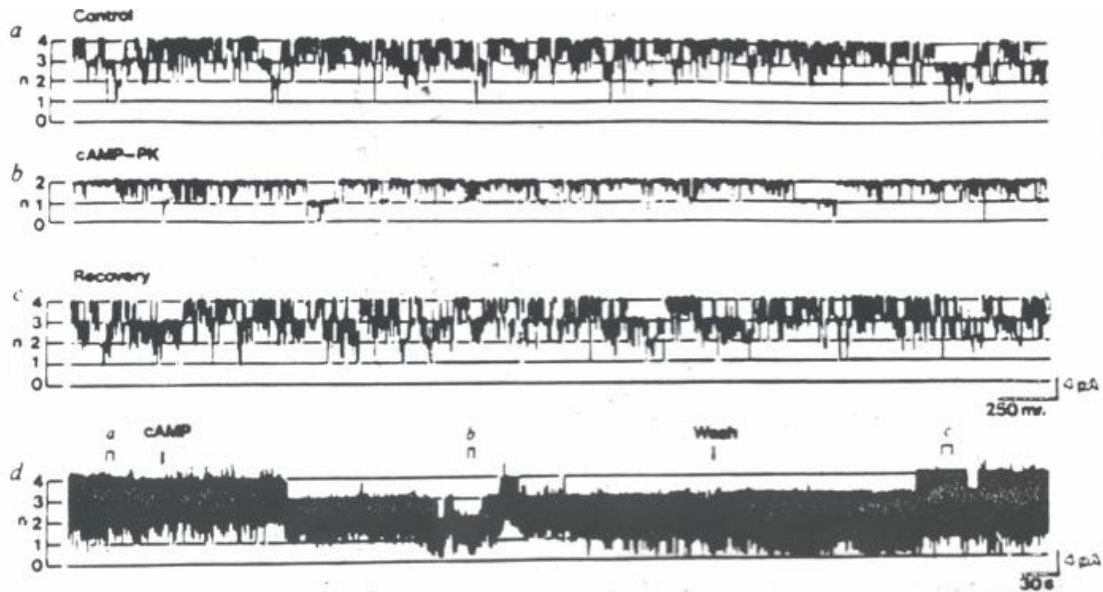
Question 2.

- A. Define the space constant, λ , with equations -- both as a measure of passive voltage spread from a current source and as a reflection of the membrane's resistive properties. (6 points)
- B. Explain why the spread (speed) of propagation of an action potential down an axon is approximately proportional to the axon's space constant. (4 points)
- C. Explain how selective pressure for rapid action potential has led to increases in λ . What separate adaptations in vertebrates and invertebrates have led to increases in λ ? Explain using the relevant equation parameters. (6 points)
- D. What one property of an axon protein or proteins best accounts for unidirectional propagation of action potentials. (4 points)

[OVER]

Question 3. {2005Q2}

Shown below is a (detached) patch-clamp recording from an *Aplysia* sensory neuron (The data were shown in class).



- A. Do you think the patch clamp was inside-out or outside-out? Why? (2 points)
- B. What is the function of the electronics in such a patch-clamp recording? (3 points)
- C. The horizontal axis on the recording indicates time. What quantity does the vertical axis indicate? (2 points)
- D. Why does the trace fluctuate between defined states indicated by the added horizontal lines? (2 points)
- E. At one point the graph indicates "cAMP-PK." What experimental operation was done here? (3 points)
- F. What is the conclusion to be drawn from the experiment? (3 points)
- G. What is the importance of the conclusion? (5 points)

[NEXT PAGE]

Question 4. [2005q6]

In a particular squid axon, the Nernst equilibrium potential for potassium is -80mV . The Nernst equilibrium potential for sodium is $+40\text{mV}$. Wires are threaded down the inside and along the outside of the axon, and a voltage clamp is hooked up. The axon is clamped for a long time to a steady voltage of 0mV . At this point, g_{Na} is $1\text{ milliSiemens/cm}^2$ and the $g_{\text{K}} = 9\text{ milliSiemens/cm}^2$. The axon is 1mm in diameter and 64mm long.

- A. What is the sodium current density (in nA/cm^2) under these conditions? (2 points)
- B. What is the potassium current density under these conditions? (2 points)
- C. How much current must the voltage clamp provide to maintain the axon at a steady 0mV ? Does the amplifier provide positive or negative charge flow to the wire inside the axon? (6 points)
- D. Would the axon be depolarizing or hyperpolarizing under these circumstances if the output voltage clamp were suddenly shut off? (2 points)
- E. How fast in millivolts per millisecond? (8 points)

Question 5. [2009q5]

In a particular frog neuron, $E_{\text{Na}} = +50\text{ mV}$; $E_{\text{K}} = -80\text{ mV}$. On this neuron, the neurotransmitter GABA binds to and opens ion channels which are nine times as conductive to potassium ions as to sodium ions. GABA is neither excitatory nor inhibitory on this neuron. For this neuron, threshold potential turns out to be 8 millivolts above (more depolarized than) the resting potential.

- A. What is the resting potential for this cell? What is the threshold potential? (12 points)
- B. At resting, this cells sodium conductance is $100\text{ microSiemens/cm}^2$. What is its conductance to potassium ions? (8 points)

Question 6.

Describe the experimental evidence that quantal release corresponds to vesicle exocytosis. In class we reviewed two very different experiments. Describe them (10 points each). In each case describe:

- The biological preparation
- The experimental setup

The technique used to detect vesicle exocytosis.

[END OF EXAM]

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7.29J / 9.09J Cellular Neurobiology
Spring 2012

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