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 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.

•••

Question 1.

Indicate how the following organisms or agents have contributed to our understanding of neurobiology. The examples should be from the lectures or the text.

(a) A mouse knockout mutant.
(b) A yeast mutant.
(c) Belladonna
(d) Eels
(e) Snakes.
(f) Frog Hearts
(g) A bacterial channel
(h) An incompetent organic chemist
(i,j) Puffer Fish (two uses

Question 2

Briefly describe the Orbeli effect. What is its evolutionary (selective) advantage to the animal? (4 points)

(b) Describe the physiological measurement of the Orbeli effect. (3 points)

(c) The Orbeli effect is mediated by two separate mechanisms. Describe the methodology used to dissociate these, both physiological and pharmacological. (7 points)

(d) One of these mechanisms is poorly understood. In contrast, something is known about the other mechanism (e.g.; cellular locus of receptors and channels involved). Describe this, and describe how it contributes to the overall Orbeli effect. (7 points)

[PAGE OVER]

Question 3.

Indicate the experimental evidence that synaptic transmission, and in particular vesicle fusion, occurs too rapidly for enzymatic reactions to be involved.

(a) Identify the experimental organism and synapse. (3 points)

(b) Describe the experimental setup. (2 points)

(c) Describe the experimental procedure and the specific trick involved to obtain the high time resolution. (7 points)

(d) Describe the experimental result – best done with two graphical traces on one co-ordinate system. Indicate the specific measurement that leads to the conclusion at the top of the question. (8 points)

Question 4.

(a) Hodgkin and Huxley did a simple experiment to show that the squid axon membrane was predominantly conductive to sodium ions at the top of the action potential (maximum overshoot). What did they do? (4 points)

(b) At the point of maximum overshoot, V_m= +50 mV; E_{Na}= +55 mV, E_K= -80 mV. What is the conductance ratio g_K/g_{Na}? (10 points)

(c) What approximating assumption did you make in calculating answer (b)? (2 points)

(d) What is the capacitative current at the point of maximum overshoot? (4 points)

[NEXT PAGE]

Question 5.

In a particular frog neuron, E_{Na}= +50 mV; E_K= -80 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 microSiemens / cm^2. What is its conductance to potassium ions? (8 points)

Question 6

(a) Write the expression for the space constant, λ of an axon. (2 points)

(b) A metal wire has, for our purposes, zero resistance (infinite conductance). How could you arrange one or more wires to **maximize** the space constant, λ? How does the maximization work? (8 points)

(c) What would the altered space constant be (approximately)? (4 points)

(d) What would the conduction velocity of the axon be (approximately)? (2 points)

(e) Has a similar experimental setup been described in this course? What was it used to do? (4 points)

END OF EXAM

7.29J / 9.09J Cellular Neurobiology

Spring 2012