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) Isoproterenol
   b) Vagusstoff
   c) Neostigmine
   d) Schaeffer Collateral
   e) Potassium S channel
   f) CNQX
   g) Freeze fracture
   h) Dopamine antagonist
   i) Somatotopic
   j) Membrane action potential

Question 2

The "Toothpaste-tube" experiment of Baker, Hodgkin, and Shaw (1962) involved a squid
axon and a rubber roller.

   a,b) Describe two important findings from the experiment. (5 points each)

   c) Describe how you would modify this experiment to find out how much
   potassium flows outward across the axon membrane during an action potential. (5
   points)

   d) Describe how you would use purely electrophysiological data to obtain an
   approximate check of your answer in C. (5 points)

[Over]

Question 3

In the bullfrog sympathetic ganglion , one presynaptically-released
neurotransmitter interacts with two postsynaptic receptor molecules.
    a) What are the two receptors? (2 points)
    b) What is the evidence for the separate receptors? (Give specific
        experimental procedures and reagents. (4 points)
    c) What are the two physiological consequences of the receptor bindings?
        (4 points)

In this ganglion, two presynaptically–released neurotransmitters act on
postsynaptic cells to produce the same physiological end-result.
    d) Give two lines of experimental evidence for this result, using distinct
        experimental procedures. (7 points)
    e) One of these neurotransmitters does not diffuse straight across the
        synaptic cleft from presynaptic release site to postsynaptic target.
        State the evidence for this. (3 points)

Question 4

This question will ask you to compare the Hodgkin-Huxley experiment in which
a squid axon is voltage-clamped (in the presence of Tetraethylammonium =
TEA) with the much later experiment in which a (similarly-treated) piece of
squid axon membrane is patch-clamped:
    a) Compare the electronics. What is the same; what is different? (7
        points for diagram, 5 points for accompanying words)
    b) Compare the experimental result. What is the same; what is different?
        (5 points)
    c) How would you get an experimental profile from the patch-clamp data
        which is equivalent to profile from the whole-axon clamp. (3 points)

Question 5

. Describe the original experiments that indicate the synaptic neurotransmitter release is
caused by:

    a) Calcium ions (5 points)

    b) Entering the cytoplasm of the presynaptic terminal from outside (5 points)

    c) Through voltage-gated channels in the membrane (5 points)

    d) To induce vesicle fusion with the presynaptic cell membrane. (5 points)

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Question 6

In a squid axon, at a time point (t_1) early in an action potential, the membrane voltage, Vm, is -40 mV. At this time the membrane the conductance to sodium ions, g_{Na}, is 5 milliSiemens/cm^2. The conductance of the membrane to potassium ions, g_K, is 1 milliSiemens/cm^2. You may assume for this problem that there is no chloride or leakage conductance. The membrane capacitance C_m, is 1 microfarad/cm^2. For this axon E_{Na} = +55 mV, and E_K = -80 mV.

a) What is the membrane voltage at time t_2, 0.01 milliseconds after t_1? (15 points)

b) How would you go about calculating the membrane voltage at a still later time, t_3, 0.01 milliseconds after t_2? What additional information would you need? (5 points)

[End of test]

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