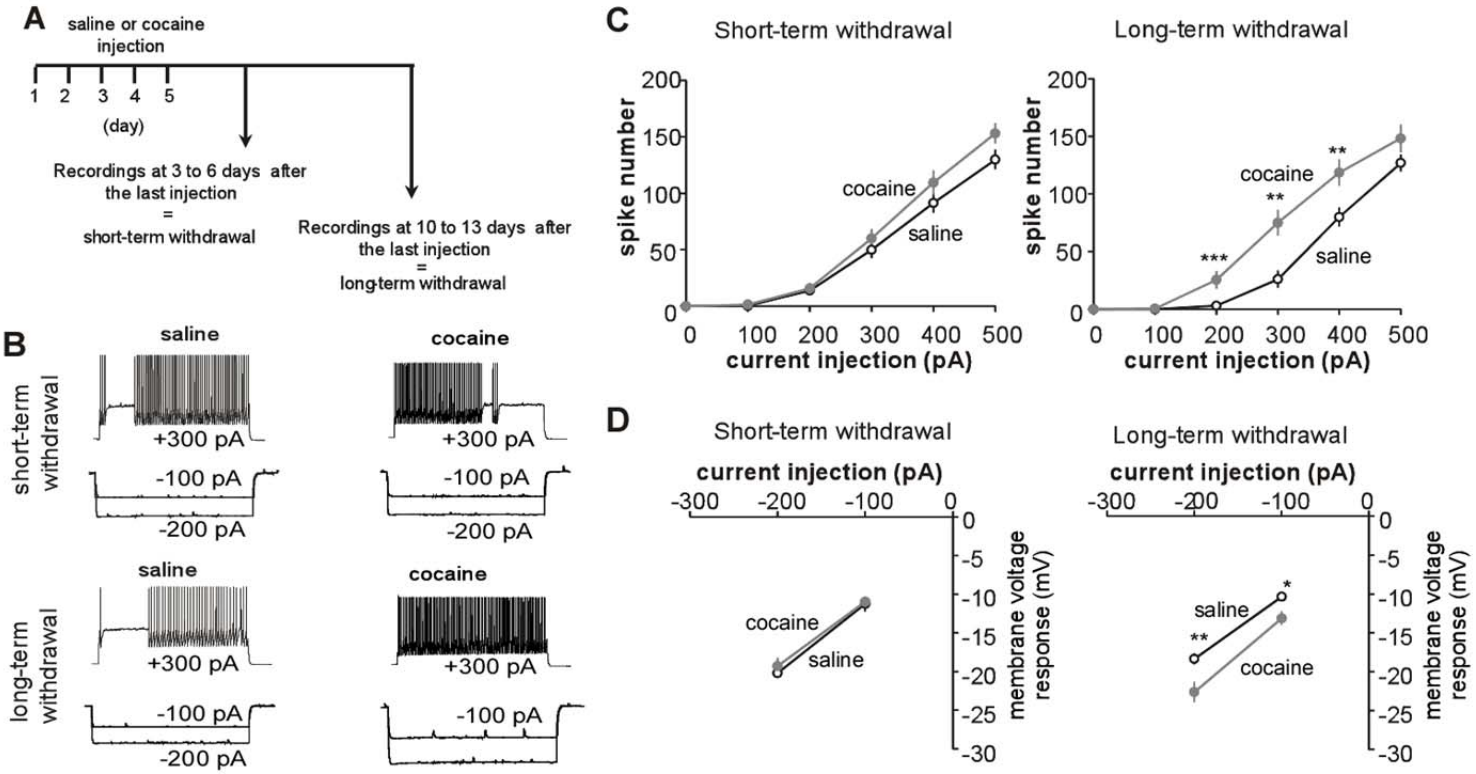
BIOL3833 Fall 2013 Exam 1 **Name:** _____

Important instructions:
1. Even if you can't answer a question completely, write down whatever you know about it. Partial credit is better than no credit!
2. For many of the questions, there is more than one correct answer.
3. A thoughtful explanation is worth partial credit even if the answer isn't exactly correct.

Questions 1-5 are based on the following figure: This figure is taken from an article published in the Journal of Neurophysiology in June 2013: Campanac, E., Hoffman, D. A., (2013). Repeated cocaine exposure increases fast-spiking interneuron excitability in the rat medial prefrontal cortex. *J. Neurophysiol*. 109**,** 2781-2792.



Campanac, E., Hoffman, D. A., 2013. Repeated cocaine exposure increases fast-spiking interneuron excitability in the rat medial prefrontal cortex. *J. Neurophysiol*. 109**,** 2781-2792.

Panel A above shows the experimental overview. The experimenters injected one group of rats with cocaine every day for five days, while another group received saline control injections on the same days. They then recorded from neurons in the rats' prefrontal cortex (a region of the brain associated with planning).
Some recordings were made at 3-6 days after the last injection (the short-term withdrawal group)
while other recordings were made 10-13 days after the last injection (the long-term withdrawal group).

It might help to tear this page off of your exam so you can refer to it while you answer the next five questions. I have a stapler so you can put it all back together when you're done.

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Panel B shows the responses of neurons to 1-second long step-current injections of -200 pA, -100 pA, and +300pA. In the top traces, the vertical lines are all action potentials

Question 1 (10 points): Describe the effects of long-term cocaine withdrawal on the firing patterns of these neurons, compared to saline controls. What change(s) in the neuron's ionic currents could produce the change in firing pattern that you described? How would the changes in ionic currents produce the effects you predicted?

Question 2: (10 points) Describe the effects of short-term cocaine withdrawal on the firing patterns of these neurons, compared to saline controls. What change(s) in the neuron's ionic currents could produce the change in firing pattern that you described? How would the changes in ionic currents produce the effects you predicted?

Question 3: (5points) What do the cell's responses to the -100 pA and -200 pA step currents in Panel B tell you about the effects of long-term withdrawal on the neurons' passive properties?

Panel C shows the F-I (frequency x current) plots recorded from cells after short-term or long-term cocaine withdrawal.

Question 4 (5 points): Based on the data in Panel C, what were the effects of short-term withdrawal and long-term withdrawal on the cells' dynamic range? What changes in the cell's ionic currents could produce these changes in dynamic range?

Panel D shows the membrane voltage change caused by current injections of -100pA and -200pA.

Question 5 (5 points) What do these data tell you about the effect of short-term and long-term cocaine withdrawal on properties of the cell? How do you explain the effect of long-term cocaine withdrawal in terms of the cells' ion channels?

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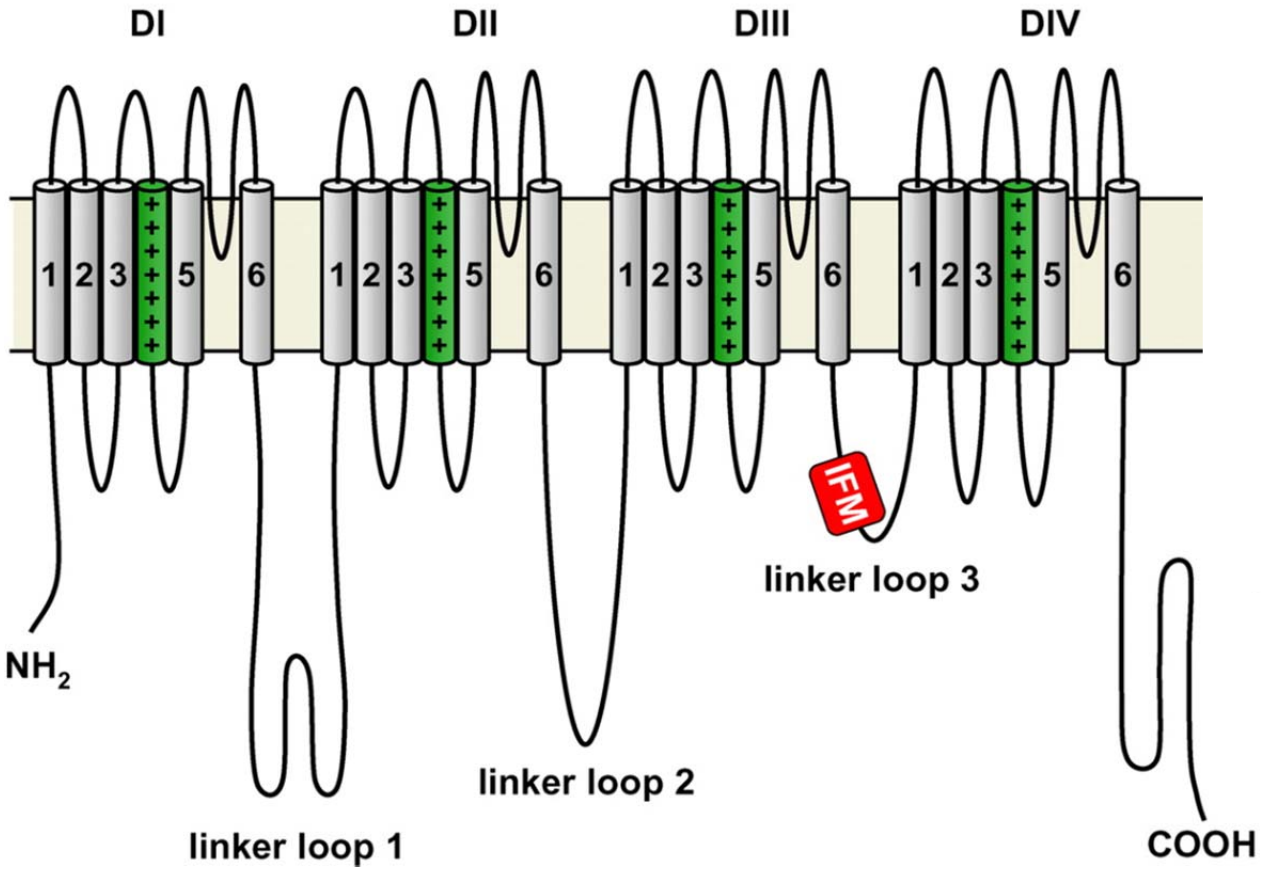
Question 6 is based on this figure:



Question 6 (10 points): The above figure shows the general structure of a voltage-gated sodium channel. Label as many parts of this this ion channel subunit as you can and describe each part's function below.

Question 7 (5 points) At any given moment during an action potential, what determines the size of the sodium current across the membrane?

Question 8. (5 points) What combination of passive properties would be best for a neuron to integrate multiple inputs over time? (That is, would lead to better summation of its inputs). Explain why.

Question 9 (5 points). What determines the neuron's membrane potential at any point in time? (There are LOTS of ways that you could answer this correctly – go with what you know).