BIOL3833 Fall 2016 Exam 1 **Name:** _____

Important instructions:
1. Even if you can't answer a question completely, write down whatever you know about it. Give as much of an answer as you can. 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.

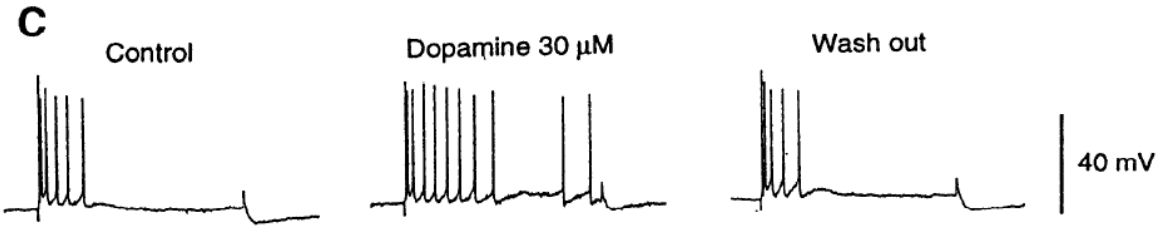
Question 1. (5 points) What determines the membrane's passive resistance, what determines the membrane's passive capacitance, and why are these properties important?

Question 2. (5 points) It is possible that at the peak of the action potential, all of the cell's sodium channels are open, but there is no sodium current across the membrane. Explain how this could happen.

Question 3. (10 points) Explain the neuron's resting potential using these terms:
a) intracellular K^+ concentration
b) extracellular K^+ concentration
c) intracellular Na^+ concentration
d) extracellular Na^+ concentration
e) ENa
f) EK
g) K^+ leak conductance
h) Na^+ leak conductance.

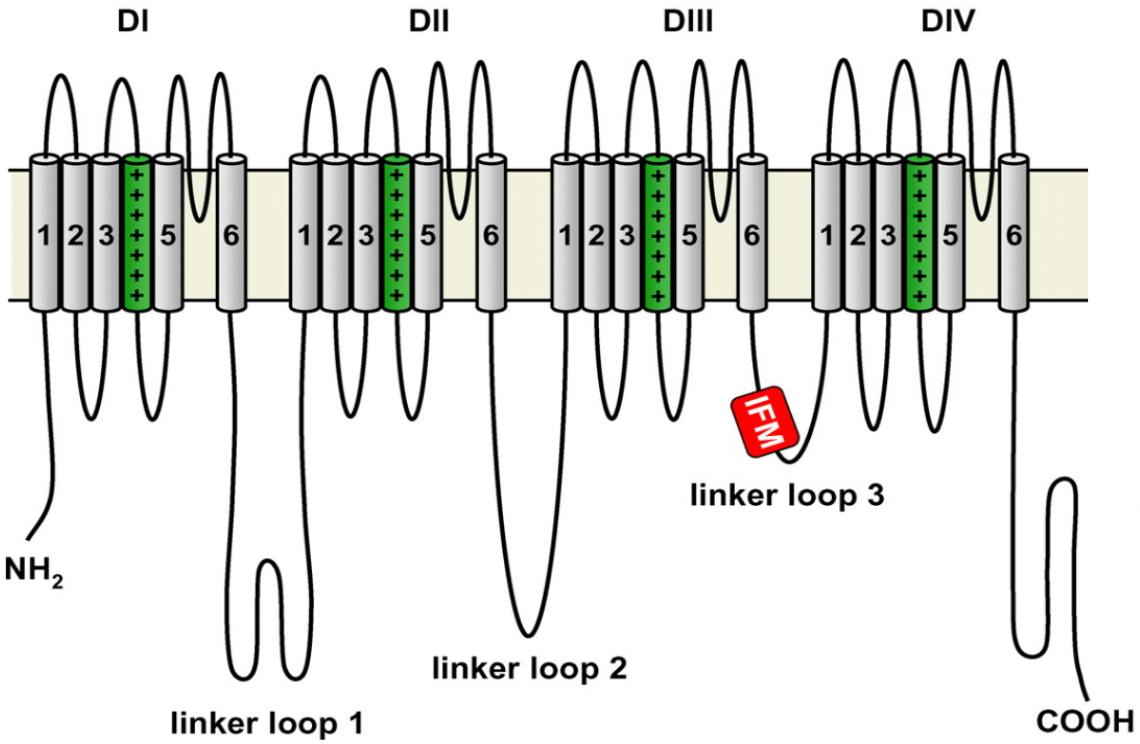
Question 4. (5 points) Name and explain two important functional properties of voltage-gated ion channels

Question 5. (5 points) Below is part of a figure from a 2005 publication that examined the effects of dopamine on the firing patterns of neurons from the hippocampus. The researchers delivered 200 millisecond stimulus currents of 3nA to cells and recorded the voltage responses and action potential patterns in normal conditions (Control) then after they exposed the cells to dopamine (center) and then again after they removed dopamine from the experimental preparation for 20 minutes (wash out). What effect(s) does dopamine have on the firing pattern of the cell? How could dopamine be changing the levels or types of ion channels present in the cell to produce these changes?



Question 6. (10 points). Explain how thalamic relay neurons switch between burst mode and transfer mode.

Question 7. (10 points): The figure below shows the general structure of a voltage-gated sodium channel. Label as many parts of this this ion channel as you can and describe each part's function below.



Question 8. (10 points) This question is based on the data shown below. The researchers recorded from neurons taken from the brains of normal mice (Wild type / WT) or mice with a mutation (R6/2) that produces the symptoms of Huntington's Disease as the mice grow older. Panel A shows a series of negative, then positive current injections at the bottom. The WT and R6/2 cells received the same set of current steps. At the top are membrane voltage response for cells from WT and R6/2 mice. Panel B shows images of a neuron from a WT mouse and the same type of neuron from a R6/2 mouse.

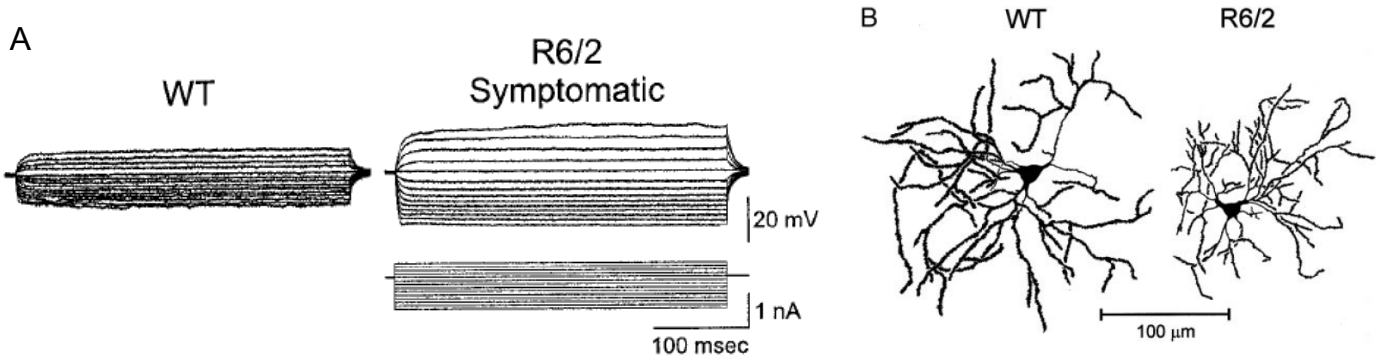


Table 1. Passive membrane properties (asterisks indicate values different from Wild-type).

	Wild-type	**R6/2 Symptomatic**
Resting Potential (mV)	-81.0 mV	-67.3 mV **
Membrane resistance (MΩ)	26.7 MΩ	48.0 MΩ **
Time constant (ms)	15.6 ms	11.0 ms **

How can the data shown in Panels A and B explain the differences shown in Table 1?