NERVOUS SYSTEM
PROBLEM SET 4

1. Write out the Nernst Equation, define each of its terms, and explain in your own words what it calculates (5 pts)

2. Using the Nernst Equation, calculate the equilibrium potentials for each of the following ions at the given concentrations:
(a) $[K+]_{out}$ = 3mM, $[K+]_{in}$ = 150mM;
(b) $[Na+]_{out}$ = 100mM, $[Na+]_{in}$ = 10mM;
(c) $[Ca++]_{out}$ = 10mM, $[Ca++]_{in}$ = 10^{-2}mM;
(d) Using the Goldman equation, what is their combined potential? (5pts)

3. Draw an axon and identify the soma, dendrites, axon hillock, and axon. What is the role of the axon hillock in spike initiation? Why it is significant that the axon hillock has a greater density of voltage-gated Na+ channels? What role might this have in guiding the AP down the axon rather than somewhere else? (5pts).

4. Myelination of an axon increases the resistance of the membrane, R_m, and decreases the effective membrane capacitance. Both of these effects speed up transmission along the axon. How/why? (explain each). (hint: what is distance propagated proportional to? You may want to consult those lectures). (5pts)

5. Neurons in a series can be said to be a chain of analog and digital signals.
(a) Which correspond to all-or-none versus graded responses? Why is this a good description of integration and/or summation at synapses and transmission via axons?
(b) What is spatial summation? temporal summation? Give an example of each, illustrating how they might these be useful for an animal.
(c) What are Excitatory and Inhibitory Post Synaptic Potentials (EPSPs and IPSPs)? How might they be useful in addition to spatial and temporal summation?
(d) Why is it important to have analog and digital responses (or signals) in the nervous system? (10pts)

6. Extra Credit (3pts):
You smell the wonderful aroma of fresh baked chocolate chip cookies. You move your hand to grab a cookie, and OUCH! You jerked your hand away and feel intense pain.
(a) List the motor and sensory pathways (and reflexes: look up flexor reflex) and from your brain to your hand and back again, as well the signal that jerks your hand away.
(b) What sensory receptors are involved, and what are some of the major reflexes, brain targets, and nuclei involved in sensing the information and then sending signals that result in your sensation of pain as well as your hand movements (both the initial reflex and voluntary movement to nurse your hand; list at least 6, more is fine)?
(c) Where are the reflexes localized (does it go all the way to your brain)? What happens first, your hand jerking away, or your realization that you are burned? You may want to consult your textbook's section on reflexes (covered in the spinal cord section chapter 8) and brain pathways (sensory centers in the brain, chapter 8).