0. When you gaze at the stars, why do you have to look slightly away from the really faint ones in order to be able to see them? (1 pt.)

**True or False (write ‘true’ or ‘false’; 9 points total; 1 point each)**

1. ________ A slow chemical synapse usually utilizes a ligand-gated ion channel in the postsynaptic membrane.

2. ________ When an ion species moves across the membrane through open channels, changing the membrane potential, the concentration gradient for that ion is abolished and needs to be reestablished later using ATP.

3. ________ Because of the existence of an absolute refractory period for voltage-gated Na⁺ channels, if you were to artificially stimulate a resting axon to threshold somewhere in the middle of its entire length, the resultant AP would move only down toward the axon terminals.

4. ________ Lateral inhibition can function in olfaction to help identify a specific type of odorant molecule even if that odorant molecule binds, at least somewhat, to several different receptor types.

5. ________ Rhodopsins are the more common visual pigments in freshwater vertebrates.

6. ________ The log₁₀ of afferent action potential frequency is linearly related to the incoming stimulus intensity.

7. ________ Glomerular convergence means that the many cell receptors for a specific type of molecular odor in the nasal epithelium tend to synapse on to the same glomerulus.

8. ________ Thermoreceptors in snakes are sometimes bimodal. When they are bimodal they usually detect both heat and odor.

9. ________ During smolting of Atlantic Salmon, these fish become more tolerant of seawater because of increased levels of Na⁺-K⁺-2Cl⁻ cotransporter, Na⁺-K⁺-ATPase, and numbers of chloride cells in the gills.
Really Short Answer (maybe a few words or a sentence; 25 points total; 2.5 points each)

1. How do both krait (a type of snake) venom and curare (used by native South Americans on blow darts) work to incapacitate their ‘victims’?

2. With respect to changing membrane potentials, what is special about the endolymph within the cochlea of the ear.

3. Give two examples of species of vertebrates that have vomeronasal organs.

4. List three properties of molecules such as ions that allow ion channels to be selective.

5. What is the equilibrium potential ($E_x$) for an imaginary ion $X^{2-}$ given the following information: $[X^{2-}]_{\text{outside}} = 75$ mM and $[X^{2-}]_{\text{inside}} = 15$ mM (please show your work).

6. What is the absolute value of the electromotive force (emf) acting on the above ion if $V_m = -50$ mV?

7. How might the following statement be false: An unmyelinated axon cannot transmit an action potential as fast as a myelinated axon.

8. List two ways that electrical synapses differ from chemical ones.
9. If both Na\(^+\) and K\(^+\) move through open cholinergic receptor channels, why does the cell membrane depolarize?

10. Which of these transmitters (A or B) leads to an EPSP and which to an IPSP? Is there evidence of temporal or spatial summation in these graphs?

Short Answer (CHOOSE 6 (SIX) of the following 8 questions; ~ 2 or 3 sentence answers; 30 points total; 5 points each)

1. Which graph (A or B) shows competitive inhibition? Why?
2. On the diagram, clearly label three phases of the action potential and indicate which ion(s) is primarily responsible for each of the phases identified.

3. Provide an example of an electrochemical gradient that is commonly established in cells. How is it established and what are some potential uses of that electrochemical gradient for the organism?

4. Briefly describe the voltage clamping method and its utility in studying physiology.
5. In nerve signal transmission, what does it mean to alternate between graded and all-or-none potentials?

6. Several examples of the conservation of proteins consisting of 7-transmembrane helices have been presented in lecture and in your text. Please list two. How does evolutionary biology explain the similar protein structures seen in several different physiological contexts?

7. Describe similarities between receptor cells for hearing and equilibrium (other than that they are often both in the ear).

8. How are salty taste and bitter taste receptor transduction different?
Longer Essay Answer (20 pts; ~a few well-organized paragraphs).
1. Explain the transduction of light into electrical signals from the point of photons hitting the cornea up to the point where signals are sent toward the central nervous system. Please be sure to touch on the following topics in your discussion: anatomy, acuity, sensitivity, amplification, membrane potential, etc.
Long Essay Answer (15 pts; ~a few well-organized paragraphs).
2. Choose one of the readings from your discussion section thus far this semester. Describe the methods used (generally), the important findings, and how the paper informs your knowledge of vertebrate physiology in a whole-animal context.