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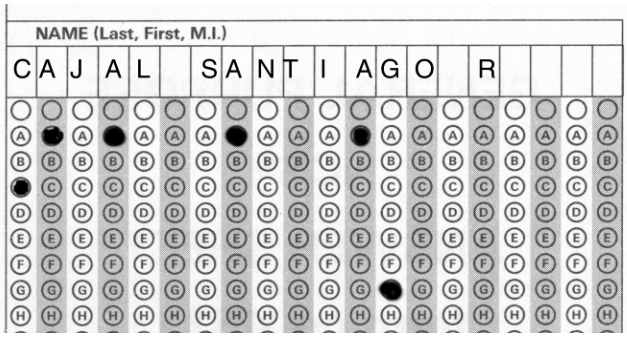
Exam 2

BioNB 2220: Introduction to Neuroscience

1. Write your name on this exam **AND** on your scantron sheet.

2. Answers to all multiple choice questions should be recorded on the **SCANTRON** in pen/pencil. Short answer questions should be written on this EXAM PAPER IN PEN. The examples to the right show you how to fill in the scantron "bubbles" properly.



3. **Write legibly. If we cannot read your answer, we cannot grade it.** Use ONLY the space provided. Do NOT use calculators or any other electronic device.

4. Check to see that your exam paper is complete. This exam packet has **8** pages.

5. Fill the answer circles completely. If you make a mistake either erase completely **OR put an X over the incorrect bubble**.

"By signing below, I acknowledge that I am abiding by Cornell University's Code of Academic Integrity."

Signature: _____

Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	SA	MC	TOTAL
8	**6**	**6**	**6**	**6**	**8**	**8**	**8**	**9**	**65**	**35**	**100**

MULTIPLE CHOICE (5 pts. each)

1. Cortical sensory maps are regions of the brain that process specific sensory information. Which of the following sense systems do **NOT** have an identified map:

   a) Vision
   b) Hearing
   c) Smell
   d) Touch
   e) All of the above have identified maps

2. You are conducting intracellular recordings of membrane potentials in auditory hair cells, a cell type in which the balance of intra- and extracellular potassium is the reverse of that seen in most neurons. Which of the following effects would you expect to see in response to a sound if you recorded hair cells in endolymph with **HIGHER** than normal potassium concentration?

   a) The cell would respond more strongly to the sound, due to a decreased driving force for K+.
   b) The cell would respond more strongly to the sound, due to an increased driving force for K+.
   c) The cell would respond more weakly to the sound, due to a decreased driving force for K+.
   d) The cell would respond more weakly to the sound, due to an increased driving force for K+.
   e) There would be no difference, because mechanical stimulation opens channels selective for Na+.

3. A patient with Parkinson's has run out of his L-Dopa medication and has not taken it for a week. What are his symptoms likely to be?

   a) Hyperkinesis, including uncontrolled 'dancelike 'choreoform movements.
   b) Hypokinesis, including an inability to stop walking once getting started.
   c) Hypokinesis, including an inability to get up from his chair.
   d) Hyperkinesis, including an inability to start walking.
   e) None of the above

4. How do climbing fibers contribute to cerebellar dependent learning?

   a) They modulate plasticity in the parallel fiber to Purkinje cell projection.
   b) They modulate plasticity in the projection from the Purkinje cells to the deep cerebellar nucleus.
   c) They are able to directly control motor output on the basis of their direct projection to branstem motor centers.
   d) They inhibit Purkinje cells though GABA receptors, causing pauses that drive movement.
   e) They project directly to dopamine neurons to cause reinforcement.

5. Which of the following statements on sensory systems is **TRUE**?

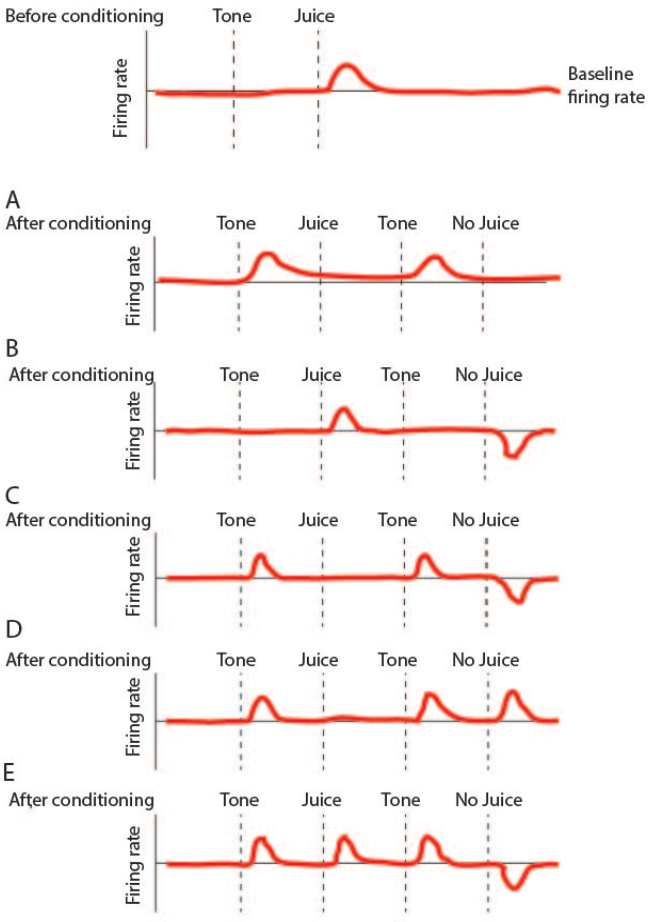
a) Neurons faithfully carry information about each sensory modality along specific parallel pathways, with none of the information being altered by other regions of the central nervous system.
b) Light results in the opening of sodium channels in the membrane of photoreceptor cells, resulting in a depolarization of the rod (or cone).
c) Taste receptors use several mechanisms, including direct ion channel activation and receptors coupled to second messenger systems, to detect the presence of different tastant molecules.
d) Lateral inhibition is a mechanism whereby the nervous system increases an area of sensation relative to the area of receptor activation.

6. Which statement concerning reinforcement learning (RL) and supervised learning (SL) is **TRUE**?

a) In SL errors drive improved performance on subsequent trials.
b) RL is dependent upon circuitry of the cerebellum, while SL is dependent upon circuitry of the basal ganglia.
c) SL depends upon the neuromodulator dopamine to signal errors, while errors are signaled directly by dedicated neurons in RL.
d) In RL there is a highly localized reinforcement signal; in SL there is a global error signal.
e) All of the above are false.

7. Dopamine neurons can encode a "reward prediction error." The firing rate of a dopamine neuron before a Pavlovian conditioning in which a tone predicts a juice reward task is shown at the top. Select the firing rate of the neuron after the Pavlovian conditioning task:

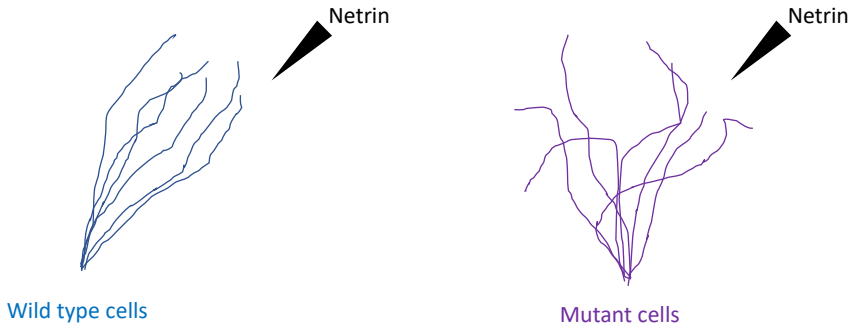
a) A
b) B
c) C
d) D
e) E



Short Answer

8. (8 pts.) In the **following figure**, the individual lines show the trajectories of different developing axons that were exposed for one hour to a diffusible chemical, Netrin-1,

issuing from the pipette visible in the upper right-hand corner. The blue lines show axons from wild type cells, and the purple from a strain of mutant cells.



a) Based on this result, what role do you think Netrin plays in the development of the nervous system (1 sentence)?

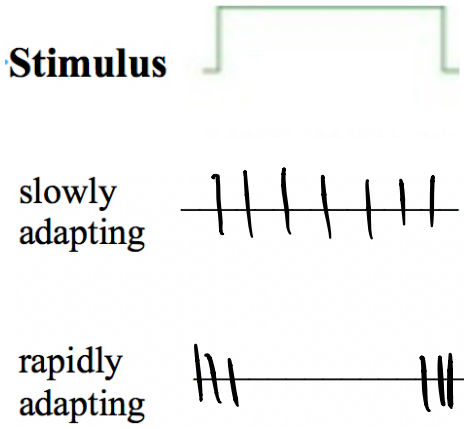
Directs growth of cells.

b) Describe one change in the mutant cell that could result in the mutant growth pattern observed on the right, and **justify** your answer (1-2 sentences).

9. (6 pts.) Although humans have only several hundred unique olfactory receptor genes, we are able to discriminate at least hundreds of thousands of different odorants. Explain how this is possible in 1-2 sentences.

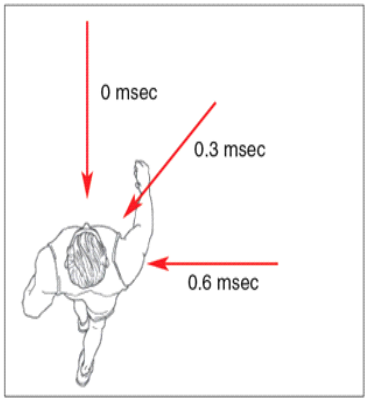
Not an injective function.

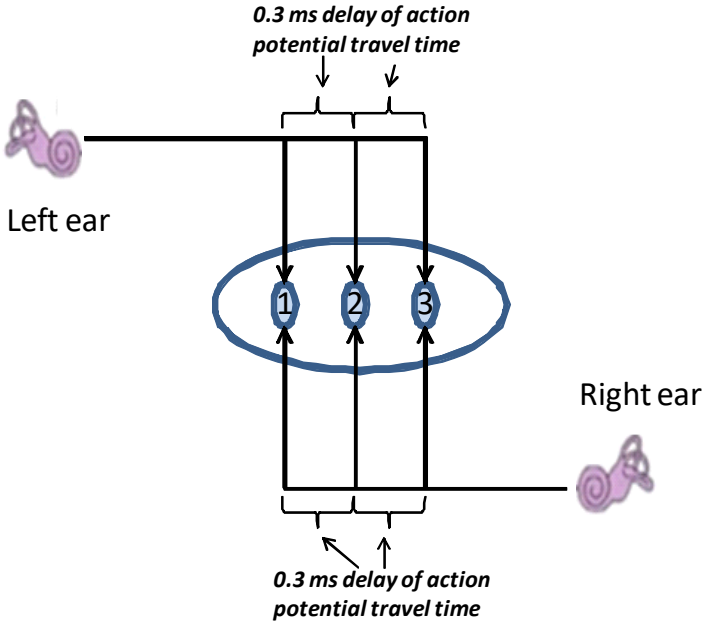
10. (6 pts.) To the right, is a plot showing an input stimulus (top row) to two different cutaneous receptors (bottom 2 rows); one receptor is slowly adapting, and the other is rapidly adapting. Fill in the action potential firing responses of the different receptors on each row.



11. (6 pts.) In the following schematic diagram of neural circuits in the auditory system, which cell will fire when a sound arrives straight from the front and the head is straight?

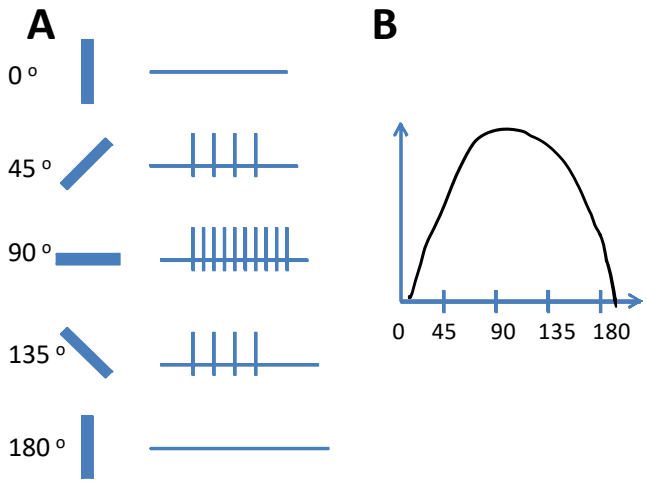
Which cell will fire if the sound arrives horizontally from the right side? Briefly explain the mechanism.





12. (6 pts.) On-center and Off-center bipolar cells both respond to changes in glutamate release from photoreceptors. Describe how it is possible that these two types of bipolar cells have opposite reactions to a decrease in glutamate release from the photoreceptor cause by light stimulation

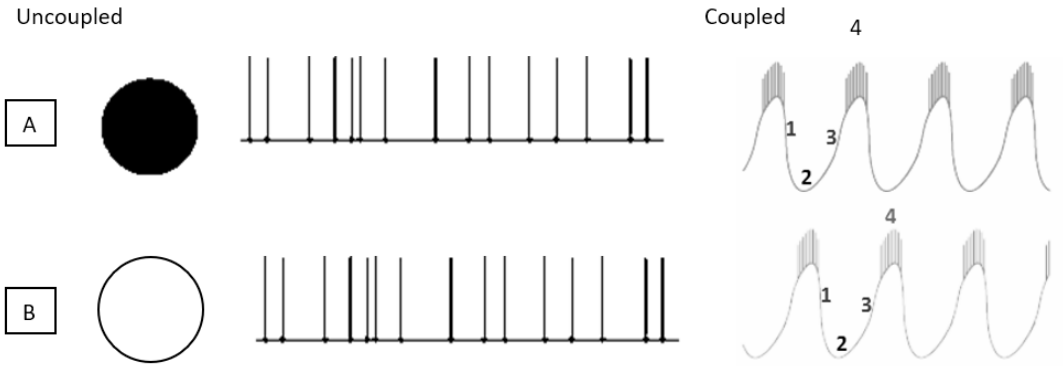
13. (8 pts.) Consider a simple cell in V1 with the action potential responses to oriented bars of light shown in A. Briefly answer the questions below.



a) In the axes provided in B, sketch the receptive field of this neuron and make sure you label the axes.

b) In words or with a diagram show how ganglion receptive fields could combine to form the receptive field of this V1 cell.

14. (8 pts.) You are recording from two neurons in a pattern generating circuit of the spinal cord, and the two neurons normally oscillate out of phase with each other. Before recording, you accidentally severed the connection between the neurons in this microcircuit, so you observe the below activity for each neuron instead of their normal rhythmic output:



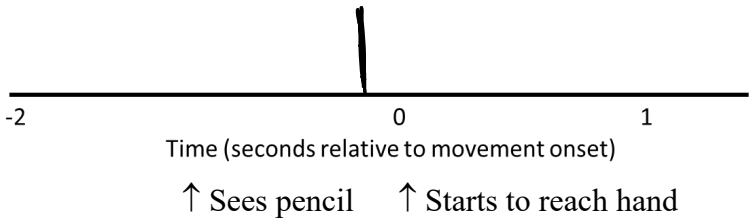
(Question continues on next page.)

A. What connections between the neurons do you hypothesize drives oscillation in this circuit?

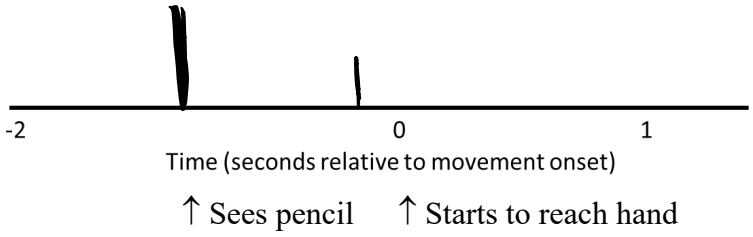
B. For stages 1-4 on the coupled diagram, what currents determine these stages in firing activity?

15. (8 pts.) You look down and see a pencil on the table before you, and then move your hand to pick it up. Below, draw two rate histograms for two cortical neurons' activity aligned to the onset of the hand reach. In the first case, imagine you are recording from a kinematically tuned neuron in the premotor cortex. In the second case, imagine you are recording from a parietal neuron that encodes object affordance.

Kinematically tuned:

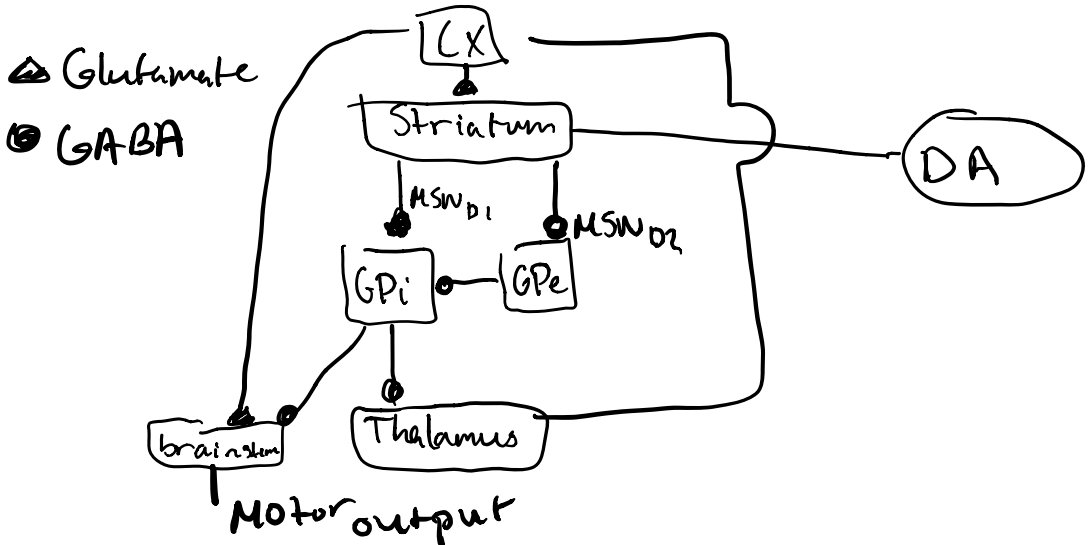


Affordance neuron:



16. (9 pts.) You have a mouse in which you can optogenetically silence MSN D1+ neurons?

a) Draw the normal basal ganglia circuit:



b) If you optogenetically silenced MSN D1+ neurons while it was running, what would happen to movement? Circle one:

Increase Decrease No change

c) If you optogenetically silenced MSN D1+ neurons while it was running, what would happen to GPi firing? Circle one:

Increase Decrease No change