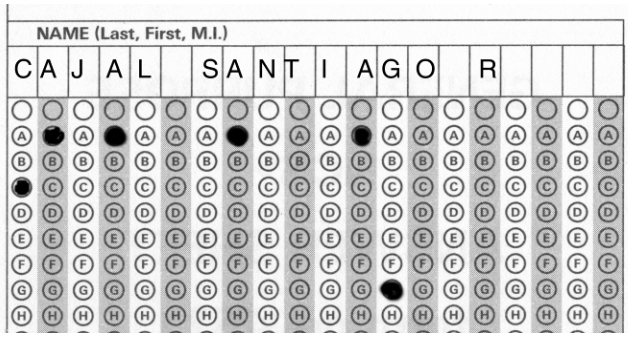
Last name: _____ First: _____ MI: ____ Cornell ID:_____

# EXAM 3 and Final

**BioNB 2220: Introduction to Neuroscience**

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

2. Answers to all multiple choice, true/false, and matching 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 **11** pages.

5. Fill the answer circles completely. If you make a mistake either erase completely OR put an **X** over the incorrect bubble. **Multiple answers will be scored as incorrect.**

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

## Signature: _____

**Your scores Exam 3**

| # | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | SA | MC | 100% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pts | 10 | 7 | 8 | 7 | 7 | 7 | 7 | 7 | 60 | 40 | 100 |
| Score | | | | | | | | | | | |

**Your scores Final**

| # | Essay 1 | Essay 2 | 100% |
|---|---|---|---|
| Pts | 50 | 50 | 100 |
| Score | | | |

**MULTIPLE CHOICE (5 pts. each)**

1. A child observes a balloon being inflated and bursting. In the future, the child reacts with fear when seeing a balloon being inflated. Which of the following statements is correct?

   a) This represents classical conditioning with the burst being the US and the balloon the CS.
   b) This represents operant conditioning with the burst being the US and the balloon the CS.
   c) This represents classical conditioning with the burst being the CS and the balloon the US.
   d) This represents operant conditioning with the burst being the CS and the balloon the US.
   e) None of the above are correct.

2. Which of the following statements do not accurately explain our hypotheses on how associative memories are formed?

   a) Hebbian modification weakens reciprocal connections between neurons that are activated at the same time.
   b) Synapses between simultaneously activated neurons undergo long-term potentiation (LTP).
   c) Representation of complex information is distributed among and within brain areas.
   d) Memories are hypothesized to be stored as assemblies, a network of cells activated by the same set of stimuli.

3. What would happen if you somehow were able to completely prevent plasticity ONLY at synapses from the auditory thalamus and auditory cortex to the basolateral amygdala?

   a) Basolateral amygdala firing rates during tones associated with shocks would not change following fear conditioning.
   b) Animals would not freeze when placed into shock-associated spatial contexts.
   c) Blood cortisol would be elevated following shock-predicting tones.
   d) Animals would show no panic response to rising CO2.
   e) Stimulating the central amygdala would have no effect on behavior.

4. A mouse, overweight since birth, begins to receive regular blood transfusions from a normal weight mouse. Soon, the overweight mouse drops to normal weight. You hypothesize that this is because the overweight mouse is missing a gene. What could this gene encode?

   a) A blood-borne factor that increases metabolism and decreases food consumption.
   b) A receptor that, when activated, decreases food consumption.
   c) An ion channel that increases the activity of AgRP neurons.
   d) An enzyme in the adrenal cortex that is part of the synthetic pathway for cortisol.
   e) A factor created in the brain that decreases the permeability of the blood-brain barrier.

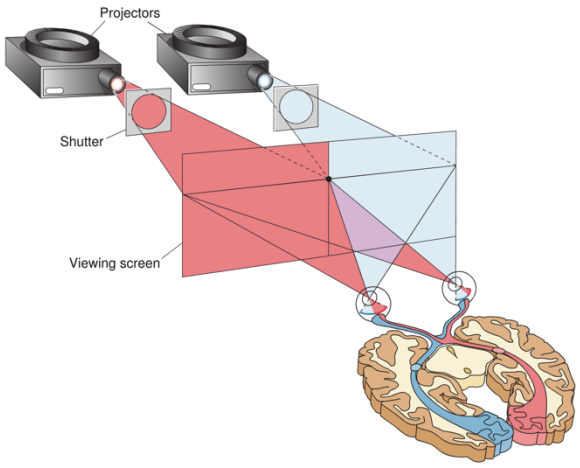
5. If you could specifically activate POMC neurons in the arcuate nucleus of the hypothalamus, what would happen?

a) Thyrotropin (thyroid-stimulating hormone) would be released, leading to increased metabolic rate.
b) The sympathetic division of the autonomic nervous system would be activated.
c) Feeding behavior would decrease.
d) All of the above.
e) B and C only.

6. Which of the following interventions would reduce the amount of time spent sleeping, if the intervention was possible? (Assume interventions are actually possible.)

a) Taking a drug that acts as a histamine antagonist.
b) Inhibiting hypocretin/orexin neurons in the hypothalamus.
c) Using a 'brain-cleaning' device that selectively prevented extracellular adenosine buildup.
d) Lesioning the brainstem midline reticular activating system.
e) Chemical suppression of the norepinephrine diffuse neuromodulatory system.

7. 'Split-brain' patients, who have had their corpus callosum cut in order to reduce epilepsy-related seizures, are sometimes tested by presenting visual information to each hemisphere independently, as in the following diagram:




These patients:

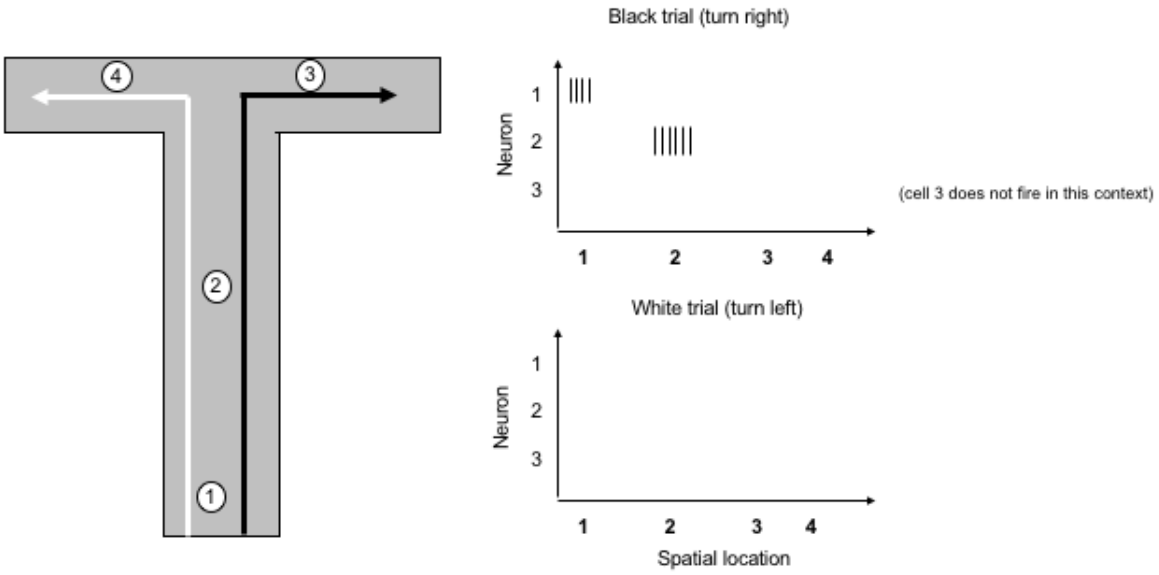
a) Are indistinguishable from people who have not received this surgery.
b) Verbally deny seeing anything when items are shown to the left hemisphere.
c) Can follow simple instructions and interact with items presented to the right hemisphere.
d) Can read text aloud when it is presented to the right hemisphere.
e) All of the above.

8. How does visual attention to a spatial location affect behavior?

a) Our eyes always move to focus on that spatial location.
b) It takes longer to react to visual changes at the location.
c) Visual changes at the location can be detected more easily.
d) It becomes more difficult to distinguish similar patterns at the attended location.
e) Color detection threshold increases at that location.

**SHORT ANSWER**

9. (10 pts) You place a rat in a maze shaped like a T and record from place cells in the hippocampus.




Given the responses of neurons 1-3 during a trial in which the rat turns right ("black trial"), fill in the "white trial" raster plot, showing hypothetical responses of these same place cells in the hippocampus which support the hypothesis that place cells do not respond exclusively to where the animal is, but are also driven by context

10. (7 pts) Patient H.M. had surgery which removed his hippocampus and some surrounding areas. Briefly name one type of memory he could form and one type of memory he could not form, and give an example of each.

11. (8 pts) Name two experimental ways to increase the firing rate of neuronal populations, and name one advantage and one disadvantage for each.

12. (7 pts) Explain the differences between Broca's aphasia and Wernicke's aphasia with respect to following:
    - Comprehension
    - Speech production

13. (7 pts) You are working with a patient that you suspect has experienced brain damage, but are unsure which region of their brain might be affected. As a test, you ask the patient to sort a deck of cards into piles based upon color. Every few minutes, you change the rule and ask them to sort cards based on shape, number, etc. You observe that the patient is unable to switch; instead, they continue to follow the original rule. Based on this, what region of the brain do you suspect was damaged?

14. (7 pts) You inject vasopressin into both ventricles of the cerebral hemispheres of a promiscuous vole species. You observe that their partner preference behavior does NOT change. Explain why in 1-2 sentences.

15. (7 pts) Your friend hypothesizes that acute alcohol intoxication can be treated in the Emergency Room with benzodiazepines, anxiolytic drugs like Valium that are enhancers of $GABA_A$ function. Will this work? Why or why not?

16. (7 pts) Describe the difference between attention and arousal and give an example of each (2-3 sentences).

# FINAL EXAM begins on the next page.

## FINAL EXAM begins here.

**Instructions**

1) Your answer should take about 1 (max 2) pages, but most can be answered in 1 page of focused content.
2) Choose **2** of the following three prompts, and mark at the top of each page which essay response goes with which prompt.
3) Although we suggest that you use the back (unlined) pages to outline ideas and create drafts, **only the front (lined) pages will be graded**.

# Prompts

***Prompt A.*** Brains are built from many different kinds of neurons that vary in shape, size, neurotransmitter, and firing patterns. Why do some kinds of neurons project very widely in the brain, while others are confined to a small spatial region? Address the following:

a) Discuss the advantages and disadvantages of widespread and local neural connectivity
b) Give an example of a widely-connected neuron in the brain, and discuss how this connectivity pattern helps to solve a problem (circuit or behavioral)
c) Give an example of a locally-connected neuron in the brain, and discuss how this connectivity pattern helps to solve a problem (circuit or behavioral)
d) Do you think it would be easier to develop a therapeutic drug by searching for compounds that affect the activity of widely-connected or local neurons? Justify your answer.

***Prompt B.*** Imagine this: You are walking along the gorge trail and in the water you see a bug. The bug is trying to swim to safety and as he is doing so, he moves his legs in a rhythmic pattern. You decide to pick the insect up and bring him back to your lab. Once there, you want to know what is controlling the swimming motion in the insect. In a 1-2 page essay, respond to the following questions:

a) What are two types of networks that could generate a rhythmic patterned movement?
b) How would you go about finding where these movement-generating neurons are? What experiments would you do? (Assume you have identified the type of insect and acquired many more for your experiments).
c) What would you do to ensure that these are the neurons generating the movement? Are there drugs you can add to isolate the neurons?
d) If you were also a great molecular biologist, how would you stimulate only the neuron/s involved in creating the movement?

***Prompt C.*** Consider yourself to be very frustrated from all the mice in your house (yikes!) that eat all the candies on your table at night. Which populations of cells in the brain change their activity when a normal mouse becomes hungry?

a) Explain a pathway that might be encouraging normal mice to eat sweet tasting food.
b) Design an experiment to test how you will find sweet sensing neurons in the mouse's brain.
c) Assume you are able to find these sweet sensing neurons. You decide to make a transgenic line that finds sweet taste to be bitter and unpleasant. What type of receptors will you find on them? What receptors would you want your transgenic mice's sweet neurons to express?
d) Assume you are able to create the transgenic mouse that finds sweet candies bitter. What new neuronal mechanism might be at play here?

**Response 1, Prompt _____, Page 1**

**Response 1, Prompt _____, Page 2**

**Response 2, Prompt _____, Page 1**

**Response 2, Prompt _____, Page 2**

**Have a great summer!**