

200 points total

Your Name: _____

Your mailing address (where you will be in the last part of June)

I. (40 points) True/False

1. ____ *Aplysia* is the only invertebrate in which observational learning has been displayed experimentally.
2. ____ Bees make controlled landings on small flowers by using sensory hairs on their head to detect wind speed.
3. ____ GABA is classified as an inhibitory neurotransmitter because it brings the neuron farther from threshold by allowing Na⁺ influx.
4. ____ All muscle cells have voltage-gated channels in the motor end-plate region.
5. ____ An evolutionary increase in the number of interneurons in the nervous system of an organism indicates an increase in complexity and an increase in the variety of possible responses.
6. ____ Cephalopods are the group of invertebrates to which humans are most closely related in terms of evolutionary origins.
7. ____ The action potential is dramatically different in every organism.
8. ____ Every action potential is due to a rapid influx of a positive ion controlled by the opening of voltage-gated channels.
9. ____ How the brain interprets neural input is dependent on **where** in the brain the input synapses.
10. ____ One indication of a more evolved nervous system is the fusion of anterior ganglia seen in some invertebrates.
11. ____ The unique ability of neurons to generate electrochemical signals is based on their creation and maintenance of ionic gradients across the cell membrane.

12. ____ If an area on a cell is described as chemically excitable it must have a concentration of ligand-gated channels in this region.
13. ____ The cell body is a major player in the action potential in the neurons of arthropods.
14. ____ Dendrites transmit action potentials to other neighboring cells as a means of communication.
15. ____ Myelin decreases internal resistance of an axon.
16. ____ Sun compass orientation was first discovered in desert ants when they went in circles when a cloud obscured the sun momentarily.
17. ____ Long-term memory in *Drosophila* is a neural process unaffected by inhibition of protein synthesis.
18. ____ A command fiber in the crayfish is one whose activity is totally controlled by the brain.
19. ____ In jellyfish, “enpassant” synaptic transmission can be in either direction.
20. ____ The major delay in the cockroach alarm response is in sensory input to the ventral nerve cord.
21. ____ Spiracles are valves in the insect respiratory system.
22. ____ When Spallanzani checked on his blinded bats, inside the stomach of one he found his missing cuff links.
23. ____ Deep-sea Dragonfish see infra-red light by converting it to visible light.
24. ____ The two hearing cells in a moth ear indicate different directions of bat approach.
25. ____ The fat in the porpoise melon serves to shift the echolocating pulse to a higher frequency.
26. ____ The primitive nature of coelenterates is shown by their lack of the protein actin.
27. ____ An isolated living fly head cannot learn an olfactory task.
28. ____ Removal of the statocysts renders the octopus eye unable to distinguish between

vertical and horizontal.

29. ____ Memory ability in *Drosophila* is affected by at least 5 mutants.
30. ____ Firefly males tend to flash in unison to reduce “optical” noise that might confuse the females—otherwise she may misread her own species code.
31. ____ Feeding termination in the blowfly is caused by rising blood sugar concentration.
32. ____ Flicker Fusion Frequency is a measure of the rapidity of an eye's response.
33. ____ In optokinetic behavior the animal moves to maintain a constant orientation to a moving background.
34. ____ Baleen whales have excellent hearing even though they do not echolocate.
35. ____ Fishing bat sonar must penetrate the water several inches to detect fish prey.
36. ____ If a food source is directly adjacent to a bee hive the foragers do a round dance.
37. ____ Each chromatophore of the octopus is innervated directly from the brain.
38. ____ Porpoise echolocation signals require air emission as bubbles.
39. ____ All types of sponges have syncytial tissues that generate action potentials.
40. ____ Cuttlefish must undergo a learning period after hatching to hunt successfully.

II. (20 points) Multiple Multiple Choice (more than one answer may be correct!)

1. Which of the following groupings are correct:
 - (a) Insects are **not** in the Phylum Arthropoda
 - (b) *Aplysia* is in the Phylum Mollusca
 - (c) Hexactinellids are in the Phylum Cnidaria
 - (d) *Limulus* is more closely related to spiders than crabs
 - (e) The jellyfish *Aurelia* is in the Phylum Ctenophora
 - (f) *Ascaris* and earthworms are in the same phylum

2. Choose the correct statements regarding the functions of the peripheral and central nervous systems:
 - (a) peripheral nervous system function always involves processing
 - (b) central nervous system does minimal integration
 - (c) peripheral nervous system function rarely involves processing
 - (d) central nervous system does the majority of integration

3. Which of the following does **not** belong in the positive-feedback cycle of an action potential?
 - (a) depolarization opens voltage-gated Na^+ channels
 - (b) Na^+ influx
 - (c) K^+ efflux
 - (d) depolarization opens voltage-gated K^+ channels

4. Na^+ influx in the axon during the action potential occurs because:
 - (a) it is actively pumped into the axon by an ATP pump
 - (b) there is an electrochemical gradient driving it across the membrane through open channels
 - (c) there is more Na^+ inside the axon than outside
 - (d) ligand-gated channels open and draw Na^+ in
 - (e) K^+ flows in the axon too and Na^+ and K^+ always go together

5. What makes an axon able to generate and propagate an action potential very quickly?
 - (a) it is electrically excitable
 - (b) its membrane resistance is very low
 - (c) its cytoplasmic resistance is very high
 - (d) it has voltage-gated channels
 - (e) all synaptic inputs occur on the axon

6. The lateral giants in the crayfish:
 - (a) innervate the fast flexor muscles
 - (b) control escape swimming behavior
 - (c) innervate the entire abdomen (all the abdomen's segments)
 - (d) inhibit the extensor muscles in the abdomen in the beginning of a tail flick
 - (e) synapse with the medial giants

7. Graded potentials, (aka receptor potentials and synaptic potentials):
 - (a) directly reflect the stimulus strength that causes them
 - (b) are regenerative, propagate actively
 - (c) can be used to transmit a signal from one end of a neuron to the other if the space constant is high
 - (d) are always depolarizing
 - (e) are all-or-none

8. Neural pathways that conduct impulses very quickly are characterized by:
 - (a) small diameter unmyelinated axons
 - (b) myelinated axons
 - (c) axons with low space constants
 - (d) predominance of chemical synapses over electrical synapses
 - (e) large diameter axons

9. The following are examples of convergent evolution in the cephalopods and humans:
 - (a) photoreceptor structure and retina organization
 - (b) arms with infinite numbers of joints
 - (c) method of detecting acceleration in three planes—spatial orientation
 - (d) memories from a given sensory modality are localized to specific regions of the brain, but are stored diffusely within that specific region
 - (e) pinhole eyes

10. The waggle dance is bee language that describes:
 - (a) how rich a food source is by the intensity of abdomen movements
 - (b) how far a food source is by how tired a bee is when it returns from foraging
 - (c) the angle from the sun that must be flown to reach the food source as shown by the angle of the waggle circuit relative to the combs inside the hive
 - (d) how high the food source is by how fast it buzzes its wings

III. (83 points total) Short Essay

(6 pts) 1. Define habituation, sensitization and facilitation and provide specific examples of each from the course.

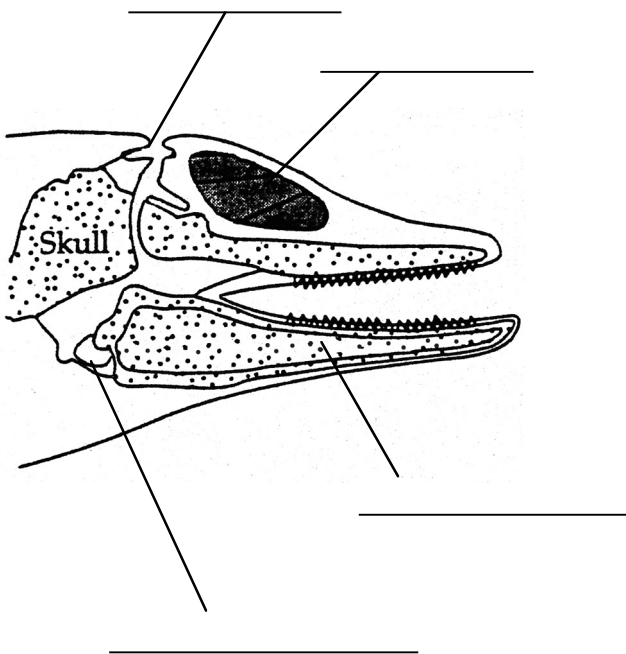
(6 pts) 2. Describe four different uses of bioluminescence and give specific examples of organisms that use bioluminescence in this way and how.

(6 pts) 3. Describe four distinct influences on the CNS of the crayfish that help determine whether a given stimulus will elicit a startle response or not.

(8 pts) 4. Describe (in sequential order) the events associated with synaptic transmission and how post tetanic potentiation is thought to cause learning and memory.

(6 pts) 5. Describe three different methods bats use to locate (and in some cases catch) food.

(8 pts) 6. Label the diagram below and explain *how* a dolphin echolocates (relate your answer to the labelled parts of the diagram). **Draw arrows** indicating the direction of the emission and the echo return.



(9 pts) 7. The brain's most important role is to integrate all the incoming sensory input. Briefly describe **three** examples of the brain's integration ability seen in experiments that demonstrated transfer of learning (1) horizontally between bilaterally symmetric sense organs AND/OR (2) from one sensory modality to another.

(6 pts) 8. In regard to toothed whale communication:

(a) What properties of the ocean enable extremely long distance communication?

(b) What property of sound transmission in water makes necessary very short communication pulses?

(c) What role does the special fat in the lower jaw and melon play in the communication mechanism?

(4 pts) 9. State two ways it is easier for a bat to use echolocation than a non-flying land animal.

1.

2.

(5 pts) 10. In the lake experiment on precision of target choice, the bats did not do too well. Something was wrong with the experiment. Explain.

(5 pts) 11. How does the honeybee tremble dance help regulate foraging activity of the population in the hive?

(4 pts) 12. Describe an experiment that suggests formation of new synapses might occur fast enough to have a role in initial establishment of memory.

(6 pts) 13. Describe one experiment that favors the visual odometer theory (optical flow) of distance measurement by the bee.

(4 pts) 14. In agonistic interactions of male animals there is little point in a battle to the finish because both combatants might be seriously injured. Discuss how this undesirable outcome is prevented in interactions between male crayfish.

IV. (32 points total) Medium Essay

(12 pts) 1. A goal of this course was to carry as many topics as possible to about where knowledge of it ends today. For each topic listed below,

- (a) state concisely the limits of current knowledge AND
- (b) offer a logical suggestion as how most profitably research on that topic might proceed.

1. Long-range homing in echolocating bats

(a)

(b)

2. Hunting and the diet of sperm whales

(a)

(b)

(10 pts) 2. Darwin thought it impossible that the eye (he meant mammalian) could have been formed by natural selection. How can we correctly answer him now? Mention important steps in the progress of eye evolution from single-celled organisms through the highest forms of eyes with consideration of genetic, functional, and structural evidence when possible.

(10 pts) 3. Learning and memory are conceded to be the toughest problems in neurobehavior.

(a) What do you think might be the most promising animal we have studied for making progress in this area **and why**?

(b) Where are we in work on this animal?

(c) If you were to continue work on this problem with adequate resources, discuss the next logical step(s).

V. (25 points) Long Essay

This course had two central themes:

- (a) knowing the neural basis of behavior helps to understand many questions in evolution, population biology and ecology;
- (b) knowing the neural basis of behavior in simpler animals helps to understand neurobiology and behavior of higher animals, as set forth in JZ Young's essay.

For **ONLY 4** of the levels of study below list one example from course materials illustrating **EITHER** theme A or theme B. Then explain your reasoning as to how your example does this.

1. at the level of the nerve cell –

2. at the level of sense organs –

3. at the level of learning and memory –

4. at the level of evolutionary biology –

5. at the level of understanding the fitness for survival of a particular kind of animal –