9.14 class #39: REVIEW QUESTIONS
May 13, 2005

Reviewing for final exam:

Pre-midterm: Review the exam, the student questions and answers, and the midterm review pictures posted before the exam
Post-midterm: Review assignments, quizzes, homework, class notes, study questions.

Some integrative questions:

1. The Papez circuit: What is it? (Specify the major links.) With what function was it associated, according to Papez? How could neural activity escape the loop and reach motor neurons? What are the inputs to this neural apparatus?

2. From the visual cortex, there are several major routes (and quite a few additional ones!) for neural activity to reach output circuitry. What are they? What other routes are there from retina to motor neurons?

3. ANOTHER VERSION OF THE QUESTION: Describe three pathways by which the visual cortex (area 17) can affect movement.

4. Compare the olfactory and the somatosensory pathways, from primary sensory neurons to neocortex.

5. For the neocortical mechanisms underlying human language, what thalamic nuclei would you expect to be most important: a) in understanding of speech? b) in production of speech? What is the role of the arcuate fasciculus?

6. In the neuronal proliferation that occurs in early development of the endbrain, there is a stage of cell division in which the total area of cortex expands, and another stage in which the thickness of the cortex increases. Contrast these two stages with respect to consequences of mitoses.

7. In the development of transcortical connections, as in the development of the optic tract, what is meant by a period of "exuberance" in axonal arborization, and by a period of "focalization"? When would you expect programmed cell death to be most important? Why might such PCD occur (what may be the cellular trigger)? What function could it serve?

8. Assume that you would like to find molecular markers of neuronal plasticity, and you are looking for antibodies to mark the more plastic neurons in the developing and adult CNS. Which proteins may be useful in this regard, because of their role in either synaptic plasticity or in axonal growth? How could you locate these proteins in experimental studies?

9. What is "LTP"? Describe one of the connections within the hippocampal formation where you would expect LTP. From the postsynaptic side of this connection, where does the information in this pathway go? (Describe the next specific, synaptic, connection and then describe the pathway out of the hippocampal formation to a non-hippocampal region.)

10. Give a neuroanatomical argument for why you would expect the mammalian corpus striatum to be involved not only in motor control, but in other functions as well. This type of argument applies also to the cerebellum.

11. Note three clear differences between neocortex and cerebellar cortex. (Suggestions: locations, developmental peculiarities, cellular architectures, local connections, dendritic geometry.) BECAUSE WE SPENT LITTLE TIME ON CEREBELLUM THIS YEAR, THIS QUESTION SHOULD BE CHANGED. INSTEAD OF CEREBELLUM, WE COULD PUT CORPUS STRIATUM OR OLFACTORY CORTEX OR OPTIC TECTUM.

12. Describe two sexual dimorphisms in the mammalian CNS. What developmental events may underlie a dimorphism? Describe an experiment that could test this idea in developing rodents.

13. It has been suggested that for at least one axis (representing upper *vs* lower retina) of the retinotopic map in the superior colliculus, chemospecific markers may be redundant for determining the topographic order of axonal connections. In what other way could this axis be determined? Concerning the other axis (representing the naso-temporal axis of the retina), what discovery has confirmed the theory of chemical (molecular) specificity? Was Sperry's idea of selective adhesion confirmed?

14. How could work on the retinotectal projection in small mammals lead to methods for treatment of spinal injury?

15. How is the problem of developmental determination of neocortical areas related to the problem of developmental determination of the organization and connections of the optic tract? What are some of the key issues in understanding the nature of this problem?

16. It has recently been discovered that neurotrophins are not only present in the developing neocortex, but are influenced by neuronal activity. Describe two possible experiments which could be done to test for a role of neurotrophins in postnatal stages of neocortical development in the cat.

17. In contrasting the diencephalon of higher primates (especially, human) with that of a rodent or insectivore, in what major division would you expect the largest differences, and why? Which cell groups should be most different in size? Name one other cell group where you would expect some marked species differences, and give your reason.

18. Describe some of the problems encountered in experiments with transplants of brain tissue. How can the problems be resolved? In the future, what kind of procedures may be better than transplants taken from human embryos?

19. If you wanted to divide the midbrain of a newly studied species into limbic-related and non-limbic related regions, what are the neuroanatomical experiments you would want to do? (What connections would you want to trace?) How could electrophysiological experiments help?

20. What was Fernando Nottebohm's famous paper, entitled "A brain for all seasons", about? What animal was he describing? Is there any similarity in the connections he was dealing with to human brain connections? What was the biggest surprise in this work for students of mammalian brain development?

21. What is the especially important neuroanatomical position of the entorhinal cortex and of the subiculum? (Where are these structures, what are some of their connections, and why do neuroscientists consider them to be of such importance in human brain?)

22. Describe two pathways by which the motor cortex (area 4) can affect movement. If a person or animal suffers a large lesion of motor cortex, but the lesion grows slowly, many movements may be little affected. What structures and pathways do you think could "take over" functions of motor cortex in such cases?

23. Brain size/weight: What besides the intelligence of the species determines it? Why might there be differences in brain size/weight even when body size/weight is equivalent?

24. What properties of the human brain differentiates it from brains of the great apes? Distinguish quantitative and qualitative differences. How are these properties important in the structural basis of intelligence?

25. What are the two major kinds of motor control, expressed in two outputs of the corpus striatum to the midbrain motor control mechanisms? How is this dichotomy represented in neocortical pathways, e.g., transcortical pathways leading from visual cortex?

26. What aspects of brain function are most demanding on quantity of neurons and connections? What does this imply about interpretations of functional imaging data?