

Questions for special emphasis in preparation for Final Exam:

Taste, olfactory systems:

- 1) Describe the pathway for taste impulses, from tongue to forebrain. Name or describe the location of each synaptic link. Where in the forebrain other than neocortex do taste pathways project? [Schneider]
- 2) Studies of olfactory projections in what “primitive” species have provided evidence for an early dominance of the olfactory system in evolution of the endbrain? [Schneider]
- 3) What are olfactory glomeruli? What is the source of its major inputs? What topography in the input pattern has been discovered? [Schneider; Malnic *et al.* (1999)]
- 4) What is a mitral cell? (Location, major input, its axonal projection) [Schneider]
- 5) Examples of “mosaic evolution” in olfactory and in taste systems. [Schneider; Striedter ch 5]
- 6) Cell turnover in the olfactory bulbs: Where do new neurons come from, and how do they get there? [Schneider; Lois *et al.* (1996); Alvarez-Buylla, & Garcia-Verdugo (2002)]

Visual system

- 7) What was the last major retinal projection to be discovered—and probably the first to evolve? What is its major function? [Schneider]
- 8) How is the pineal gland related to the lateral eyes in mammals? [Schneider]
- 9) Describe the two largest pathways in mammals for information from the retina to reach the endbrain. Name two non-mammalian groups of animals where similar pathways exist. For one of those groups, name or describe the endbrain termination area. [Schneider; Allman]
- 10) What are the five neuromeric divisions of the embryonic CNS traversed by the optic tract, in order? [Schneider]
- 11) Name or describe four types of axonal inputs to the midbrain tectum in higher vertebrates. [Schneider]
- 12) What are the optic radiations? How does temporalization of the hemispheres distort these fibers? [Schneider]

- 13) Explain what is meant by proportional connectivity, absolute connectivity, and small world architecture. [Striedter; Schneider]
- 14) What are the two major transcortical pathways of the mammalian visual system, and what are their major functions? [Schneider; Allman]
- 15) What is “perhaps the most spectacularly laminated brain region in vertebrates” (Striedter) found in certain fish?
- 16) Describe how the primate visual cortex has provided a striking example of phylogenetic proliferation by addition. [Striedter]

Auditory system

- 17) According to fossil evidence, what major transformation of the hearing apparatus occurred in early mammals? [Allman; Schneider]
- 18) Give examples of how the sizes of the superior and inferior colliculi of the midbrain vary among mammals. [Striedter; Schneider]
- 19) Instinctive aversive behavior in response to loud noise, and learned fear responses to specific sounds, depend on different ascending connections. Contrast the connections. [Schneider]
- 20) Contrast two major ascending pathways of the auditory system of the brainstem of mammals: Origins, major structures where synaptic contacts are made. [Schneider]
- 21) How is a “place code” used for encoding of sound frequency information? Describe the apparatus at the level of the periphery and of the secondary sensory neurons. [Schneider]
- 22) What is a major function of auditory cortex in the cat, from the results of unit recordings and from the effects of ablation? [Schneider]

Forebrain evolution [Schneider; Striedter]

- 23) What similarity in physiological function, involving metabolism and autonomic control, is shared by birds and mammals, and seems to be a precursor of enlarged brains? At what levels of the CNS is this function controlled?
- 24) What sensory function besides audition increased in capacity in the earliest mammals?
- 25) What structure in reptiles is most similar to the neocortex of mammals? What evidence demonstrates the similarity? What is a major difference? What is the comparable structure in birds?

- 26) What major endbrain structure is found in reptiles and birds but not in mammals? What was the finding, surprising at the time, of Harvey Karten, working at MIT in the 1960s, about this structure?

Limbic system 1

- 27) What is diabetes insipidus, and how does it involve the brain? [Brodal; Schneider]
- 28) How does hypothalamus send influences to the cerebral cortex? Describe two different pathways. [Schneider]
- 29) Contrast the styles of motor innervation of somatic muscles and smooth muscles (including the contrast between sympathetic and parasympathetic). [Nauta; Swanson; Schneider]
- 30) Contrast the pathways for hypothalamic control of the two divisions of the neurohypophysis (pituitary). [Nauta; See also Brodal, Schneider.]
- 31) What were the three widely projecting monoamine-containing systems first characterized by Dahlström and Fuxe in the 1960s, and the locations of the cell bodies? Several more diffusely projecting systems have been discovered since that time. Describe one of them with cells located in the hypothalamus. (Swanson ch 7; also Schneider chapter 17)
- 32) What appears to be the critical forebrain area for “spontaneous locomotor behavior” (intrinsically generated locomotion)? Name it or describe its location. It is critical for an animal’s “drive” to locomote, a motivational state also associated with the appetitive behavior of various drives. [Swanson; Schneider]
- 33) How are the Papez’ circuit structures connected to non-limbic neocortical areas? [Schneider]
- 34) What is a major “reward pathway” in the mammalian CNS? [Schneider]
- 35) If you could electrically stimulate the midbrain of a cat, where would you locate the electrode tip in order to cause a) a general arousal response (including sympathetic nervous system arousal) without much change in motivational state, b) reward in a training situation, c) vigorous locomotion, d) turning of head and eyes, e) movement of a paw. [Schneider]

Limbic system 2

- 36) What are two major factors correlated with brain size in humans? [Schneider]
- 37) When do sex differences in specific cell groups in the human hypothalamus appear? [Swaab and Hofman]

- 38) Name or describe two different factors that are involved in causing sex differences in the mammalian brain, other than overall size. [Schneider]
- 39) Describe the evidence from Nottebohm *et al.* that the male canary brain changes from season to season.

Limbic system 3

- 40) What is the name of the major input pathway to the hippocampus of mammals and where does it originate? Where does it terminate within the hippocampal formation? [Brodal; Schneider]
- 41) Important neuromodulatory input reaches the hippocampus directly from what subcortical structure, using acetylcholine as the neurotransmitter? What group of axons do these axons follow? [Brodal; Schneider]
- 42) What are two kinds of evidence that has indicates that the hippocampal formation of mammals is the homologue of the medial pallium of non-mammalian vertebrates? [Striedter]
- 43) In what sense are evolutionary changes in hippocampal connections like the evolutionary changes in striatal connections? [Striedter]
- 44) Where is long term potentiation (LTP) found in the hippocampus? [Schneider]
- 45) Why is the neocortex of critical importance in the function of the hippocampus in mammals? How are these structures connected? [Schneider]
- 46) Give an example of collateral sprouting in the adult hippocampus. What causes it, and which axons do it? [Schneider]

Limbic system 4

- 47) Describe Downer's experiments (1962) in monkeys with unilateral amygdectomy in a split-brain monkey. [Schneider; Mesulam]
- 48) Describe Papez' Circuit (Papez, 1937). What did Papez claim about it? [Schneider]
- 49) Describe two sensory pathways to the amygdala. [Brodal; Schneider]
- 50) What is the "stria terminalis"? Where does it originate? Describe two of its subcortical terminations. [Schneider; Brodal]
- 51) In Alzheimer's disease, what is the pathology involving the basal forebrain? What connections are lost? [Brodal; Schneider]

Corpus striatum

- 52) Explain the meaning of the statement that the major output of the extrapyramidal system is the pyramidal system. [Nauta & Feirtag; Schneider]
- 53) Contrast the major source of sensory inputs to the striatum in amphibians and in mammals, according to Striedter. [also Schneider]
- 54) What are two outputs of the striatum (and globus pallidus, or pallidum) to the midbrain? These projections have been overshadowed in mammals, particularly in large mammals, by what output of the pallidum? [Schneider]
- 55) What appears to remain in modern mammals of the earliest structures of the striatum? [Schneider]
- 56) The expansion of the striatum in mammals (also other higher vertebrates) occurred in evolution because of what change in connections? [Schneider]
- 57) Contrast the pathways to motor cortex and the pathways to the superior colliculus from the caudate and putamen. [Schneider]
- 58) Give an example of the "double inhibition" of pathways through the striatum. What neurotransmitter is involved? [Brodal; Schneider]
- 59) In treatment of Parkinson's disease with transplants, what is the source of the tissue used, and where is it usually placed? [Schneider; other readings]
- 60) How is locus of a transplant within the striatum related to possible functional effects? [Schneider; other readings]
- 61) Describe a method of treating Parkinson's disease that has become common in recent years. [Schneider]

Neocortex [covered in class, in Schneider readings, and where noted]

- 62) How does human ability to cook food promote larger brain size? [Allman]
- 63) What changes in Wernicke's area of the human brain appear to result from greater education, according to Golgi studies by Arnold Scheibel and collaborators? [Allman]
- 64) What are the two different types of association areas, according to Mesulam? [Schneider; class lectures]
- 65) What are the two "heteromodal fields" (multimodal areas) in the primate brain? Which appears to be larger? [Schneider; class presentation of Mesulam]

- 66) What thalamic nuclei connect with the two neocortical fields in the previous question?
[Schneider; Brodal]
- 67) Name the major thalamic nucleus that receives input from a) the retina, b) somatosensory pathways from the spinal cord, c) the ascending auditory pathways.
- 68) Contrast different routes for sensory information to travel from primary sensory cortical areas, e.g., visual cortex, to motor output systems. Try to describe at least three routes.
- 69) What is the rhinal sulcus?
- 70) Contrast: pyramidal cells and stellate cells of the neocortex.
- 71) Layer four of the neocortex is most different in two areas: the motor cortex and the primary visual cortex: Summarize the differences.
- 72) What is the arcuate fasciculus? How is it related to human language?
- 73) What are the radial fascicles of the neocortex? Describe or name three types of axons found in such fascicles.

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9.14 Brain Structure and Its Origins

Spring 2014

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