

9.14 Qs on post-midterm class sessions and Schneider chapters 18-34

(Bold font indicates terms you should be able to define.)

Ch 18

1. In comparative neuroanatomical studies, the taste system provides some of the most dramatic examples of mosaic evolution (illustrated in chapter 4). Explain the meaning of mosaic evolution and describe examples.
2. Describe the functions of the innervation of the tongue by four different cranial nerves.

Ch 19

3. What are the major differences between the projections of the olfactory bulbs in a primitive vertebrate like the sea lamprey and in an amphibian like a frog or salamander?
4. Describe the difference between the main olfactory bulb and the **accessory olfactory bulb**: Inputs to the two portions of the bulb, and differences in their projections to the cerebral hemispheres.
5. Contrast the very orderly organization of the olfactory nerve axons to the olfactory bulb, with the nature of the **mitral cell** projections to the olfactory cortex.
6. Contrast: “**compensatory sprouting**” and “**compensatory stunting**” of lateral olfactory tract axons. What intrinsic factor may explain the above phenomena?
7. How can one prove the existence of neuronal precursors in the adult mammalian brain
8. Contrast **concerted and mosaic evolution**.

Ch 20

9. Light controls the daily rhythm of secretion of melatonin by the pineal gland. How is this control accomplished? Describe two different pathways in different animals, one much more ancient in evolution than the other.
10. Recall the hypothesis using Darwinian logic concerning the evolution of a predominantly crossed representation of visual space.
11. Contrast the type of visual orienting for which the midbrain tectum (superior colliculus) has become dominant in most species, and the visual orienting for which the pretectal area, independent of the midbrain tectum, is important in some species—according to discoveries in frogs and tree shrews.

12. Distinguish between two very different visual functions of the midbrain tectum, each involving a different output pathway. For which of these functions is precise acuity more important?
13. What are the two main methods that have been used by neuroscientists to map the topography of the representation of the visual field or of the retina in the superior colliculus?
14. Visual pathways to the endbrain follow multiple routes. Describe three such routes, beginning at the retina.

Ch 21

15. Name the five main optic-tract termination areas in the order they are reached by the optic tract. What additional areas receive sparse retinal projections from the main optic tract?
16. Axons that leave the main optic tract and terminate in small cell groups (up to 3 of them) are described as the _____ optic tract axons.
17. Describe at least four different anatomical methods that can be used to uncover distinct layers within the optic tectum or superior colliculus.
18. Name three animals or groups of animals that have a very large optic tectum? (See also chapters 6 and 11.)
19. Why is the term “optic tectum” misleading about this structure?

Ch 22

20. What are the two routes to the endbrain taken by visual information that are usually considered the major ones in present-day mammals, reptiles and birds?
21. What is the most rapid route from retina to endbrain, the route that has become the most dominant of the multiple visual pathways to the endbrain in the primates?
22. What visual areas of the neocortex are believed to be the most primitive?
23. What causes the “**temporalization**” of the cerebral hemispheres? In development and in evolution it is correlated with the expansion of one group of thalamic nuclei. Which nuclei?
24. What are the **optic radiations**, and what happens to them in animals with relatively large temporal lobes?

25. What are two methods used by neuroscientists to map multiple visual areas in the neocortex? Why is it believed that the human brain contains more visual areas than the 32 described for the rhesus monkey?
26. Visual inputs to most, probably all, visual areas in neocortex come via two types of pathways. What are the two types?
27. Contrast the functions of the three transcortical pathways described in chapter 22, from primary visual cortex in primates and probably in other mammals as well. Also describe major anatomical differences in these pathways.

Ch 23

28. Instinctive aversive behavior in response to loud noise, and learned fear responses to specific sounds, depend on different ascending connections. Contrast the connections.
29. Fear in response to detection of specific auditory stimuli, even if very low in amplitude, can be learned. Such learning in rodents appears to depend on a pathway from the medial geniculate body of the thalamus direct to a subcortical structure. What structure? (This pathway may be considerably larger in mammals with a relatively smaller neocortex.)
30. What transformation of the middle ear apparatus occurred in very early mammals that gave them an advantage in avoiding reptilian predators? What did the evolution of these changes accomplish for auditory function?
31. How is a “**place code**” used for encoding of sound frequency information? Describe the apparatus at the level of the periphery and at the level of the secondary sensory neurons.
32. Why do some of the auditory nerve axons that terminate in the ventral cochlear nucleus end in a giant terminal enlargement, the **endbulb of Held**? Answer with a description of the distribution of synapses formed by such axons. (Note the importance of spatial summation and convergence in the triggering of action potentials.)
33. What is the **trapezoid body**? Describe one important function of a trapezoid body cell group in extracting information from the auditory input.
34. Distinguish between two prominent pathways of the auditory system: the **lateral lemniscus** and the **brachium of the inferior colliculus**.
35. Where does information about location of sounds and sights converge in the subcortical structures of the CNS? What happens if the auditory and visual maps get out of register?
36. Characterize two separate functions of auditory system pathways ascending through the brainstem. How is the separation of these two functions expressed in the endbrain—in transcortical pathways?

37. What is the area in birds that is comparable to the primary auditory neocortex of a mammal?

Ch 24

38. What was apparently the earliest part of the forebrain? Recall the earlier discussion of the invertebrate chordate *Amphioxus* (*Branchiostoma*).
39. What cranial nerves are attached to the forebrain? Two of the four are not among the 12 that are usually named for human brain.
40. Long after removal or disconnection of the forebrain, animals are missing major segments of normal behavior, even if an island of hypothalamus remains attached to the pituitary. Describe missing aspects of behavior. (See also chapter 7.)
41. What studies in recent years have provided evidence for the old hypothesis that the endbrain in early chordate evolution was dominated by olfaction? (See also chapter 19.)
42. Contrast the suggested early functional roles of the **medial pallium** and the **corpus striatum**.
43. In most chordate groups, brain size increases in evolution, but in a few groups, it decreases. Why would it ever decrease?
44. What, in evolution, was the major cause of the differentiation of dorsal and ventral parts of the corpus striatum?

Ch 25

45. Compare the two arousal systems of the midbrain. What structures are involved? What are the major types of connections to these structures? What are the effects of electrical stimulation? Is there habituation to repeated stimulation?
46. Describe how hypothalamic neurons control secretions from each of the two divisions of the pituitary organ (the hypophysis).
47. What hormones are secreted into the bloodstream in the posterior pituitary (neurohypophysis)? Give three examples of hormones secreted in the anterior pituitary (adenohypophysis).
48. What is **diabetes insipidus**?
49. What **homeostatic** mechanisms are associated with the hypothalamus? Give two examples.
50. Where would you expect hunger and satiety cues to influence the CNS? Why?

51. What evidence indicates that attack motivation in cats is separate from hunger?

Ch 26

52. The hypothalamus has two major divisions, medial and lateral. What is a major anatomical difference between these two divisions?

53. Information about the internal environment of the body reaches the hypothalamus via two major means. What are they?

54. Describe the basic **Papez' circuit**. Why has there been a revival of interest in this circuit?

55. How are the Papez' circuit structures connected to non-limbic neocortical areas?

56. What is the "**basal forebrain**"? Name three structures within this region.

57. Describe two ways that the hypothalamus can influence the neocortex.

58. What is a major "reward pathway" in the mammalian CNS?

59. Contrast the effects of sudden disconnection of the hypothalamus from more caudal structures, and more gradual disconnection accomplished in many small steps.

Ch 27

60. What in addition to hormonal factors may explain male-female differences in brain structure and function?

61. Neuroanatomical studies of sex differences in the human brain were initially focused on what region? More recent studies have used methods for imaging the brain of living persons. Give an example of findings using this method.

62. Name and describe the location of a cell group in the spinal cord where sexual dimorphism is very marked.

63. What appears to be a major cause of variation in sexual orientation in humans?

64. What were the striking findings made in Fernando Nottebohm's lab at Rockefeller University in their studies of canary brains?

Ch 28

65. Contrast the learning manifest in the two major links between olfactory inputs and motor outputs as proposed for primitive vertebrates.

66. Describe differences between **place cells** and **head direction cells** as recorded in rats. How are shifts in head direction signaled to the endbrain?
67. Describe the major difference between place cells in the dorsal and the ventral hippocampus in rats.
68. What is the major change in the configuration of the medial pallium of what we call more primitive vertebrates and the hippocampus of mammals?
69. What is the difference in location of the hippocampus of large primates and its location in the rat?
70. In a section cut across the longitudinal axis of the hippocampus, the cell layer is subdivided by anatomists into four sectors, **CA1 to CA 4**, with the dentate gyrus cupped around CA4 like the hem of a skirt. What do the letters CA stand for, and where did the name come from?
71. Describe the circuit that begins in the entorhinal cortex and can be followed through the hippocampus to the subiculum, from which a major output to the mammillary bodies of the hypothalamus arises.
72. Where is long term potentiation (LTP) found in the hippocampus?
73. Describe one example of anatomical plasticity seen in the hippocampus after a specific lesion in adulthood.
74. How might neuromodulators affect the functioning of the hippocampus during waking and sleep?
75. Why is the neocortex of critical importance in the function of the hippocampus in mammals?
76. In what sense are evolutionary changes in hippocampal connections like the evolutionary changes in striatal connections? (Striedter, p. 291) **See also Q 86.**

Ch 29

77. What are the most direct routes (monosynaptic and disynaptic) from neocortex to the hypothalamus?
78. Describe the **stria terminalis**: its origins, course, and major connections.
79. What sensory inputs come to the cortical and medial nuclei of the amygdala without passing through the neocortex? Comparative studies indicate that these inputs are very ancient.

80. The lateral nucleus of the amygdala receives various sensory inputs via neocortical association areas. What sensory pathways come to the lateral amygdala directly from the thalamus?
81. The amygdala is involved in habit learning. What kind of habits?
82. Describe the lesions, made in monkeys by Downer, that produced a loss of learned fears (e.g., in social interactions) when one eye was closed and not when the other eye was closed.
83. What is the "**basal forebrain**", and what is its involvement in **Alzheimer's Disease**? (See also Q 56.)
84. What kind of abnormal brain connections may be a cause of some types of schizophrenia? What could cause such abnormal connections to form?

Ch 30

85. What are two major outputs of the corpus striatum via the globus pallidus (dorsal pallidum)? Which one of them is the larger one in mammals?
86. Contrast the major source of sensory inputs to the striatum in amphibians and in mammals.
87. What is the **limbic striatum**? How does it differ from the non-limbic striatum? What are several of the structures that it includes? (See also chapter 29, ~~Q 82~~)
88. What is the "**ansa lenticularis**"?
89. What are the major "satellites" of the striatum? Which of these has direct outputs to midbrain structures that are important in controlling orienting movements and locomotion?
90. Contrast the pathways to motor cortex and the pathways to the superior colliculus from the dorsal striatum (caudate-putamen).
91. What is meant by "double inhibition" in pathways through the striatum and its satellites? What neurotransmitter is involved?
92. How are the neocortical projections to the putamen different from the neocortical projections to the caudate nucleus?
93. The corpus striatum is involved in all, or nearly all, of the functions of neocortical areas. What neuroanatomical findings support this statement?

94. What are **striosomes**?

95. What is the **lentiform nucleus**? Describe its location in a human brain.

Ch 31, 31a

96. How can imaging of the living brain be used to assess success of a transplant of fetal nigral tissue into an adult Parkinson's Disease patient?

97. How has neuroanatomical assessment been done using tissue obtained at autopsy? Describe a result.

98. What are alternatives, now or in the future, to transplants of tissue from human fetal substantia nigra?

99. Where has a substantial amount of neurogenesis in the adult mammalian brain been discovered in research since the 1960s? What types of neurons are involved?

Ch 32

100. From what part of the primitive pallium of pre-mammalian reptiles did neocortex evolve? What part of the mammalian cortex does this pallial region in modern reptiles most closely resemble?

101. What structure in the bird endbrain evolved in a way that resembles the way that neocortex evolved in mammals?

102. Describe three different types of axon projections in the neocortex that begin and end within the cortex.

103. The neurologist/neuroanatomist Marek Marsel Mesulam has pictured the **paralimbic cortical areas** as divided into two main regions related to the two major types of learning referred to in question 64. What did he call these two regions?

104. Contrast the anticipatory activity of the neocortical areas rostral to the primary motor cortex with the anticipatory activity of the multimodal association areas of the parietal and temporal lobes.

105. What was probably the earliest **parcellation** of the pallium in chordates?

106. Criticize the common belief that the multimodal association areas of the neocortex, including the posterior parietal areas and prefrontal areas, are recent products of brain evolution.

107. How does human ability to cook food promote larger brain size?

108. What is meant by “thalamic **parcellation**” during brain evolution?

Ch 33

109. Contrast the two major morphological types of neocortical neurons.

110. How have neuroscientists defined cortical columns? Name three methods.

111. How did **Brodman** differentiate different areas of the mammalian neocortex?

112. Following axons from the somatosensory and motor areas of the neocortex to the spinal cord, the name of the group of axons that includes them changes. Give the names of the axon groups in succession, beginning with the neocortical white matter.

113. Secondary sensory neurons of the olfactory system, the mitral cells of the olfactory bulb, terminate in the olfactory cortex, or paleocortex. How does olfactory information go from this cortex to the neocortex?

114. What three thalamic cell groups project to three major territories of the human neocortex, namely, the central cortical regions, the prefrontal regions, and the posterior association cortex? (Subdivisions of the thalamic cell groups need not be named.)

115. What are the “**association layers**” of the neocortex? Why are they given this name?

116. How can long transcortical projections found in experimental studies of monkeys be verified for the human brain, other than by using postmortem dissection? What is an important limitation of the method?

Ch 34

117. What is the **subpial granular layer**? When and where and in what animals is it found?

118. What is the difference between symmetric and asymmetric cell division, and what are the consequences for development of the neocortex?

119. How do neurons that begin their migration from the ventricular (or subventricular) zone in the neocortex reach their final destinations? What is meant by an “inside-out” pattern of migration?

120. Many inhibitory interneurons do not migrate from the neocortical ventricular or subventricular zones. Give two examples of where they originate. (See also chapter 12.)

121. Describe an example of how neuronal activity can affect the development of axonal connections even prenatally.

122. What evidence has been found in mammals for brain changes after blinding?

123. Recall the experiments with mature monkeys in which changes in the primary somatosensory cortex were found as a result of training. Describe the behavioral task and the nature of the changes found.

124. The important role of the hippocampus in the formation of new spatial or declarative memories has been made clear by effects of lesions. Where are the engrams underlying the long-term storage of these memories? Where are the cells that show an anatomical plasticity that is likely to be involved in the formation of such long-term memories?

125. What are two major types of transcortical inputs to the prefrontal areas that shape the planning of movements in the immediate future?

Multi-chapter:

126. Thought question: Contrast different routes for sensory information to travel from primary visual cortex to motor output systems. Try to describe at least three routes.

127. Discussion question: How does the hippocampal system facilitate the ability to anticipate the stimuli that an animal or person is about to encounter? What neocortical region is primarily involved?

Pre-midterm: Review the midterm exam

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9.14 Brain Structure and Its Origins

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