

9.14 Classes 24-25: Auditory system

Readings:

Schneider, chapter 23, Auditory Systems, pp 417-446

Allman ch 5 pp 98-101 on “the first mammals.”

Supplementary:

Striedter ch 8 pp 259-268. “What’s special about mammal brains?” Also, study figure 8.10 on p 282. Also recommended: p 255-258, 268-287.)

Striedter ch 5 pp 154-157 (On mosaic evolution in medulla: electrosensory system)

Striedter ch 5 pp 162-171 (Focus on what is written about avian song systems and on the auditory parts of the midbrain.)

Additional reference: Butler & Hodos ch 11, section on “Dorsolateral cranial nerves: lateral line and octaval systems” pp 148-152; ch 28, “Auditory and vocal forebrain in amniotes” pp 410-421.

Questions based on Schneider chapter 23 and classes:

- 1) As in the case of the visual system, an important function early in evolution of audition must have been avoidance and escape from predators. Describe an example of a fixed action pattern triggered in a small mammal by sounds of a predator.
- 2) Two closely related questions on ascending connections of the auditory system:
 - a) Instinctive aversive behavior in response to loud noise, and learned fear responses to specific sounds, depend on different ascending connections. Contrast the connections.
 - b) 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.)
- 3) 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?
- 4) 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.

- 5) What is the trapezoid body? Describe one important function of a trapezoid body cell group in extracting information from the auditory input.
- 6) 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.)
- 7) Distinguish between two prominent pathways of the auditory system: the lateral lemniscus and the brachium of the inferior colliculus.
- 8) 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?
- 9) 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?
- 10) Describe several properties that have enabled investigators to distinguish multiple neocortical auditory areas in the cat.
- 11) How are ablation effects in auditory cortex of the cat related to “word deafness” after certain cortical lesions in humans?
- 12) What is the area in birds that is comparable to the auditory neocortex of a mammal?

Questions on supplementary readings

Allman, supplemented by Striedter:

- 1) According to fossil evidence, what major transformation of the hearing apparatus occurred in early mammals?
- 2) What is believed to be the functional advantage of this transformation? How are the outer hair cells, another feature unique to mammals, involved?
- 3) Why does Allman think that these innovations were linked to developments in parental care, which were related to evolution of temperature homeostasis?

Striedter ch 8, also Schneider

- 4) It is likely that early mammals were nocturnal. This would promote the evolution of olfaction and audition. What skull feature supports the idea of an innovation in the hearing apparatus just prior to evolution of mammals?
- 5) What brains of extant species probably resemble the brains of very early mammals?

Striedter ch 5, also Schneider.

- 6) What are the functions of the facial and vagal lobes of teleost fish, used by Striedter as examples of mosaic evolution?
- 7) What is the even more spectacularly enlarged hindbrain system in Mormyrid fish?
- 8) Describe the correlation between structural size of the Higher Vocal Center in songbirds and function.
- 9) How do the sizes of the superior and inferior colliculi of the midbrain vary among mammals?

MIT OpenCourseWare
<http://ocw.mit.edu>

9.14 Brain Structure and Its Origins

Spring 2014

For information about citing these materials or our Terms of Use, visit: <http://ocw.mit.edu/terms>.