

Classes #3-4: Steps to the CNS of chordates

Questions based on Schneider chapter 3:

- 1) Describe some basic, multipurpose actions that every animal, even one-celled animals, must be able to perform.
- 2) How can conduction between cells occur without synaptic connections? Such conduction is found in sponges and in Cnidarians like Hydra.
- 3) In the very early stages of nervous system evolution envisioned by George Parker and George Mackie, there were only one or two cell-cell connections between the sources of sensation and contractile cells that caused movements. What was the addition emphasized by Nauta?
- 4) Define primary and secondary sensory neurons and motor neurons. What is the intermediate network?
- 5) Where are neuronal cell bodies of the peripheral nervous system located?
- 6) How are the words “nerve” and “tract” used in the naming of axon bundles?
- 7) What animal is often called “the simplest living chordate”?
- 8) What is the Bell-Magendie Law? Is it always true?
- 9) What is meant by “primary brain vesicles”?
- 10) In which subdivision of the CNS do visual inputs enter? Describe or name the two visual inputs found in many chordates.

- 11) Summarize the basic rule that governs the process of evolution.
- 12) What are “ongoing background activities”? What type of nervous-system mechanism controls them?
- 13) Approach and avoidance (or flight) movements are controlled by sensory inputs plus one other important thing. What is that other thing (of great importance in the evolution of the CNS)?

Questions based on Schneider chapter 4:

- 1) There are no fossils of the brains of ancient or extinct animals. So how can we learn anything about brain evolution?
- 2) In the very early evolution of the chordate neural tube, what led to changes at the rostral end? What kinds of changes?
- 3) Hindbrain expansions in chordates resulted from the evolution of adaptive sensory and motor functions. Give examples of these sensory and motor functions.
- 4) Compare the specializations for taste senses of two fish, the fresh-water buffalofish and the catfish, and how the hindbrain is affected.
- 5) Explain the proposal concerning the first expansion of the forebrain in evolution: What sensory input played a key role? What was special about connections in the striatum?
- 6) What structure in the midbrain has become greatly enlarged in most predatory teleost fish. Contrast the motor functions of two major outputs of this structure, one involving descending axons that cross the midline and the other involving an uncrossed descending projection.
- 7) Why do the pathways from each eye to the midbrain cross to the opposite side?
- 8) What is likely to have led to a second major expansion of the forebrain in evolution?
- 9) A third major expansion of the forebrain has occurred in mammals. What structure was primarily involved?
- 10) Describe the method of comparing brain size in the various major groupings of chordates. Describe a major result of such comparisons, from comparative studies.

Additional questions:

- 1) What is the notochord?

- 2) What closely related brain systems evolved to serve visceral and social needs of animals?
- 3) An expansion of the neocortex was correlated with expansion of other brain structures as well. What brain structure in the hindbrain expanded in a fashion correlated with the expansion of neocortex?

Questions on supplementary readings:

- 4) What is the method of comparing brain weights introduced by Harry Jerison in his 1973 book, *Evolution of the Brain and Intelligence*? This method is used in many figures in the books for this class, especially in Georg Striedter's book.
- 5) What are the four major groups of vertebrate animals in which there has been an evolution of marked expansions in brain size. (There is much variation in each of these groups.)
- 6) Serotonin is an important neuromodulator substance released at the axonal endings of certain neurons. Which animals have such serotonergic neurons? What is the type of function of these neurons emphasized by Allman?
- 7) Using only a few words for each, contrast the methods used to study brain localization by Franz Josef Gall and Johann Spurzheim, Pierre Flourens, Paul Broca, John Hughlings Jackson, and Gustav Fritsch and Eduard Hitzig, and Clinton Woolsey.
- 8) How did Tatsuji Inouye, an ophthalmologist in Japan, first discover the topographic organization of the primary visual cortex in humans? (Similar methods were used for both somatosensory and visual systems of humans by Hans-Lukas Teuber—the founder of the department at MIT that became BCS—and his collaborators in the USA.) How has his map been confirmed and extended for humans recently?
- 9) According to Striedter (and many others, including Butler and Hodos), what is the problem with using some kind of “scale of nature” (Latin *scala naturae*) to rank different species and use such a ranking to understand evolution?
- 10) What is a cladogram? Cf. Darwin's sketch reproduced on p. 29 of Striedter's book. The modern neuroscientist Glen Northcutt has used cladistics (“neurocladistics”) extensively in his studies of brain evolution.

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