

9.14

Classes #9-12: Differentiation of the brain vesicles

Questions on Schneider chapter 10:

- 1) How is the hindbrain embryologically very similar to the spinal cord?
- 2) The obex is a landmark in the hindbrain viewed from the dorsal side. What is the obex?
- 3) The hindbrain is known to be an essential controller of “vital functions.” What vital functions are involved?
- 4) In what other “routine maintenance functions” is the hindbrain important or even essential?
- 5) How is the hindbrain involved in human speech?
- 6) Nauta and his collaborator Ramon-Moliner (in Moliner, the emphasis is on the last syllable, which rhymes with “air”) described what they called the isodendritic core of the brainstem. What is the difference in the shape of isodendritic neurons and idiiodendritic neurons?
- 7) Describe segmentation of the hindbrain and the evidence for it. Compare the expression of hindbrain segmentation with segmentation of the spinal cord.
- 8) Compare and contrast the columns of secondary sensory and motor neurons of the hindbrain and spinal cord.
- 9) What is a sensory placode? Contrast neural-crest and placodal origins of secondary sensory neurons.
- 10) How many cranial nerves are there? Discuss this in terms of comparative anatomy. [Note: students should study table 10.1 a number of times so that soon you will memorize the numbers, names and basic functions.]
- 11) Look at figure 10.10 of the adult caudal hindbrain (the medulla oblongata). Which sensory modalities are represented at this level of the brainstem? See also figure 10.11. \
- 12) Which cranial nerve carries somatosensory input from the face into the brain? Give the number of the nerve as well as its common name. Where are the primary sensory neurons of this nerve? Where are the secondary sensory neurons?

- 13) Contrast trigeminal nerve and trigeminal lemniscus.
- 14) What was most likely the most ancient ascending pathway from the secondary sensory neurons of the trigeminal system?
- 15) Describe the hypothesis for how the somatosensory and visual system pathways to the midbrain and forebrain evolved to become predominantly crossed.
- 16) What is the meaning of the term “pons”? (See the end of chapter 5.) What is a major input, and what is the major output, of the cells of the pontine gray matter?
- 17) What causes quantitative distortions of the basic structural layout of the hindbrain? What is the major distortion that occurs in the development of the hindbrain of humans and other primates?
- 18) What is the role of the “rhombic lip” – a structure seen during the development of the rostral hindbrain?
- 19) Try to describe the critical roles of the hindbrain in feeding behavior.

Questions on Schneider chapter 11:

- 1) What are the two inputs carrying information about light levels into the CNS?
- 2) What are three major types of multipurpose movement controlled by descending pathways that originate in the midbrain? What structures in the midbrain give rise to these pathways?
- 3) What two regions of the midbrain are called the limbic midbrain areas? What is the neuroanatomical basis for this designation?
- 4) There are motor neurons located in the midbrain. What movements do those motor neurons control? (These direct outputs of the midbrain are not a subject of much discussion in the chapter.)
- 5) The roof of the midbrain includes two pairs of structures (colliculi, meaning little hills) that show a great amount of variation in size among various species. Give examples for each pair. (You may want to refer to chapter 6 also.)
- 6) Name two pathways that originate in the midbrain and descend to the spinal cord.
- 7) At the base of the midbrain (ventral side) one finds a fiber bundle that shows great differences in relative size in different species. Give examples. What are the fibers called and where do they originate?
- 8) A decussating group of axons called the brachium conjunctivum also varies greatly

in size in different species. It is largest in species with the largest neocortex but does not come from the neocortex. From which structure does it come? Where does it terminate? (Try to guess before you look it up.)

- 9) What two major instigators of action are discussed in this chapter on the midbrain? One involves sensorimotor pathways. What about the other one?
- 10) Because of differences in functions and connections, we can divide both midbrain and 'tweenbrain into two regions. What are they called in this chapter?

Questions on Schneider chapter 12:

- 1) What are the ganglionic eminences of the developing endbrain?
- 2) What are the two largest subdivisions of the diencephalon? Identify also two additional subdivisions. Which of the subdivisions are mostly somatic in nature (connections, functions) and which are mostly limbic in nature?
- 3) In the telencephalon, what are the two major divisions of the pallium (cortex)? What are the two major divisions of the subpallium (striatum)?
- 4) This division of pallial and subpallial regions of the endbrain is supported by the existence of two pathways followed by their output axons, as well as by axons coursing in the opposite direction. What are these two groups of axons called by embryologists and comparative neuroanatomists? What are other names used for all or parts of these two systems in the adult mammal?
- 5) What is a striking difference in the outputs from the neocortex on the one hand and from the corpus striatum on the other?
- 6) What are neuromeres? What are prosomeres?
- 7) Describe the neuromeres of the diencephalon.
- 8) What subpallial structure in sauropsids (reptiles and birds) has connections that are like the connections of the neocortex of mammals? What connections?
- 9) The neocortex has layers that are not present in the dorsal cortex of reptiles and amphibians. The layers are the more superficial layers 2-4. Those layers contain many inhibitory interneurons that do not arise from the ventricular layer of the developing cortex. Where do they come from?
- 10) The lateral ventricular angle region of the mammalian embryonic brain is at least partly homologous to the dorsal ventricular ridge of sauropsids. There is some evidence from Golgi studies that some neuroblasts from this region migrate into

neocortex, but such studies, and also gene expression studies, indicate that they migrate into non-neocortical structures as well. Which structures?

Questions on readings: Nauta ch 5 (also, Schneider chapters & lectures)

1. Which primary sensory neurons are at a surface of the body?
2. What are muscle spindle organs? Describe their location and what they respond to. They are located at the sensory end of monosynaptic reflex arcs.
3. What is meant by a "lemniscus"?
4. Why is the term "spinothalamic tract" somewhat of a misnomer?
5. Draw, on an outline of the embryonic mammalian CNS, the spinothalamic pathway (the "paleolemniscus) leading from skin to neocortex. Note where the axons decussate, and where there are synapses. [This is a repeat of a previous question.]
6. Contrast the medial lemniscus and the lateral lemniscus: modality represented, origin of the axons.
7. Which receptor cells, of a major sensory modality, are cells of the forebrain?

Supplementary questions:

Questions on Allman ch 5

8. What property evolved in birds and mammals that required a five to ten-fold increase in energy expenditure?
9. Which is energetically more expensive, to heat the body or to cool it? How does this explain the body temperature of endothermic animals?
10. How is parenting behavior related to temperature homeostasis?
11. Name two of the multiple functions of the hormone oxytocin.
12. What was a very important result of the major transformation of the hearing apparatus that occurred in the earliest mammals?
13. What is pedomorphism? How is pedomorphism in early mammals related to relative brain size?
14. How is evolution of neocortex in mammals and related structures in birds related

to temperature homeostasis?

15. Why does Allman think that the visual Wulst of the owl is more efficiently “wired” than the visual cortex of mammals?

Questions on Butler & Hodos (some answered in Schneider chapters & lectures)

16. Why do Butler and Hodos find the traditional enumeration of 12 cranial nerves to be inadequate? (p. 120, 133-134, 127)
17. Why do the authors suggest that embryonic hindbrain divisions result from a kind of "bar code" pattern of gene activity? (p. 122 col. 1, fig. 9-1)
18. Contrast neural crest and placodal origin of sensory and other structures (main features). Give an example of each.

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