

Classes #1-2: Introduction; neuroanatomical techniques

Throughout the term, additional beyond the required textbook items are supplementary, i.e., recommended but not assigned.

Questions on Schneider chapter 1:

- 1) Should brain structures and their organization make sense to you? What kind of sense?
- 2) Define “central nervous system” (CNS). What are its basic elements?
- 3) Beginning at the caudal end of the central nervous system (CNS), what are the names of the major subdivisions?
- 4) Why is the hindbrain called the “rhombencephalon”?
- 5) What coordinates are used by anatomists in discussing distances and directions within the brain? What are the most common synonyms for the words used?
- 6) What are the commonly used planes of section through the brain?
- 7) What kind of tissue constitutes the CNS? This can be answered by using the name of the tissue in the embryo that gives rise to the developing CNS.
- 8) How do we define and recognize specific cell groups in the CNS?
- 9) What is meant by the phrase “primitive cellular mechanisms” in a discussion of the nervous system?
- 10) What was the nature of communication between conductive cells in primitive organisms, before the evolution of chemical synapses?
- 11) Contrast the meanings of “synapse” and “bouton” in descriptions of neuronal structures.
- 12) What membrane structures had to evolve in order for action potentials in axons to evolve?
- 13) Contrast excitatory and inhibitory post-synaptic potentials.

- 14) Contrast the nature of conduction in a dendrite and in an axon.
- 15) What is the functional purpose of an active pumping mechanism in the axonal membrane?
- 16) What is a dorsal root ganglion?
- 17) What are oligodendrocytes and Schwann cells?
- 18) What is the major function of a myelin sheath? What is saltatory conduction?
- 19) Many sensory receptor cells are not actually neurons. How are they different from neurons, and how do they interact with neurons?
- 20) What kind of molecule are actin and myosin? When is actin found most abundantly in neurons?
- 21) Describe the dream of Otto Loewi that led him to make one of the greatest discoveries of neuroscience in the early twentieth century. What was the discovery?
- 22) Describe the major characteristics of a synapse when tissue of the CNS is examined with an electron microscope? What are some of the various synaptic arrangements seen with the electron microscope?
- 23) Describe active transport mechanisms within the axons of neurons. How are the directions of such transport described?
- 24) What is endogenous activity of a neuron or an organism? Describe examples.

Questions on Schneider chapter 2:

- 1) What is meant by brain fixation?
- 2) What are some techniques used to prepare brain tissue for cytoarchitectural studies? Describe some findings of such studies.
- 3) What are some techniques used to prepare brain tissue for fiber-architectural studies? Describe some findings of such studies.
- 4) How was histochemistry used for help in identifying comparable forebrain structures in mammals and birds?
- 5) Describe a use of immunohistochemistry for neuroanatomical studies, after defining what immunohistochemistry is.
- 6) Distinguish between studies of fiber architecture and experimental studies of fiber connections.
- 7) How can an anatomist most unambiguously demonstrate the existence of a brain connection?

- 8) Describe advantages and disadvantages of using the Golgi method for tracing interconnections of structures in the CNS.
- 9) Who was Ramon y Cajal?
- 10) If every connection of an animal's nervous system were known, could this information be used to explain and predict all the animal's behavior?
- 11) How did Ivan Pavlov's discoveries make the S-R model of behavior more comprehensive?
- 12) Describe an argument made by Karl Lashley against the adequacy of an S-R model for explaining all human behavior.
- 13) Contrast retrograde degeneration and anterograde degeneration.
- 14) How was the phenomenon of retrograde degeneration used in experiments on animals to establish the existence of a major pathway taken by visual information to the neocortex? What belief was destroyed by the experiments?
- 15) What electrophysiological method can be used to verify the existence of a direct axonal pathway from one location to another in the CNS? It was used by Sherrington and others.
- 16) What was the advance in neuroanatomical methods made by Walle J. H. Nauta, who later became a professor in the Brain & Cognitive Science department at MIT?
- 17) What was a major difference between the tract-tracing methods of Marchi and Nauta?
- 18) Fink and Heimer at MIT in the 1960s altered the Nauta method to make it much more sensitive for the tracing of axons. For many pathways, a group of axons could be traced to their terminal enlargements—the boutons where synapses are made. Describe another technique that can be used for such tract tracing from neuronal cell bodies to their endings. What problem with methods using axon degeneration did the new method overcome?
- 19) What is HRP, and how is it used in neuroanatomical studies?
- 20) Describe advantages of using fluorescent molecules for tract tracing. They have become increasingly used as the sensitivity of fluorescence microscopy has improved.
- 21) What is the method of diffusion tensor imaging? What are its advantages and its limitations?

Questions on supplementary readings:

- 1) Explain what is meant by "brainlike functions in unicellular organisms". Give examples (see Allman, Swanson, Schneider).
- 2) According to Allman, what are the simplest organisms to possess nervous systems, with action potentials based on voltage gated sodium channels? (See also Schneider, ch 3)

- 3) George Parker's work at Harvard is described by Nauta. Parker, using the Golgi technique, found a kind of nervous system in certain sea anemones, an even simpler organism. What kind of nervous system was it?
- 4) "...a sponge has no neurons—or else all its cells are neurons" (Nauta). What two types of intercellular junctions in the sponge was Nauta discussing? How are they recognized in studies with an electron microscope?
- 5) "Animals with large brains are rare—there are tremendous costs associated with large brains" (Allman). What costs? (See also Schneider ch 32)
- 6) Swanson describes the nerve net of hydra, including two-way connections made by motor neurons with each other. What structure makes such two-way conduction possible? Ramon y Cajal called such fibers "amacrine processes", distinguishing them from dendrites and axons.

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>.