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9.01 Introduction to Neuroscience
Fall 2007

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9.01 Recitation
Section 1 (Mondays)

Resources / Websites:

OCW: <http://ocw.mit.edu/OcwWeb/Brain-and-Cognitive-Sciences/9-01Fall-2004/CourseHome/>

Animations: <http://www.blackwellpublishing.com/matthews/animate.html>

Brown Neuro Course Website: <http://www.brown.edu/Courses/BN01/>

Anatomy Quiz: use Ch. 7 Appendix in textbook (pages 206-248) to study

Review Questions for Ch. 1-2:

- 1) The neuron doctrine states that
 - a) Neurites are fused together to form a continuous network
 - b) Neurites are not continuous and communicate by contact
 - c) Neurons must contain a soma, an axon, and dendrites
 - d) DNA is transcribed to mRNA which is translated into protein

- 2) On September 13, 1848, Phineas Gage was the unfortunate victim of an explosion that sent a tamping iron through his head. (This tamping iron was 3'7" long, 1.25" in diameter, and weighed 13.5 lbs.) He miraculously survived the incident. Which glial cells might have played a large role in his defiance of death?
 - a) Schwann cells
 - b) oligodendrocytes
 - c) microglia
 - d) astrocytes

- 3) Knowing what you know about phospholipid bilayers, if you wanted to build your own membrane protein, what would your amino acids need to have in order to stay in the membrane?
 - a) hydrophobic groups
 - b) hydrophilic groups
 - c) ionic selectivity
 - d) heptanary structure

- 4) Golgi and Ramon y Cajal disagreed over the neuron doctrine; their argument was not resolved until the advent of the electron microscope because:
 - a) Synapses are destroyed by the fixation process used for light microscopy; fixatives used for the more sensitive electron microscopy technique preserve the synapse.
 - b) The limit of resolution of the light microscope is 100 nm, whereas the electron microscope has a limit of resolution of 0.1 nm.
 - c) The Golgi stain only stains a small percentage of neurons, and even then not completely; the chances of finding a pair of interconnected neurons is too small to determine whether neurons communicate by contact, not continuity.
 - d) The Nissl stain, which is necessary to resolve synapses, can only be used with the electron microscope.
 - e) The Golgi stain, which is necessary to resolve synapses, can only be used with the electron microscope.

- 5) There are two types of neurites: axons and dendrites. Which of the following is true about these neurites?:
- Dendrites are relatively short in length (about 2mm), have a uniform diameter along their entire length, and act as the antennae of the neuron to receive incoming signals or input.
 - Axons are relatively long (can be over a meter), if they branch at all, they do so at right angles, and act like "wires" that carry the output of the neurons.
 - The power of the Golgi stain is that, unlike the Nissl stain, it reveals the elaborate dendritic structure of the neuron; nevertheless, neither stain fills the axon.
 - ALL OF THE ABOVE ARE TRUE
- 6) Charles Bell and Francois Magendie cut dorsal and ventral spinal roots in experimental animals; what were they able to show with these experiments?
- That nerves contain a mixture of many nerve fibers, some that carry sensory information from the skin and others that carry motor information to the muscles.
 - That sensory and motor information is carried bidirectionally in the same nerves from the skin and to the muscles.
 - That the central and peripheral nervous systems are functionally distinct subdivisions, which have no anatomical correlates.
 - That ventral roots and dorsal roots carry nerves that primarily supply the autonomic nervous system.
 - That ventral roots and dorsal roots carry nerves that primarily supply the somatic nervous system.
- 7) Oligodendrocytes and Schwann cells differ in what way:
- Oligodendrocytes are found in the central nervous system, whereas Schwann cells are found in the peripheral nervous system.
 - Oligodendrocytes are myelinating glia, whereas Schwann cells are microglia
 - One oligodendrocyte will surround one axon, whereas each Schwann cell affiliates with several axons.
 - Oligodendrocytes form nodes of Ranvier, while Schwann cells do not.
- 8) Kinesin and dynein are proteins that bind microtubules. Which of the following is FALSE?
- They convert chemical energy contained in phosphate bonds into mechanical energy
 - They establish plasma membrane composition at the axon terminal by selectively moving different receptor subtypes into and out of the terminal.
 - They mediate gene transcription by carrying signaling proteins at the terminal back to the nucleus
 - Kinesin is involved in retrograde transport, while dynein is involved in anterograde transport.
 - Their function can be hijacked by viruses and neuroscientists to serve their own purposes
- 9) Which of the following is TRUE about ribosomes?
- They are necessary for transcription
 - They are found dotting the surface of smooth ER
 - They are not found in glia
 - They bind mRNA
- 10) Which of the following is TRUE about axons?
- They are only found in neurons
 - They contain rough ER so proteins can be synthesized throughout their length
 - You can show retrograde transport of proteins in axons by injecting a cell's soma with radioactive amino acids.
 - A & B are true
 - B & C are true

Answers to Review Questions

- 1) B
- 2) C
- 3) A
- 4) B
- 5) B
- 6) A
- 7) A
- 8) D
- 9) D
- 10) A

Explanations, Additional Info for Select Questions

Question 2

- Schwann cells: myelinating glia, provide layers of membrane that insulate axons; PNS
- oligodendrocytes: myelinating glia, provide layers of membrane that insulate axons; CNS
- microglia: phagocytes that remove debris left by dead or dying cells
- astrocytes: glia, fills spaces between neurons (regulating whether neurites can grow); regulates chemical content of extracellular space

Myelin sheath; exposed areas are known as nodes of Ranvier; speeds propagation of nerve impulses, is known as saltatory conduction

Question 4

Limit of resolution refers to the distance for which two points are distinguishable. The limit of resolution for human eye is ~100 μm . The space between neurons is ~0.02 μm (or 2 nm).

Question 8

Axoplasmic transport

- no rough endoplasmic reticulum in axon; proteins are transported from the cell body
- Augustus Waller removed axons from cell bodies; showed that axons cannot be sustained without soma; the axon degenerates; this is known as Wallerian degeneration
- movement of material up or down axon is known as axoplasmic transport
- material enclosed in vesicles, "walked down" microtubules
- proteins involved
 - kinesin for anterograde transport (soma \rightarrow axon)
 - dynein for retrograde transport (axon \rightarrow soma)
- ATP is used

Horse-radish peroxidase (page 42)

- used by scientists exploiting retrograde transport to trace connections in the brain
- taken up by axon terminals, transported to cell body
- inject HRP into the brain, a few days later will see HRP-labeled neurons