Nervous System Neurons and Synapses: Physiology Study Guide, Chapter 7

List of medical roots, suffixes and prefixes

<table>
<thead>
<tr>
<th>Term</th>
<th>Meaning</th>
<th>Example</th>
<th>Term</th>
<th>Meaning</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>af-</td>
<td>toward</td>
<td>Afferent</td>
<td>-ferent</td>
<td>carried</td>
<td>afferent</td>
</tr>
<tr>
<td>a-, an</td>
<td>without</td>
<td>anesthesi a</td>
<td>-glia</td>
<td>glue</td>
<td>neuroglia</td>
</tr>
<tr>
<td>-algia</td>
<td>painful</td>
<td>neuralgia</td>
<td>haplo-</td>
<td>single</td>
<td>haploid</td>
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<tr>
<td></td>
<td></td>
<td>Analgesia</td>
<td></td>
<td></td>
<td>(single set of chromosomes)</td>
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<tr>
<td>astro</td>
<td>star</td>
<td>astrocyte</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>dend r-</td>
<td>tree</td>
<td>dendrite</td>
<td>lemm-</td>
<td>sheath</td>
<td>neurilemm a</td>
</tr>
<tr>
<td>di, diplo</td>
<td>two</td>
<td>diploid (two sets of chromosomes)</td>
<td>neuro-</td>
<td>nerve</td>
<td>neuron</td>
</tr>
<tr>
<td></td>
<td></td>
<td>oligo-</td>
<td>few</td>
<td></td>
<td>oligodendrocyte</td>
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<tr>
<td></td>
<td></td>
<td>syn-</td>
<td>together</td>
<td></td>
<td>somatics</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>synapse</td>
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**Part I. Clinical Applications and Short Essay**

1. A brain tumor is found in a CT scan of Mr. Child's head. The physician is assuming that it is not a secondary tumor (i.e., it did not spread from another part of the body) because an exhaustive workup has revealed no signs of cancer elsewhere in Mr. Child's body. Is the brain tumor more likely to have developed from nerve tissue or from neuroglia? Why?

   Considering that nerve cells do not usually divide (amitotic), the tumor is most likely a glioma, developing from one of the types of neuroglia.

2. Describe how the following substances exert their effects on the body: botulism; curare; tetrodotoxin; and nerve gas.

   **Botulism** is caused by botulinum toxin, produced by the bacterium *Clostridium botulinum*. The toxin inhibits acetylcholine release at the neuromuscular junctions. Characterized by muscle paralysis, vomiting, visual disorders, and death (asphyxiation) if untreated and/or the poison amount is too great.

   **Curare:** Tubocurarine (from a plant) is the active ingredient of curare that binds to and blocks acetylcholine receptors. It is used as a poison in blow darts and arrows by South American Indians to paralyze their prey. Curare based drugs are often used during surgery to relax skeletal muscles.

   **Tetrodotoxin (TTX)** is a toxin found in puffer fish. The toxin blocks voltage-gated Na+ channels resulting in muscle paralysis and possible death by asphyxiation.

   **Nerve Gas** inhibits acetylcholine esterase activity. If acetylcholine degradation is blocked, the muscle continues to contract and paralysis ensues.

3. Explain what the acronym SSRIs stand for and describe the mechanism of action of SSRIs such as Prozac, in the treatment of depression.

   **SSRIs** stands for selective serotonin reuptake inhibitors. They are a class of medications that are used to treat depression, which is characterized by a deficiency of serotonin. These antidepressants work by selectively blocking the reuptake of serotonin into the presynaptic axon terminals. The neurotransmitter serotonin is allowed to stay longer in the synapse (since its "uptake" is inhibited), thereby activating postsynaptic neurons that maintain a more positive mood. Common SSRIs include Prozac, Paxil, and Zoloft.
4. What role do the nodes of Ranvier play in the conduction of an action potential?

The nodes of Ranvier represent an area along the axon where there is an absence of myelin. Because ions can cross the membrane only at the nodes, only a node can respond to a depolarizing stimulus. Action potentials appear to "leap" or "jump" from node to node. A process called salutatory conduction. The process conducts nerve impulses along an axon several times faster than continues conduction.

5. What is the difference between an EPSP and an IPSP and how does each type affect the generation of an action potential?

An EPSP is a depolarization produced at the postsynaptic membrane. If an EPSP depolarization reaches threshold at the axon hillock than an action potential is produced. An IPSP is a hyperpolarization produced at the postsynaptic membrane. A hyperpolarized membrane is inhibited because a larger-than-usual depolarization stimulus must be provided to bring the membrane potential to threshold.

6. What is multiple sclerosis and why are people with this disorder likely to lose their ability to control skeletal muscles?

Multiple sclerosis is an autoimmune disorder in which your body's immune system attacks the oligodendrocytes and myelin sheath covering the nerves of CNS. The attacks form hardened scars or plaques (scleroses) along the axons and interfere with nerve conduction. Since the CNS provides commands for skeletal muscles, destruction of the CNS axons will cause a lose of control of the skeletal muscles.

7. What is Myasthenia Gravis and how is it treated?

Myasthenia Gravis is an autoimmune disease in which the body's antibodies block and destroy ACh receptors on neuromuscular junctions. The lack of ACh receptors results in progressive weakening of the skeletal muscles because action potentials cannot form to stimulate the muscle. Treated with anticholinesterases such as neostigmine or physostigmine. These decrease the activity of acteylcholinesterase allowing ACh more time to act on the ACh receptors still present.

8. Before fixing a cavity, your dentist injected Novocain, a local anesthetic, into the nerve pathway supplying the region. As a result you felt no pain during the drilling and filling procedure. How does Novocain work?

Novocain blocks voltage-gated Na+ channels. Initiation and propagation of action potentials will not occur in the sensory nerve fibers acted on by the local anesthetic because blockage of the Na+ channels would prevent the massive opening of voltage-gated Na+ channels. As a result, action potentials in nerve fibers that carry pain signals would not be formed and the signals would not reach the brain.
### Part II

1. central nervous system
2. somatic nervous system
3. peripheral nervous system
4. autonomic nervous system
5. central nervous system
6. peripheral nervous system
7. neuroglia
8. neurons
9. neurons
10. neurons
11. neuroglia
12. neurons
13. neuroglia
14. neuroglia
15. neuroglia
16. neuroglia
17. axon terminal
18. dendrite
19. myelin sheath
20. cell body
21. axon
22. refractory period
23. depolarization
24. polarized
25. repolarization
26. action potential
27. potassium ions
28. sodium-potassium pump

### Part III

1. cutaneous sense organs
2. Schwann cells
3. synapse
4. tract
5. association neuron (interneuron)
6. nodes of Ranvier
7. ganglion
8. efferent neuron
9. proprioceptors
10. stimuli
11. afferent neuron
12. neurotransmitter
13. cell body
14. myelin
15. dendrite
16. axon
17. mitochondria
18. are; myelin; are not; gray
19. Schwann; PNS; CNS; PNS; regeneration
20. impulses; presence of ion channels and resting membrane potential (RMP)
21. little; ion; leakage; voltage-gated
22. polarized; negative; -70 mV; Fig 9.2 shown below
23. K+
24. large; Their size prohibits them from leaving the cell.
25. Na+/K+ pump; active; Na+; ATP
26. negativity inside the cell

### Part IV

1. more; voltage-gated channels
2. -70 mV; positive; -60 mV; depolarization
3. -60 mV; reversed
4. inside; out; -70 mV; repolarization; hyperpolarization; -80 mV
5. action potential; neuron; muscle cells
6. propagated
7. B
8. A
9. E
10. C
11. E
12. D  12.1  F  12.2  G
13. The all-or-nothing principle deals with action potentials. As long as a stimulus is strong enough to cause depolarization to threshold, the voltage-gated Na+ and K+ channels open and an action potential occurs. The size of the AP is always the same.
14. Continuous conduction is a type of action potential that occurs in unmyelinated axons (and in muscle fibers). Each segment of the plasma membrane depolarizes to threshold and generates an AP that depolarizes to threshold and generates an AP that depolarizes the next patch of membrane.

15. myelinated; faster; Voltage-gated Na+ and K+ channels are located primarily at the nodes of Ranvier (gaps in myelin). Current carried by these ions at one node generates currents at the next node. Impulses travel further in a given time period compared to continuous conduction.

16. “Jump” is just a metaphor; the AP at one node depolarizes the membrane at the next node to threshold, so that a new AP is produced at the next node. Remember that voltage-gated Na+ and K+ channels are located primarily at the nodes of Ranvier. Current carried by these ions at one node generates currents at the next node.


18. Depolarization of the neuron causes calcium channels to open. Because calcium is more concentrated in the interstitial fluid, it flows into the channels by diffusion and enters the neurons.

19. Calcium causes the release of neurotransmitters via exocytosis into the synaptic clefts.

20. presynaptic
21. depolarization; hyperpolarization; -80 mV
22. postsynaptic summation
23. ACh; excitatory; inhibitory; slower
24. Inhibitory; excitatory
25. 30. B
26.
27.
28. myelin; women; virus
29. hardened scars or plaques; is; does

30. B
31. E
32. C
33. T
34. F; Take neurons out, add microglia
35. T
36. F; The cranial and spinal nerves
37. T
38. A C B
39. A C B
40. D

Part V
5. A 11. A
6. A 12. D

17. peripheral; brain and spinal cord; nuclei; tracts; ganglia; nerves
18. dendrites; axons; cell body
19. afferent; pseudounipolar; toward (to); motor; multipolar; away from; six
20. voltage; action; refractory; absolute; relative; frequency;
21. gap; smooth; cardiac
22. exocytosis; neurotransmitter; chemically (ligand); graded; summated; hillock
23. 5, 7, 4, 1, 3, 8, 2, 6