NEUROSCIENCE EXAM 1 FALL 2011 KEY

Multiple Choice: Read the entire question and all answers before choosing (circle the letter) <u>the one best answer</u>. Each question is worth 2 point

1. Which of the following is/are **TRUE** regarding fast axonal transport?

a) Fast axonal transport requires hydrolysis of ATP and occurs at a rate of 400-1000mm/day.

- b) Fast axonal transport occurs only in the anterograde direction along the axon.
- c) Fast axonal transport in the anterograde direction utilizes dyenins.
- d) all of the above are true.
- e) none of the above (a-c) are true.
- 2. Which of the following is/are **TRUE**?
- a) During the relative refractory period the neuron will not fire another action potential no matter how large the PSP entering the axon hillock because the voltage gated Na⁺ channels are insensitive to voltage during this period.
- b) During the relative refractory period triggering an action potential requires a larger than normal EPSP.
- c) During the relative refractory period an IPSP will initiate an action potential.
- d) Both b and c are true.
- e) None of the above are true.

3. Which of the following is a difference between voltage-gated sodium channels and voltage-gated potassium channels?

- a) A greater amplitude PSP is required to open the potassium channels than to open the sodium channels.
- b) Both voltage gated Na⁺ and voltage gated K⁺ channels will open in response to a suprathreshold EPSP, but the opening of the voltage gated K⁺ channels is delayed for a brief period, whereas the voltage gated Na⁺ channels open immediately.
- c) The sodium channels open in response to a suprathreshold EPSP, whereas the potassium channels may open in response to either a suprathreshold EPSP or an IPSP.
- d) All of the above correctly describe differences between these two types of channels.
- e) None of the above correctly describes differences between these two types of channels.

4. With regard to the sodium-potassium pump:

- a) Three Na⁺ ions are pumped out of the cell for every two K⁺ ions pumped into the cell.
- b) The pump is powered by the hydrolysis of ADP.
- c) Two sodium ions are pumped out of the cell for every three potassium ions pumped into the cell.
- d) Both a and b are true
- e) Both b and c are true.

5. Assume that you have a typical neuron, and that the E_{K} + = -80mV, and the resting membrane potential is -65mV. If the membrane potential were suddenly brought to -100mV, which way would potassium ions flow across the membrane?

a) Potassium would flow out of the cell

- b) Potassium would flow out of the cell
- b) Potassium would he as not flow of notoesium serves the
- c) There would be no net flow of potassium across the cell membrane
- d) It is not possible to tell based on the information provided.

6. Assume that you have a typical neuron with a resting membrane potential of -65mV and an E_{Na} of +50mV. If you artificially brought the membrane potential of the neuron of the neuron up to +80mV and opened the Na⁺ channels in the membrane, which way would Na⁺ move across the membrane?

- a) Into the neuron.
- b) **Out of the neuron**.
- c) There would be no net movement of Na^+ across the membrane.
- d) Cannot tell from the information given.

7. The sensory division of the nervous system is also known as:

- a) the afferent division
- b) the autonomic division
- c) the efferent division
- d) the enteric division
- e) none of the above

8. Which of the following is responsible for ensuring that the action potential is conducted in only one direction along the axon.

a) the absolute refractory period

- b) slow axonal transport
- c) saltatory conduction
- d) Dale's principle

9. The relative refractory period:

- a) Is caused by the hyper-polarization of the membrane.
- b) Is caused by the inactivation gates of the voltage-gated sodium channels.
- c) Is caused by the inactivation gates of the voltage-gated potassium channels.
- d) None of the above

10. You have two neurons, a pre-synaptic neuron and a post-synaptic neuron. When the pre-synaptic neuron generates action potentials at a frequency of 10/sec the post-synaptic neuron does not generate any action potentials. When the pre-synpatic neuron generates action potentials at a rate of 20/sec, the post-synaptic neuron generates an action potential. This is an example of _____.

a) temporal summation

- b) spatial summation
- c) an EPSP
- d) an IPSP
- e) none of the above
- 11. G-protein coupled receptors _____.
- a) mediate fast-synaptic responses
- b) exert long-lasting effects on the cell
- c) act in target cells through second messengers
- d) all of the above
- e) both b and c
- 12. Which of the following neurons use secretory granules to store neurotransmitter?
 - a) cholinergic neurons
 - b) peptidergic neurons
 - c) adrenergic neurons
 - d) amino acidergic neurons
 - e) serotonergic neurons

13. In which of the following would the speed of impulse conduction be the greatest?

a) a myelinated axon, 20 microns in diameter.

b) an unmyelinated axon, 20 microns in diameter.

c) a myelinated axon, 2 microns in diameter.

d) an unmyelinated axon, 2 microns in diameter.

e) an unmyelinated axon, 25 cm long.

14. Which of the listed neurotransmitters opens Cl⁻ channels:

- a) Glycine
- b) GABA
- c) Acetyl choline
- d) Serotonin
- e) Glutamate

15. A catecholaminergic neuron using norepinephrine as its neurotransmitter would also be expected to contain _____.

a) dopamine

- b) epinephrine
- c) serotonin
- d) all of the above
- e) both a and b

Matching: From the list below select the word that best matches the numbered item and place the letter next to the numbered item. Not all words in the list are used, and some may be used more than once. Each question is worth 2 points.

- a. Adrenergic neurons
- b. Serotonergic neurons
- c. Cholinergic neurons
- d. Glycenergic neurons
- e. Peptidergic neurons
- **_E__** 16. Are characterized by an abundance of rough endoplasmic reticulum.
- _C___ 17. Use acetylcholine as their neurotransmitter
- _**D**____18. Use glycine as their neurotransmitter
- _A___ 19. Use epinephrine as their neurotransmitter.
- **_E**___ 20. Neurotransmitters of this type are used by neurons in pain pathways of the CNS.

<u>TRUE/FALSE</u>. Circle T if the statement is true. Circle F if the statement is false. For false statements you must cross out the word or words that make the statement false and replace them with a word or words to make a true statement. <u>You may</u> <u>not</u> add additional words to the sentence to make it true without crossing out words. <u>You may not</u> cross out the entire statement in constructing a true statement. (Each is worth 2 point)

east

Example: T \mathbb{F} The sun rises in the west.

21. T-F Kinesins are used in anterograde transport along axons and dendrites.

Nodes of Ranvier

22. T-F Areas of exposed axonal membrane between myelinated areas are called gap junctions.

astrocytes

23. T-F The blood-brain barrier is established by microglia.

24. T-F Schwann cells myelinate axons in the peripheral nervous system.

fast

25. T-F Synaptic vesicles are transported by slow axonal transport.

DROPPED

26. T-F Muscarinic receptors must bind two molecules of acetylcholine to be activated.

tryptophan

27. T-F Serotonin is derived from the amino acid tyrosine.

28. T-F Eppendymal cells line the hollow spaces of the CNS.

29.T-F Satellite cells of the PNS have similar functions to the astrocytes of the CNS.

Short Answer Essay Questions:

30. Define the following terms: (each is worth 2 points)

SNARE proteins:

Proteins found in the axon terminal that are expressed on synaptic vesicles and the inside of the presynaptic membrane. They bind when calcium ions and when activated bind the synaptic vesicle to the presynaptic membrane promoting membrane fusion and the release of neurotransmitter into the synaptic cleft.

Threshold:

Membrane potential at which voltage gated sodium and voltage gated potassium channels open.

Potassium spatial buffering:

The taking up and distribution of potassium ions by astrocytes in the CNS. Prevents the accumulation of potassium in regions.

Relative refractory period:

Period following the initiation of an action potential during which a second action potential can be initiated but a larger than usual amplitude EPSP is required to reach threshold.

Spatial summation:

The summing of two or more PSPs that are initiated at different synapses on the neuron, but arrive at the axon hillock at the same time.

Neurite:

A cell process extending from the soma of a neuron.

28. You discover an alien life-form that uses the same ions and ion channels as Earth life- forms to generate membrane potentials. Based on your investigations you find that the ion concentrations in the body fluids of the alien life-form are such that intracellular fluids contain 35mM K⁺ and 80mM Na⁺, and extracellular fluids contain 70mM K⁺, and 40mM Na⁺. The concentrations of other ions in the body fluids are like that of earth life-forms.

a) Based on the above information, the E_{Na+} for the neurons in the alien lifeform is: (show your calculations!) (Worth 4 points)

Need to know the Nernst Equation to solve this problem. No points were deducted for math errors.

 $E_{Na+} = -18.5 mV$

b) Assuming that the membrane permeability to K^+ is 40 times higher than it is to Na⁺, calculate the theoretical membrane potential for the alien neurons. Please show your calculations (Worth 4 points).

Need to know the Goldman Equation to solve this problem. No points were deducted for math errors.

 $\mathbf{Vm} = +17.4\mathbf{mV}$

29. What are the three criteria that a molecule must meet to be considered a neurotransmitter? (Worth 6 points).

- a. It must be synthesized in a neuron and stored in the axon terminal.
- b. It must be released in response to the depolarization of the axon terminal.
- c. When it is experimentally applied to the postsynaptic neuron, the response of the postsynaptic neuron must mimic its response when the chemical is released from the axon terminal.

30. Starting with the binding of neurotransmitter to receptor on the postsynaptic membrane of a neuron, describe the events **in the correct sequence** that lead to the release of neurotransmitter from the same neuron. **In your essay you** <u>must</u> **correctly use the terms**: passive current flow, refractory, post-synaptic potential, threshold, sodium channels, potassium channels, calcium channels, action potential, axon terminal, SNARE, synaptic vesicles, axon hillock, chemically-gated, voltage-gated, trigger-zone, saltatory conduction, neurotransmitter, synaptic cleft (Worth 16 points).

For the situation described above, the binding of neurotransmitter to its receptor on the post-synaptic membrane initiates a fast synaptic potential in which chemically-gated sodium channels open to allow sodium to flow into the neuron at the synapse and create an excitatory post-synaptic potential. The EPSP spreads through the cytosol of the neuron to the axon hillock or trigger zone of the axon. If the EPSP is large enough to reach threshold it will trigger the opening of the voltage gated sodium channels in the membrane of the axon hillock. This will initiate the action potential. The inflow of sodium ions creates a local current flow that spreads back into the cell body and down the axon. If the axon is myelinated the current will flow down to the next node of Ranvier and trigger an action potential in that node. This process by which the action potential jumps down the axon from one node of Ranvier to the next is referred to as saltatory conduction. The action potential is only conducted down the axon to the axon terminal and not back up the axon, due to the fact that the sodium channels in the previous node of Ranvier is in there refractory period and so are unable to trigger another action potential. When the action potential enters the axon terminal it depolarizes the membrane causing the opening of voltage gated calcium channels. The opening of the voltage-gated calcium channels allows calcium to move into the axon terminal down its electrochemical gradient. The increased concentration of calcium in the axon terminal triggers the SNARE proteins on the inside surface of the pre-synaptic membrane and synaptic vesicles to bind. This binding of the SNARE proteins brings the pre-synaptic membrane and vesicle membrane close to one another and promotes membrane fusion. When the membranes fuse, the neurotransmitter contained in the synaptic vesicle is released into the synaptic cleft.