-0

Name _____ Period _____

Chapter 48: Neurons, Synapses, and Signaling

Concept 48.1 Neuron organization and structure reflect function in information transfer

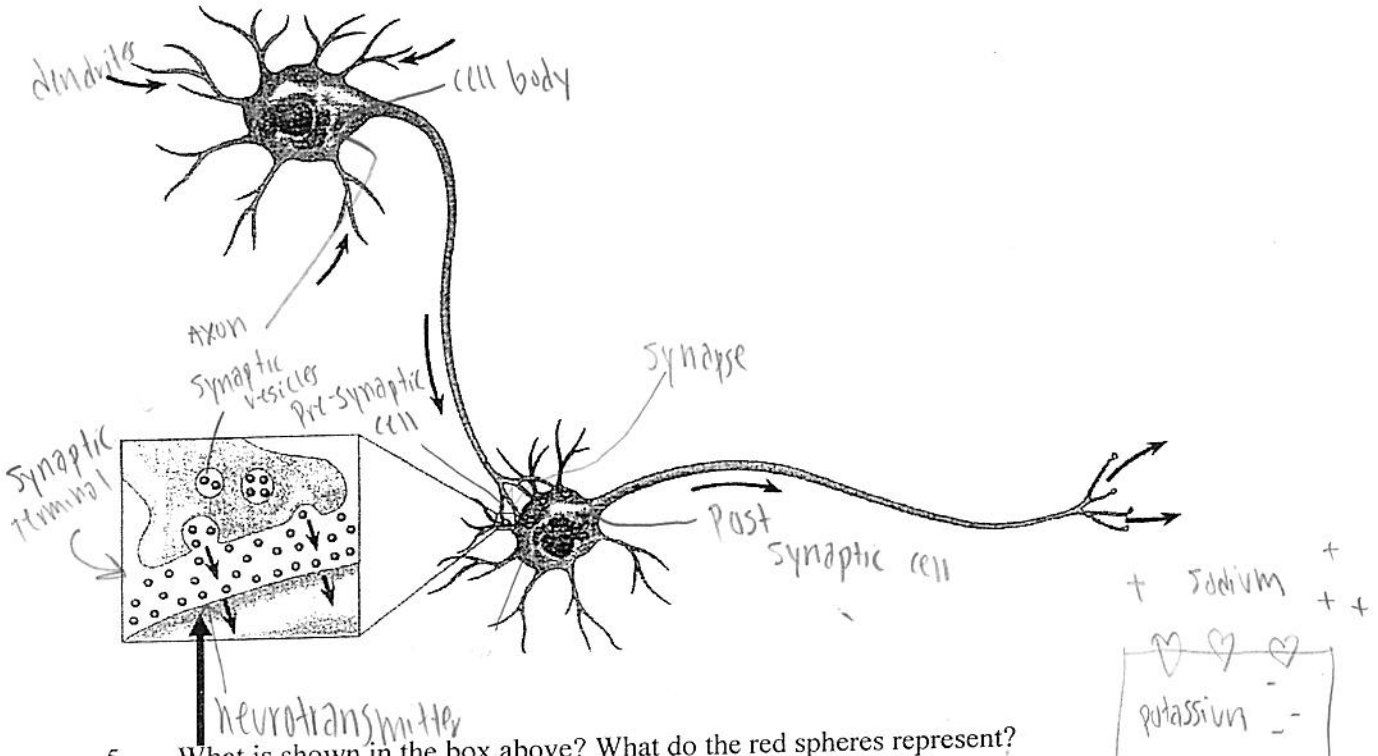
1. What is a *neuron*? Nerve cells that transfer information within the body.

2. Neurons can be placed into three groups, based on their location and function.

Type of Neuron	Function
Sensory	Transmit information *from* a sense receptor to the brain or spinal cord
Interneurons	Integrate information within brain or spinal cord; connect sensory and motor neurons; located entirely within the CNS
Motor neurons	Transmit information *from* the brain or spinal cord *to* a muscle or gland; Cause muscle contraction or gland secretion

3. Which division of the nervous system includes the brain and spinal cord?
The CNS includes the brain & spinal cord. The neurons that carry info in/out of the CNS make up the PNS

4. This sketch shows two neurons. Label the following elements of this figure: *cell body, dendrites, axon, synapse, presynaptic cell, postsynaptic cell, synaptic vesicles, synaptic terminal*, and *neurotransmitter*.



5. What is shown in the box above? What do the red spheres represent?
The transfer of a neurotransmitter (message) from one neuron to another.
Neurotransmitter

Salty Banana

Sa/K pump outside axon (along it)

6. What is indicated by the red arrows in the main figure?
The transfer of the neurotrasmitter across the synapse

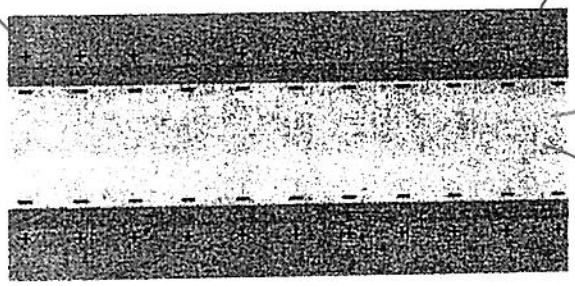
7. What are *glial cells*?
Supporting cells, insulate the axons of neurons, and regulate extracellular fluid surrounding neuron

Concept 48.2 Ion pumps and ion channels maintain the resting potential of a neuron

In this section you will need to recall information about the structure and function of the plasma membrane. Ions are not able to diffuse freely through the membrane, because they are charged and so must pass through protein channels specific for each ion.

8. All cells have a *membrane potential* across their plasma membrane. What is the typical *resting potential* of a neuron?
Resting potential is a resting neuron that isn't sending a signal, between -60 & -80 mv (-70)

9. On the sketch below, label the following: *outside cell, inside cell.* Show where the concentrations of Na^+ and K^+ are highest.



10. How are the concentration gradients of Na^+ and K^+ maintained?
Sodium-Potassium pumps in the plasma membrane. ATP hydrolysis actively transports Na^+ (sodium) out of the cell and K^+ (potassium) into the cell

Concept 48.3 Action potentials are the signals conducted by axons

11. As you see in the figure above, in a resting neuron, the outside of the membrane is positively charged relative to the inside of the membrane. If positively charged ions flow out, the difference in charge between the two sides of the membrane becomes greater. What is the increase in the magnitude of the membrane potential called?
Hyperpolarization

12. When a *stimulus* is applied, ion channels will open. If positively charged ions flow in, the membrane is said to *depolarize*. If depolarization causes the membrane potential to drop to a critical value, a wave of depolarization will follow. What is this critical value called?
Graded Potential

13. What is the wave of depolarization called?
Nerve Impulse

14. Just like toppling dominoes in a row, either the *threshold* of depolarization will be reached and an *action potential* will be generated, or the threshold will not be reached and no wave will occur. What is this response to stimulus called?

Action potential

15. Figure 48.10 contains almost all you need to know about nerve impulse transmission, so it is worth some careful study time. Let's approach it in steps.

a. Label Na^+, K^+, and their respective *ion channels*.

b. Label the *Resting state* figure. Are the Na^+ and K^+ channels open, or closed?

closed

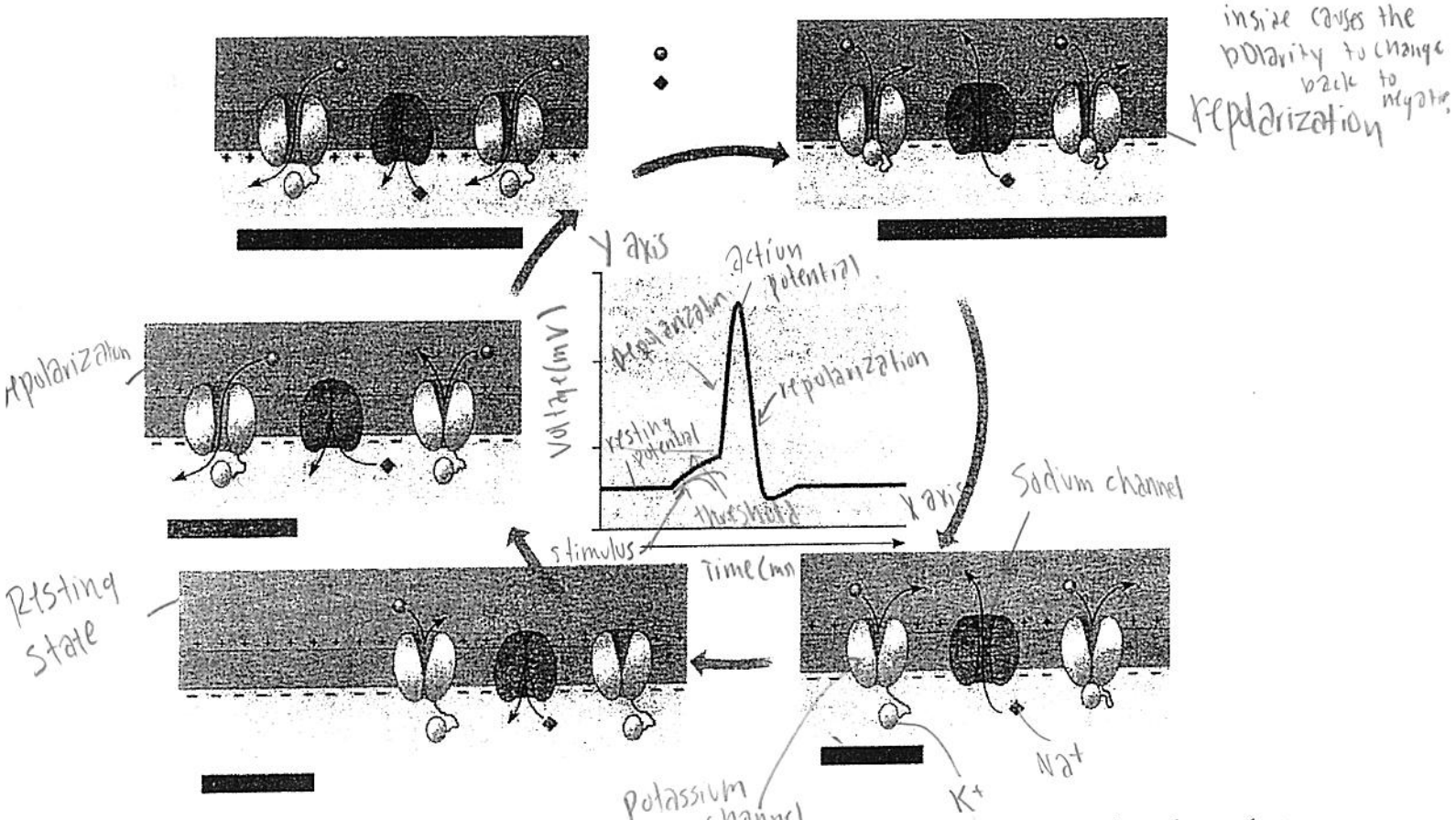
c. Label *Depolarization*. What triggers depolarization? What channels open? What occurs if the depolarization threshold is reached? Sodium inflow Sodium

Triggers an action potential

d. Label Stage 4 in the figure *Repolarization*. How is the charge on the membrane reestablished?

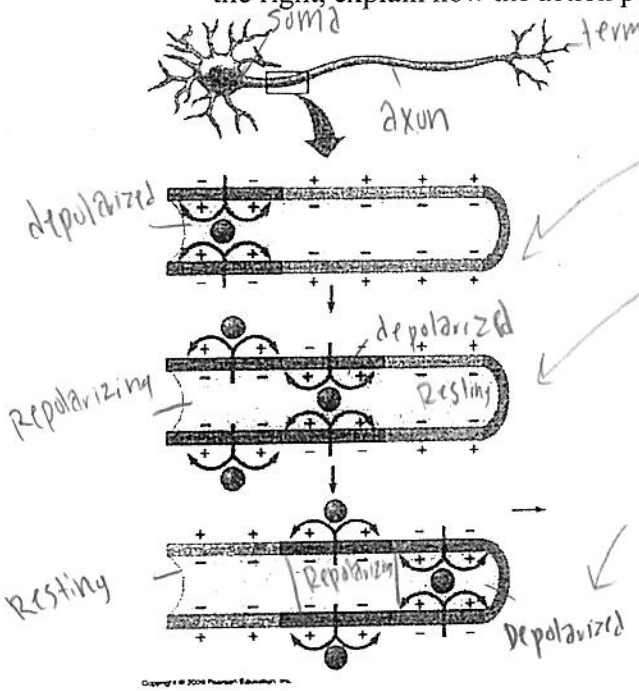
The movement of K^+ ions to the outside causes the polarity to change back to positive & the loss of K^+ ions on the inside causes the polarity to change back to negative

e. Label these regions of the graph: x- *and* y-*axes, threshold, resting potential, depolarization, action potential*, and *repolarization.*



f. Let's see if you really understand this concept. Draw in another line on the graph to show what the change in membrane potential would look like if a stimulus were applied that did *not* reach the depolarization threshold.

16. Here is a closer look at what is happening along the membrane as a wave of depolarization (an action potential) travels along the length of the axon. Label the key elements of the figure; and to the right, explain how the action potential is conducted.



1) In response to a signal, the soma end of the axon becomes depolarized (sodium in flow)

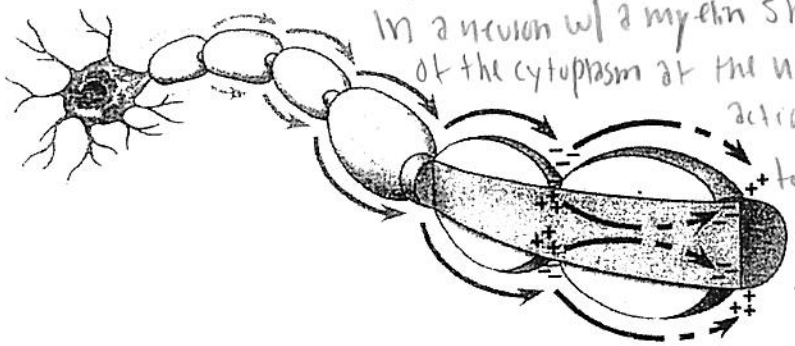
2) The depolarization spreads down the axon, while the first part of the membrane repolarizes NA+ channels are inactivated & K+ channels are opened, the membrane cannot depolarize again.

3) Action potential continues to travel

17. What are the two types of glial cells that produce *myelin sheaths*?

Oligodendrocytes in the CNS, A Schwann cells in the PNS

18. How does a *myelin sheath* speed impulse transmission? Use the figure below, and include a discussion of *saltatory conduction* and *nodes of Ranvier* in your response.



The action potentials form only at the nodes of Ranvier. In a neuron w/ a myelin sheath, ions can only move in & out of the cytoplasm at the nodes of ranvier. B/c of this the action potential jumps from one node to another, a process called saltatory conduction and will travel must faster than a neuron with a myelin sheath

19. In the disease multiple sclerosis, the myelin sheaths harden and deteriorate. How would this affect nervous system function?

It would affect the communication and transfer of neurotransmitter from one neuron to another.

Concept 48.4 Neurons communicate with other cells at synapses

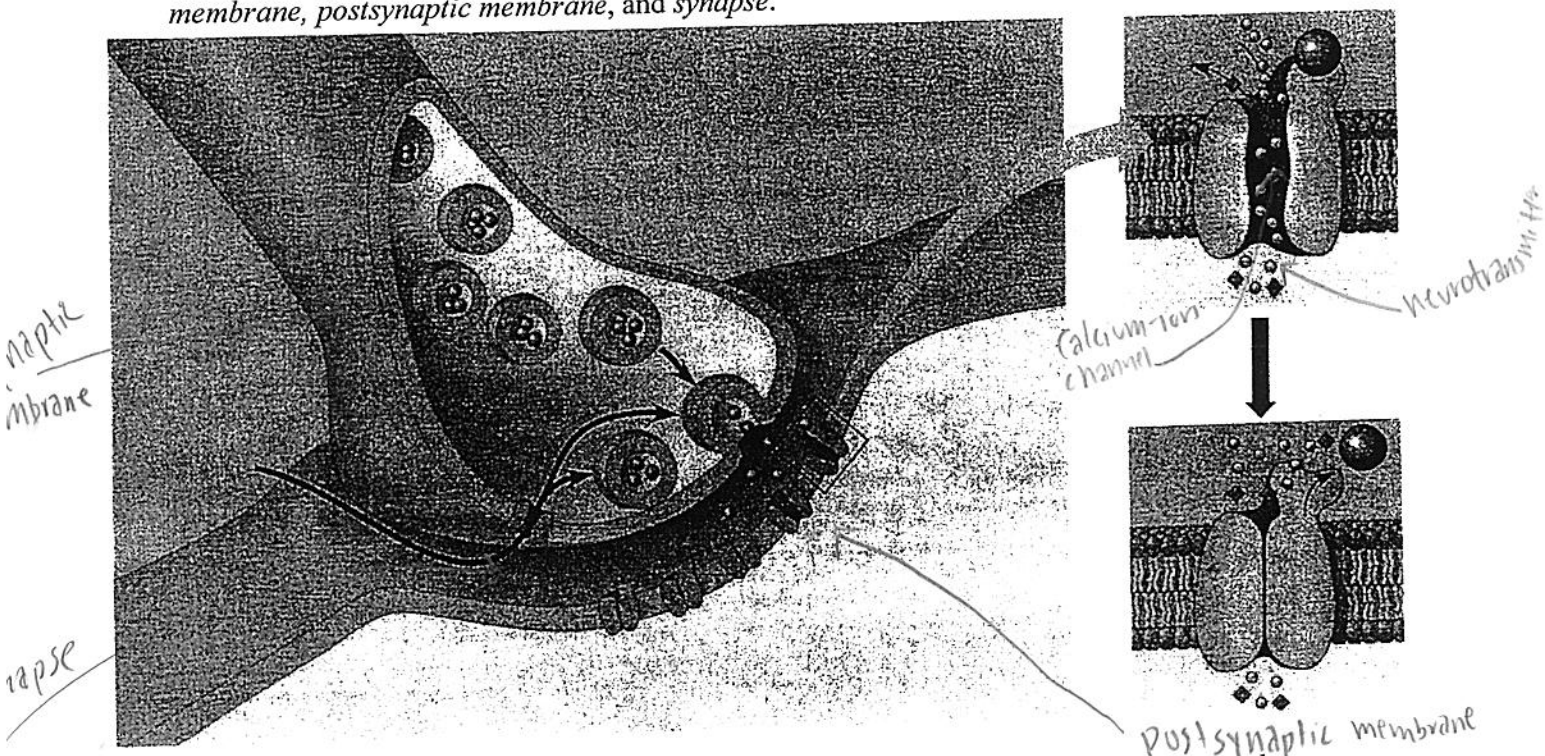
20. When the wave of depolarization arrives at the synaptic terminal, calcium ion channels open. What occurs to the *synaptic vesicles* as the Ca^{2+} level increases?

The elevated $CA2_+$ concentration in terminal, causes Synaptic vesicles to fuse with the presynaptic membrane

21. What is contained within the *synaptic vesicles*?

Neurotransmitter

22. Label the figure below: *synaptic vesicle, neurotransmitter, calcium ion channel, presynaptic membrane, postsynaptic membrane*, and *synapse*.



23. Explain how an action potential is transmitted from one cell to another across a synapse by summarizing what is shown above in six steps.

(1) Presynaptic membrane: Action potential depolarizes the membrane of the Synaptic terminal

(2) Calcium ion channel - open voltage-gated calcium channels in the membrane, which triggers an influx of $CA2^+$

(3) Synaptic vesicle: Elevated $CA2+$ concentration causes synaptic vesicles to fuse w/ presynaptic membrane

(4) Synapse: the vesicles release the neurotransmitters into the cleft

(5) Post synaptic membrane - neurotrasmitter binds to the ligand-gated ion channels, & $NA+$ & $K+$ can diffuse through channels

(6) Neurotransmitter: the neurotransmitter is released from the receptors, & the channels close. Transfer over the synapse ends when neuro. diffuses out

24. There are many different types of neurotransmitters. Each neuron secretes only **one** type of neurotransmitter. Some neurotransmitters *hyperpolarize* the postsynaptic membrane. Are these *excitatory* or *inhibitory* neurotransmitters?

They are inhibitory postsynaptic potentials (IPSPs)

25. Define and explain *summation*.

Excitatory postsynaptic potentials (EPSPs) produced by different synapses on the same postsynaptic neuron add together

26. A single postsynaptic neuron can be affected by neurotransmitter molecules released by many other neurons, some releasing *excitatory* and some releasing *inhibitory* neurotransmitters. What will determine whether an action potential is generated in the postsynaptic neuron?

The combination of EPSPs through spatial & temporal summation can trigger an Action Potential

27. Table 48.1 lists several of the major neurotransmitters. You are not expected to know their actions or secretion sites, but you *should* recognize that they are neurotransmitters! Go through the list that follows, and say each term aloud. Put a checkmark by any that you have heard mentioned before: *acetylcholine, epinephrine, norepinephrine, dopamine, serotonin, GABA, glutamate, glycine, substance P, endorphins*, and *nitric oxide*. That's all for this question!

28. There is one neurotransmitter we want you to memorize. It is the most common neurotransmitter in both vertebrates and invertebrates, and it is released by the neurons that synapse with muscle cells at the *neuromuscular junction*. If you look ahead to Chapter 50, Figure 50.29, you will see a synapse between a neuron and a muscle cell, resulting in depolarization of the muscle cell and its contraction. What is this very important neurotransmitter?

Acetylcholine

Testing Your Knowledge: Self-Quiz Answers
Now you should be ready to test your knowledge. Place your answers here:

1._____ 2._____ 3._____ 4._____ 5._____ 6._____