Name _____ Period _____

Chapter 48: Neurons, Synapses, and Signaling

Concept 48.1 Neuron organization and structure reflect function in information transfer

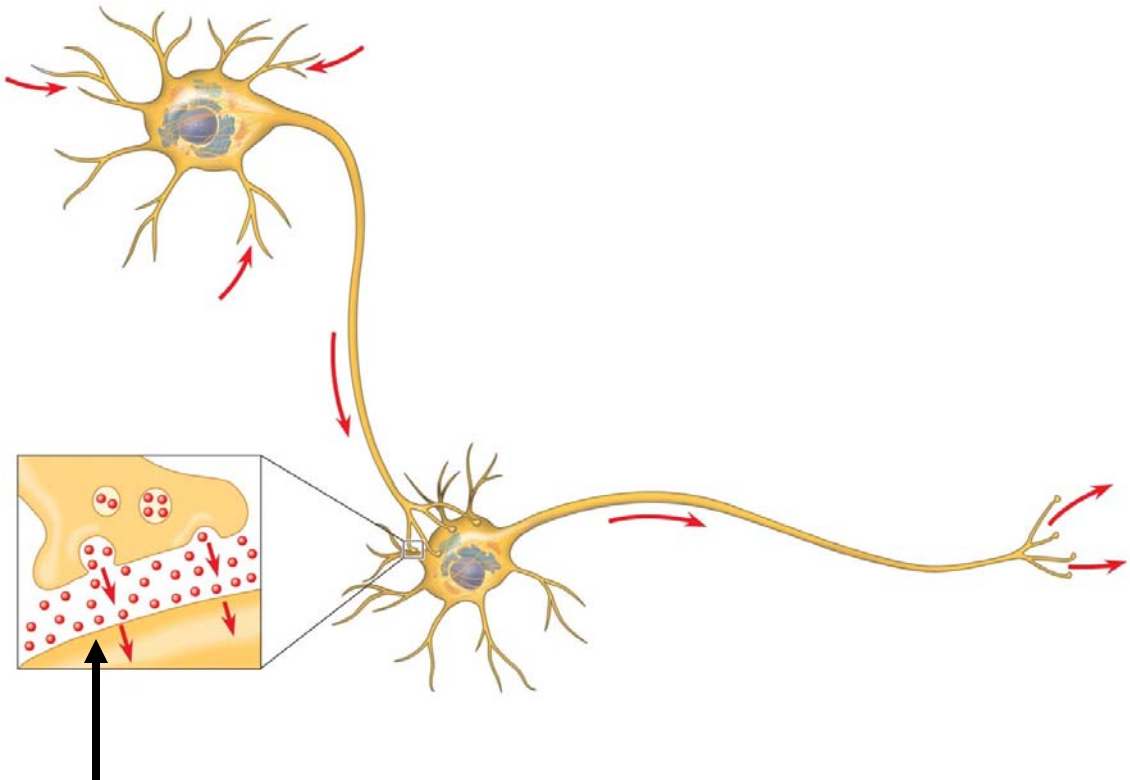
1. What is a *neuron*?

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

Type of Neuron	Function
	Transmit information *from* a sense receptor to the brain or spinal cord
	Integrate information within brain or spinal cord; connect sensory and motor neurons; located entirely within the CNS
	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?

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?

6. What is indicated by the red arrows in the main figure?

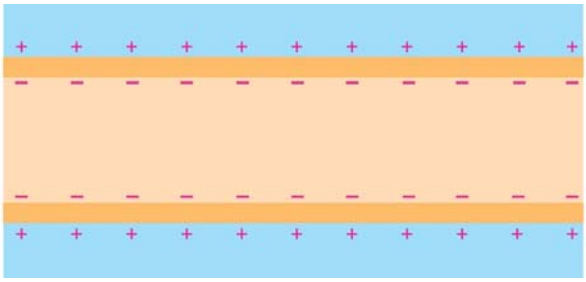
7. What are *glial cells*?

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?

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?

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?

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?

13. What is the wave of depolarization called?

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?

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.

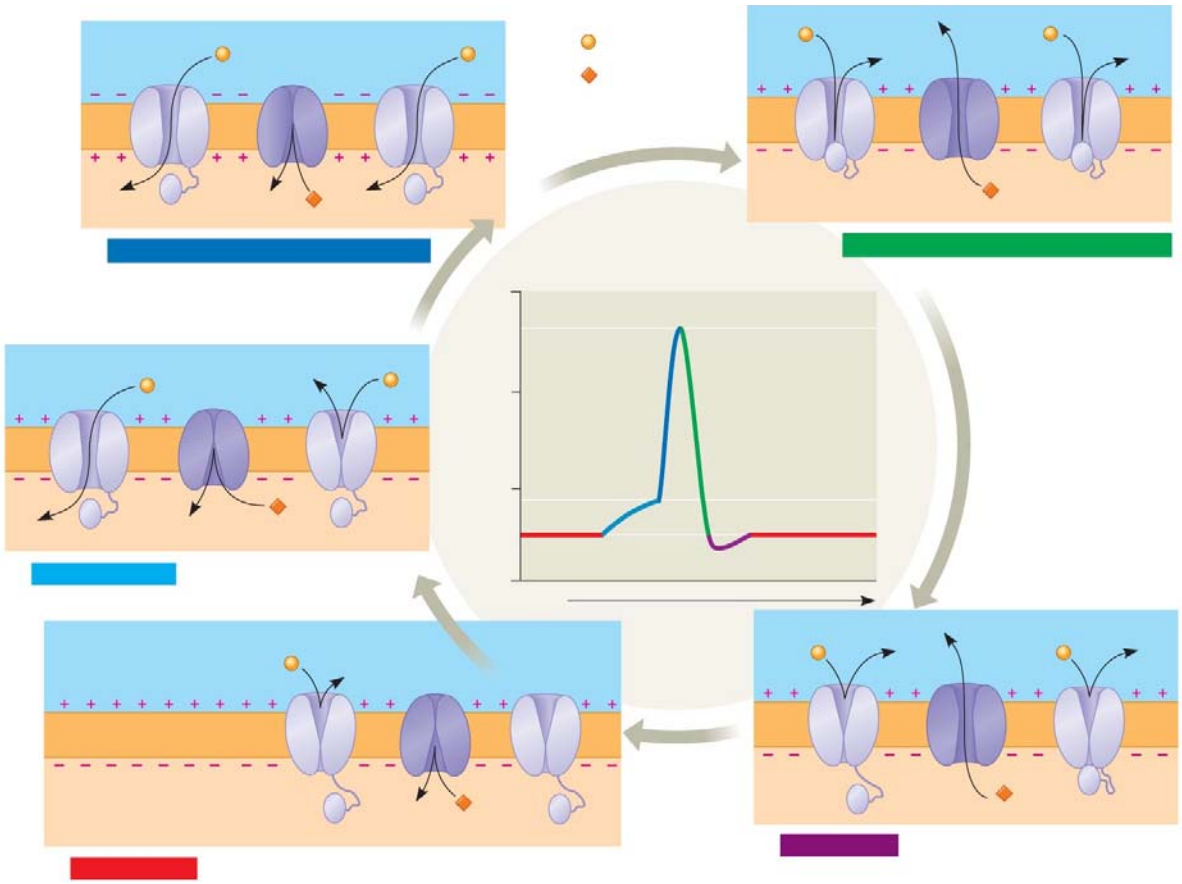
    a. Label Na^+, K^+, and their respective *ion channels*.

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

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

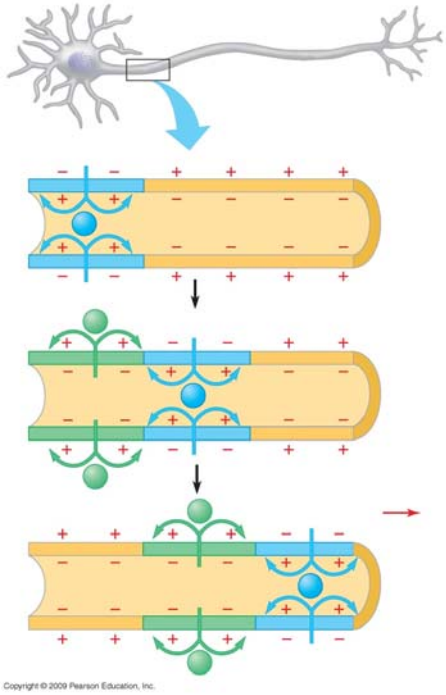
    d. Label Stage 4 in the figure *Repolarization*. How is the charge on the membrane reestablished?

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



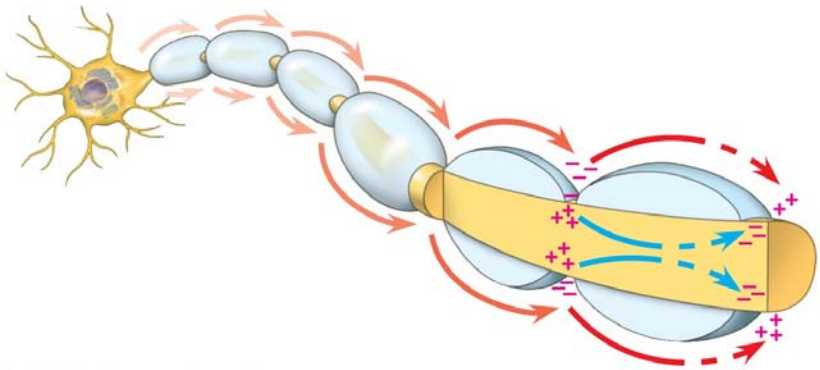
    f. Let's see if you really understand this concept. Draw in another line on the graph to show what the change in membrane potential would look like if a stimulus were applied that did *not* reach the depolarization threshold.

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.



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

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.



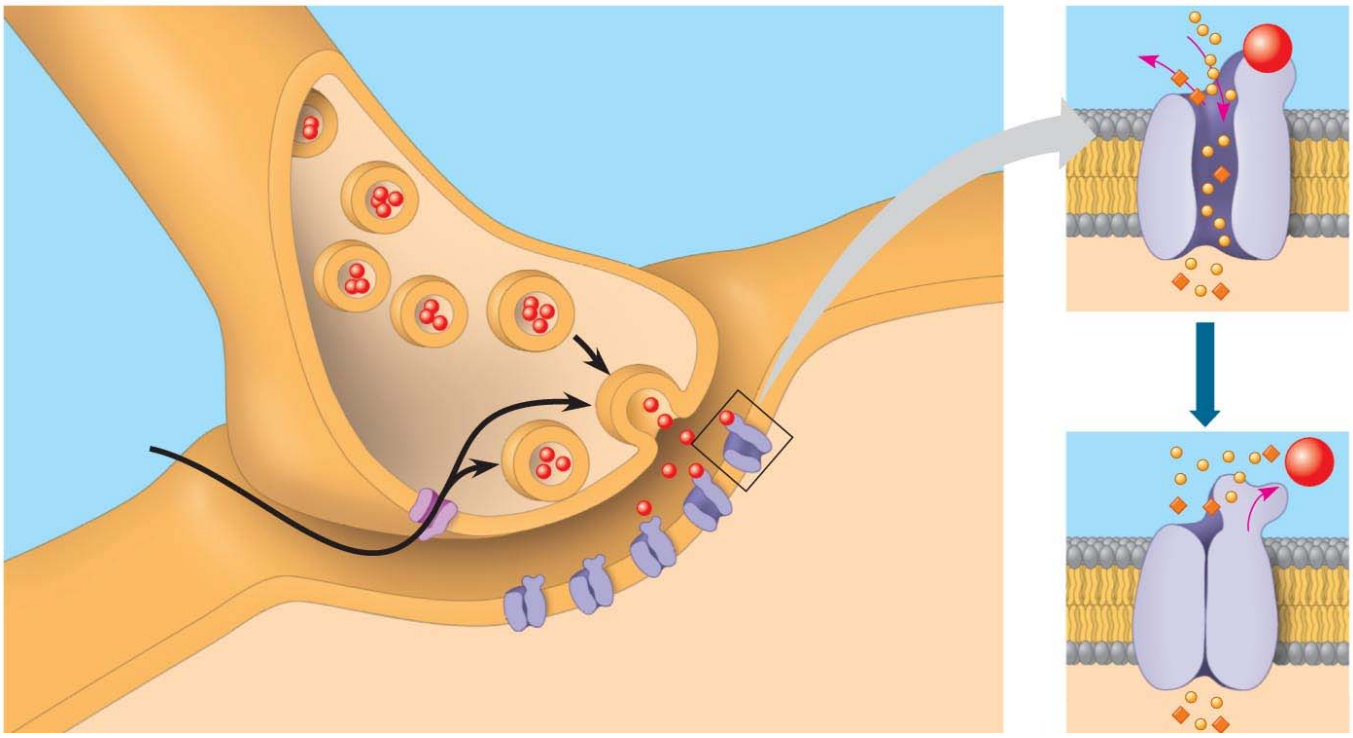
19. In the disease multiple sclerosis, the myelin sheaths harden and deteriorate. How would this affect nervous system function?

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?

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

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)

(2)

(3)

(4)

(5)

(6)

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?

25. Define and explain *summation*.

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?

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?

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._____