

Chapter 12 – Nervous System

Complete using BC Biology 12, pages 372 - 407

12.1 Nervous Tissue

pages 376 - 377

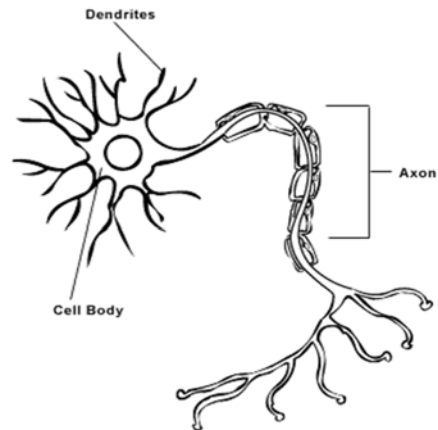
1. The nervous system has two major anatomical divisions. The central nervous system^(a) (CNS) consists of the brain^(b) and spinal cord^(c) which are located midline of the body. The peripheral nervous system^(d) (PNS) consists of nerves^(e) that carry sensory^(f) messages to the CNS and motor^(g) commands from the CNS to the muscles^(h) and glands⁽ⁱ⁾.
2. Name and distinguish between the two types of cells in the nervous system.
 - a. neuron: transmit nerve impulses
 - b. neuroglia (glial cells): support and nourish neurons, form myelin, may aid in signal transmission

Types of Neurons and Neuron Structure

3. Describe and state the function of the:
 - a. **sensory neuron:** takes messages TO the CNS. Have sensory receptors that detect changes in the environment (e.g. photoreceptors, chemoreceptors, etc)
 - b. **interneuron:** lies entirely in the CNS. Receives input from sensory neurons, sums up the message and communicates with the motor neurons.
 - c. **motor neuron:** takes message AWAY from CNS to an effector (organ, muscle, or gland). Gives a response to stimuli.

4. Every neuron has the three parts listed here. What is the function of each? Draw a basic neuron in the box.

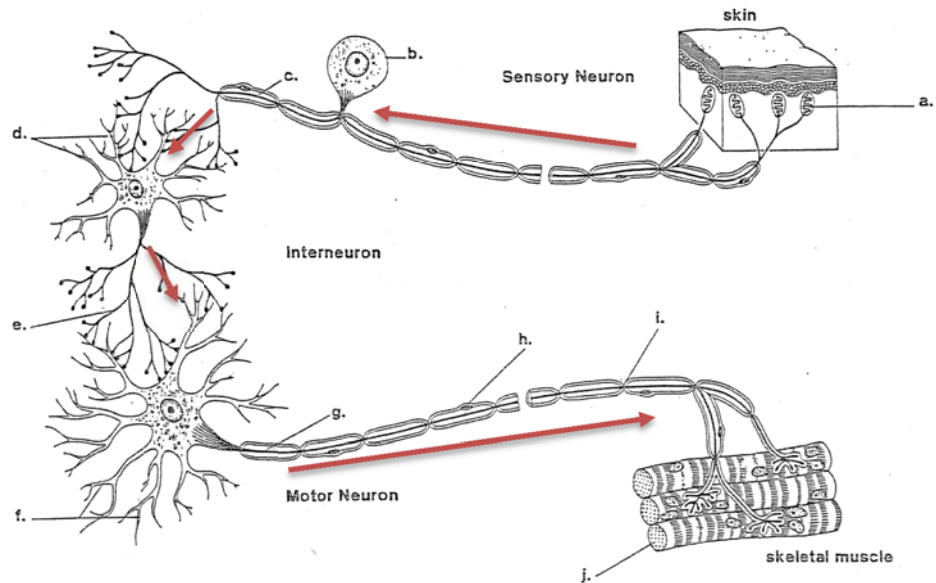
- a. **dendrite:** extensions that receive signals from other neurons and takes them TO the cell body
- b. **cell body:** contains the nucleus and all basic organelles like any other cell (also known as the "soma")
- c. **axon:** conducts nerve impulses AWAY from the cell body to other neurons or an effector



The first neuron feeling the social exclusion from the other cells.

5. Use arrows to show the direction of conduction then label the parts of the sensory neuron, the interneuron and the motor neuron, using the following list of terms (some terms may be used more than once). Make note of the structural differences between the 3 types of cells.

- axon **c,e,g**
- cell body **b**
- dendrite **d,f**
- effector **j**
- node of Ranvier **i**
- Schwann cell **h**
- sensory receptor **a**



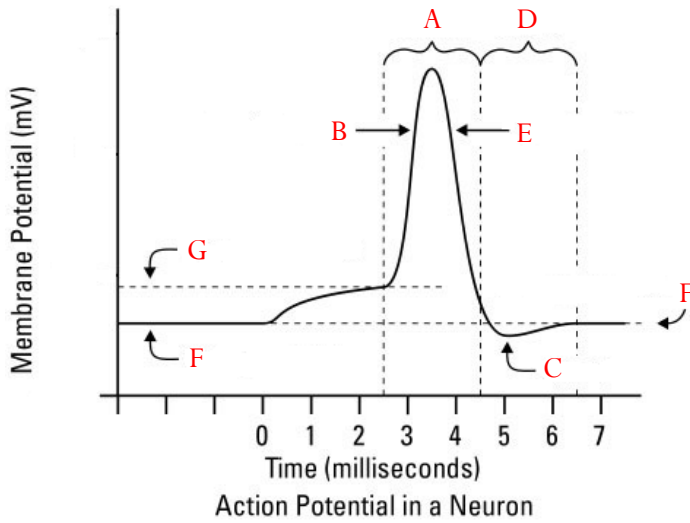
Myelin Sheath

6. What is the myelin sheath produced by in the CNS? oligodendrocytes
7. The CNS is composed of two types of nervous tissues. What is the difference between white and grey matter?
Grey matter is composed of neurons with short, non-myelinated axons while white matter is the myelinated axons that run together in tracts.
8. The surface of the brain is grey ^(a) matter and the white ^(b) matter lies deep within the brain. The central part of the spinal cord consists of grey ^(c) matter and the white ^(d) matter surrounds it on the exterior.

12.2 Transmission of Nerve Impulses pages 377 - 381

9. What device is used to measure the electricity produced by a nerve impulse? oscilloscopes
10. Create a brief definition the following terms:
- a. **resting potential:** the membrane potential of an inactive neuron (~70mV)
 - b. **sodium-potassium pump:** carrier protein that moves Na⁺ out and K⁺ into neurons
 - i. What specific type of integral protein are the “pumps”? carrier
 - c. **action potential:** electrochemical changes that occur across the axon membrane, “the nerve impulse” (max +35mV)
 - d. **threshold:** minimum depolarization required to cause an action potential to occur (-55mV)
 - e. **refractory period:** in non-myelinated axons, a period when sodium gates are unable to open following an action potential
11. Since the axomembrane is more permeable to (circle one of: sodium or potassium), there are always more (circle one of: positive or negative) ions outside the membrane than inside.

12. Complete the graph below with the following terms: (A) *action potential*, (B) *depolarization*, (C) *hyperpolarization*, (D) *refractory period*, (E) *repolarization*, (F) *resting potential* (x2), (G) *threshold*



At what mV is the average...

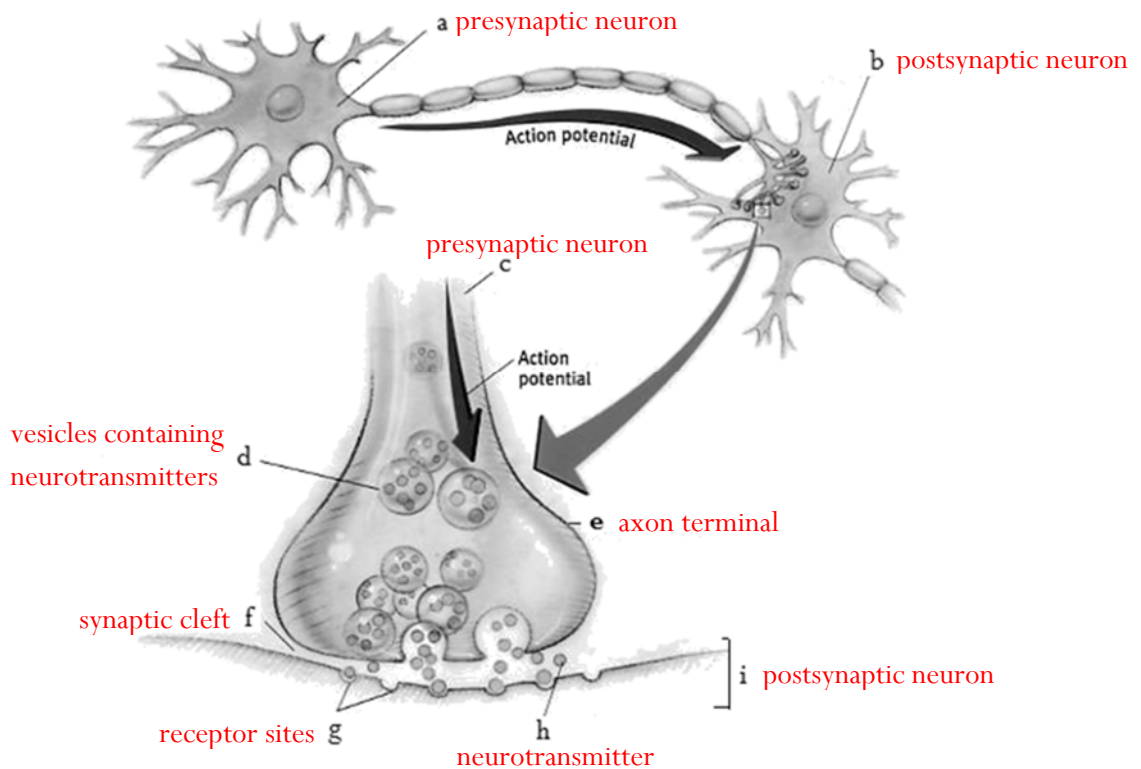
- a. resting potential -70 mV
- b. threshold -55 mV
- c. peak of action potential +35 mV

* hyperpolarization (-90mV)

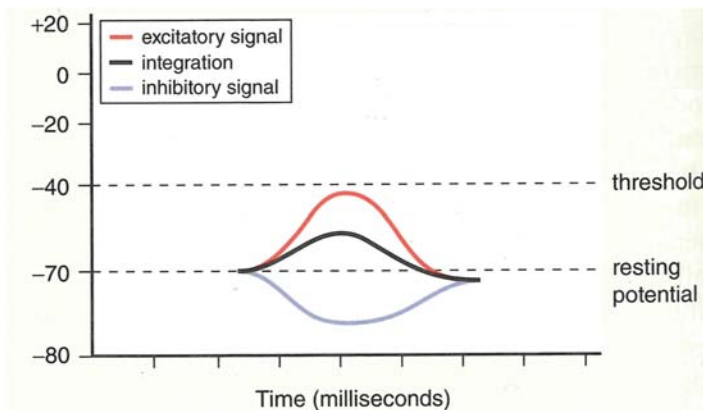
13. Describe the concept of “saltatory conduction”. occurs in myelinated axons when the action potential “jumps” from node-to-node

Transmission Across a Synapse

14. Label the diagram below with the following terms: *axon terminal*, *neurotransmitter*, *postsynaptic neuron* (x2), *presynaptic neuron* (x2), *receptor sites*, *synaptic cleft*, *vesicles containing neurotransmitters*.

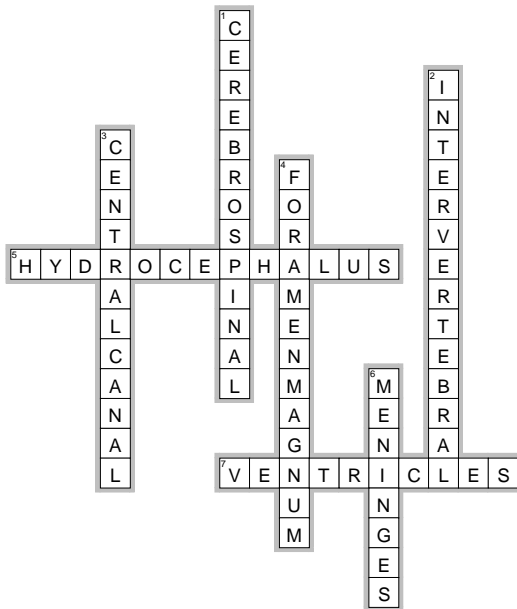


15. When nerve impulses reach an axon terminal, what element enters? calcium
- What type of integral protein does the element enter through? voltage-gated channel
 - Explain the purpose of that element entering. Causes the contractile proteins to pull synaptic vesicles to presynaptic membrane
-
16. What is the difference between an excitatory and an inhibitory signal? Use the words *hyperpolarizing* and *depolarizing* in your explanation. Excitatory have a depolarizing effect so they encourage an action potential but inhibitory have a hyperpolarizing effect, leading to a reduced chance of an action potential occurring.
-
17. Use Figure 12.6 to create a graph to explain **synaptic integration**.



18. At least 25 different neurotransmitters have been identified. Name two of the most well-known ones.
- acetylcholine (ACh)
 - norepinephrine (NE)
19. What prevents continuous stimulation (or inhibition) of postsynaptic membranes by neurotransmitters?
- Presynaptic membrane quickly reabsorbs – may repack for future use (endocytosis)
 - Enzymes rapidly inactivate neurotransmitters (e.g. acetylcholinesterase AChE)
-
20. Many drugs that affect the nervous system act either by interfering with^(a) or potentiating (enhancing^(b)) the action of neurotransmitters. Drugs can enhance^(c) or block^(d) the release of a neurotransmitter, mimic^(e) the action of a neurotransmitter or block the receptor^(f), or interfere with the removal^(g) of a neurotransmitter from a synaptic cleft.
21. What is “botox” and what is it used for? Highly diluted toxin from the bacteria that are responsible for botulism (muscle paralysis). Used to treat everything from eyelid spasms and back pain to wrinkles.
-
22. Indicate where these statements are true (T) or false (F)
- F A single neuron synapse with only one other neuron.
 - T Integration is the summing up of excitatory and inhibitory signals
 - F The more inhibitory signals received, the more likely an axon will conduct a nerve impulse
 - F Norepinephrine is broken down by acetylcholinesterase (AChE) in the synaptic cleft
 - T Several venoms and poisons, insecticides and nerve agents interfere with the AChE enzyme

23. Complete the crossword after reading through pages 381 – 382.



Across

- CSF accumulation also known as “water on the brain”; can cause brain damage.
- Hollow interconnecting cavities in the brain; reservoir for CSF

Down

- The spaces between the meninges are filled with _____ fluid.
- These disks cushion and separate the vertebrae. May rupture and cause pain and loss of motor function.
- Hollow area of the spinal cord; reservoir for CSF (2 words).
- Opening in the skull through which the spinal cord enters (2 words).
- Protective layers of membrane around the brain and spinal cord

Follow-up questions

Structure of the Spinal Cord

24. Why does the left side of our brain control the right side of our body and visa-versa? The tracts of white matter cross as they enter and exit the CNS

25. The spinal cord serves as a means of communication^(a) between the brain and the peripheral nerves^(b) that leave the cord. If the spinal cord is severed, we suffer a loss of sensation and a loss of voluntary control - that is paralysis^(c). The spinal cord is also the center for thousands of reflex arcs^(d) which allow us to respond to stimuli quickly and efficiently.

The Brain

26. Name the four major parts of the brain:

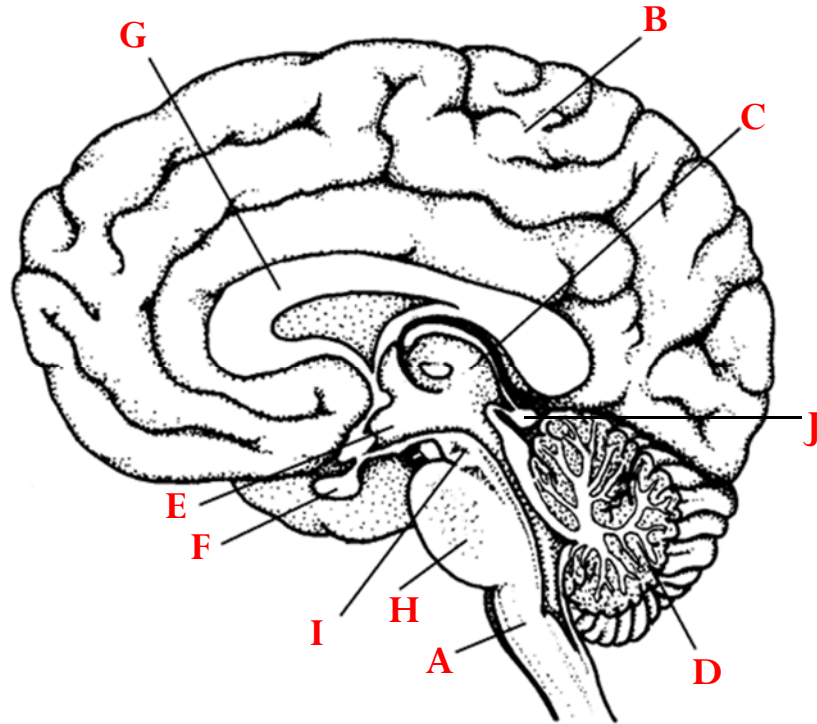
- cerebrum: largest portion of human brain; higher thought processes
- diencephalon: made up of hypothalamus and thalamus; maintains homeostasis
- cerebellum: maintains posture and balance; enables coordination
- brain stems: midbrain, pons, medulla oblongata; connection to CNS

27. The lobes of the cerebrum

- frontal: centers for reasoning and movement
- parietal: centers for somatic sensing and taste
- temporal: center for hearing
- occipital: center for vision

28. Longitudinal (or sagittal) section of the brain. Label the following parts.

- A. medulla oblongata
- B. cerebrum
- C. thalamus
- D. cerebellum
- E. hypothalamus
- F. pituitary gland
- G. corpus callosum
- H. pons
- I. mid brain
- J. pineal gland



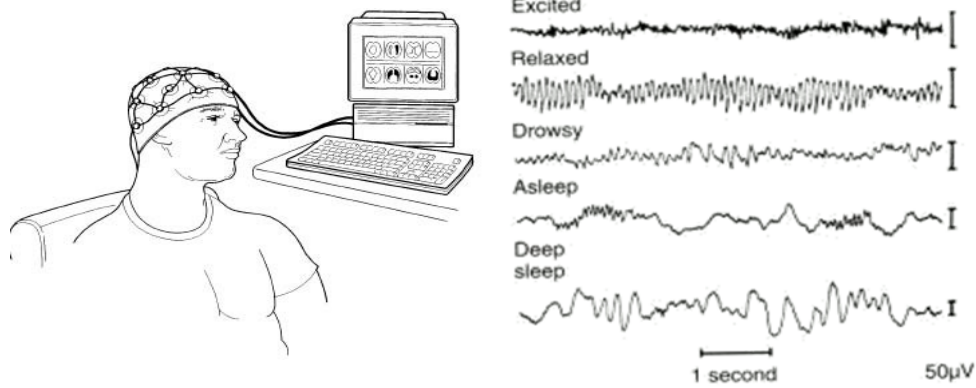
29. Match the above parts of the brain to the descriptions below.

- B** communicates with and coordinates the activities of the other parts of the brain; separated in to two halves
- I** top of brain stem; acts as a relay station for tracts passing between the cerebrum & spinal cord or cerebellum
- G** bridge of white matter that allows communication between the two halves of the cerebrum
- E** the “master gland” works to maintain homeostasis; links the nervous and endocrine systems
- C** receives all sensory input (except smell); higher mental functions including memory and emotions
- J** secretes melatonin which maintains our normal sleep-wake cycle
- F** lies just below the hypothalamus; produces a variety of hormones
- A** regulates vital functions like heartbeat, breathing and blood pressure; contains reflex centers as well
- D** maintains posture and balance; coordinates muscles to work together for smooth movements
- H** contains bundles of axons that travel between the cerebellum and rest of CNS; works with medulla oblongata

30. Name the brain terms for the following descriptions.

- A. The cerebrum is divided into the left and right hemispheres
- B. Deep groove that separates the halves of the cerebrum longitudinal fissure
- C. Shallow grooves dividing each hemisphere into lobes sulci
- D. Thin but highly convoluted outer layer of gray matter cerebral cortex
- E. Folds or convolutions in structure D gyri
- F. Helps us understand written and spoken words (sensory speech) Wernicke’s area
- G. Directs motor area to stimulate the muscles for speaking (motor speech) Broca’s area

31. Electrical activity of the brain can be recorded in the form of an electroencephalogram (EEG)



12.4 The Peripheral Nervous System

32. The peripheral nervous system (PNS) is composed of

- a. **nerves:** bundles of axons in the PNS
- b. **ganglia:** swellings of nerves that are a collection of cell bodies

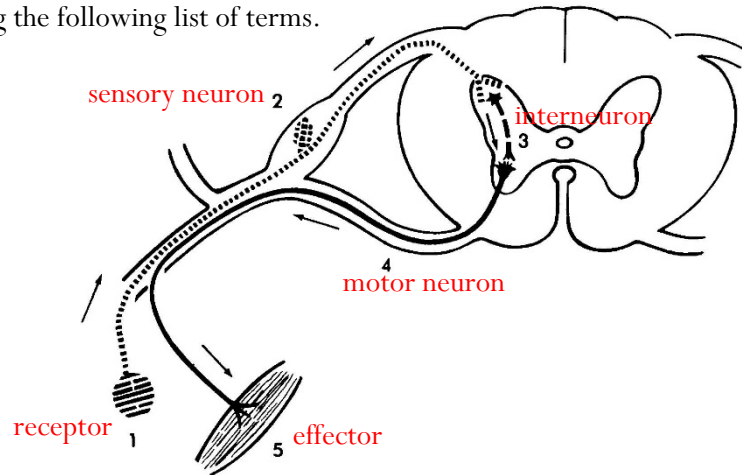
33. Humans have 12 pairs of **cranial nerves** attached to the brain and 31 pairs of **spinal nerves** emerging from opening in the vertebral column of the spinal cord

34. What is a "mixed nerve"? contains many sensory AND motor fibres

35. How does the **vagus nerve** differ from other cranial nerves? also goes to most of the internal organs

36. Label this diagram of the reflex arc, using the following list of terms.

- effector
- interneuron
- motor neuron
- receptor
- sensory neuron



37. Describe the evolutionary purpose of a reflex arc. They are responses to stimuli that keep us safe (and alive) and thus allow an organism to live long enough to reproduce

38. Explain how the brain becomes aware of automatic reflex actions. Interneurons carry impulse to brain afterwards (brain then directs other reactions such as pain responses)

39. Indicate three ways in which the sympathetic and parasympathetic systems are similar.

- a. Function automatically and involuntarily
- b. Innervate all internal organs
- c. Use 2 motor neurons that synapse at a ganglion

40. Complete the table. Your knowledge of the disorders will not be tested but rather is provided for interest sake.

Disorder	Description
Brain Disorders	
Alzheimer's disease	Most common cause of dementia; begins with loss of memory and gradually loses the ability to perform any type of daily activity and becomes bedridden.
Parkinson's disease	Characterized by gradual loss of motor control; results from degeneration of neurons in brain that release dopamine.
Multiple sclerosis (MS)	Most common neurological disease in young adults; myelin sheaths of the white matter in brain are destroyed by white blood cells.
Stroke	Disruption of the blood supply to the brain due to either leakage from small arteries or sudden loss from a thrombus (blood clot).
Meningitis	Infection of the meninges that surround the brain and spinal cord; can be caused by either bacteria or viruses.
Prions	Infectious agents that are thought to be made only of proteins that have been misfolded. Examples of diseases caused by these are: <ul style="list-style-type: none"> • Kuru • Creutzfeldt-Jakob • Fatal familial insomnia
Spinal Cord Disorders	
Paraplegia	An injury that results in paralysis of the lower body and legs.
Quadriplegia	An injury that results in paralysis of entire body below the neck.
Amyotrophic lateral sclerosis (ALS)	Also known as Lou Gehrig's disease; affects the motor nerve cells of the spinal cord; most deaths are due to failure of respiratory muscles.
Peripheral Nerve Disorders	
Guillian-Barré Syndrome	Inflammatory disease that causes demyelination of peripheral nerve axons.
Myasthenia Gravis	Autoimmune disorder in which antibodies are formed that react against the acetylcholine receptor (AChR), preventing muscle stimulation.

- | | | | |
|--------------|--------------|--------------|--------------|
| 1. <u>D</u> | 14. <u>B</u> | 27. <u>C</u> | 40. <u>B</u> |
| 2. <u>B</u> | 15. <u>B</u> | 28. <u>C</u> | 41. <u>D</u> |
| 3. <u>A</u> | 16. <u>B</u> | 29. <u>B</u> | 42. <u>B</u> |
| 4. <u>C</u> | 17. <u>C</u> | 30. <u>D</u> | 43. <u>D</u> |
| 5. <u>A</u> | 18. <u>B</u> | 31. <u>B</u> | omit 44 |
| 6. <u>D</u> | 19. <u>B</u> | 32. <u>D</u> | 45. <u>A</u> |
| 7. <u>B</u> | 20. <u>C</u> | 33. <u>A</u> | 46. <u>C</u> |
| 8. <u>C</u> | 21. <u>D</u> | 34. <u>D</u> | 47. <u>B</u> |
| 9. <u>C</u> | 22. <u>C</u> | 35. <u>B</u> | 48. <u>D</u> |
| 10. <u>A</u> | 23. <u>B</u> | 36. <u>A</u> | 49. <u>D</u> |
| 11. <u>C</u> | 24. <u>C</u> | 37. <u>D</u> | |
| 12. <u>A</u> | 25. <u>C</u> | 38. <u>D</u> | |
| 13. <u>C</u> | 26. <u>C</u> | 39. <u>A</u> | |

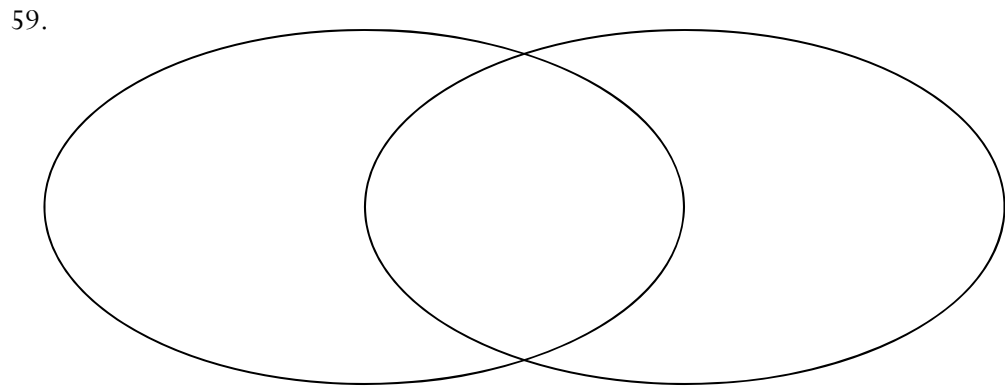
51. _____

53. _____

57. Sympathetic (S) or Parasympathetic (P)?

(a) _____ (b) _____ (c) _____ (d) _____ (e) _____ (f) _____ (g) _____ (h) _____ .

58. _____



62. Think about which neurotransmitter would be blocked. _____

63. (a) _____ (b) _____

(c) _____

(d) _____

64. _____

65. _____ released by the _____