Chapter 49: Nervous Systems

49.1 Describe the overall structural and functional organization of nervous systems.

49.2 Review the relationship of structure to function for major brain regions.

49.3 Discuss the function of the cerebral cortex in processing, integrating, and transmitting information.

49.4 Summarize how changes in the number and strength of synapses provide a basis for learning and memory.

49.5 Use examples to illustrate how changes in molecular pathways can lead to disorders of the nervous system.

This chapter continues your study of the nervous system with specifics about reflex arcs and brain function.

Study Tip: The chapter opening figure in your text presents the different regions of the brain that are engaged in order to process and respond to a spoken question. Follow steps 1–3 on this figure and then explain how memories are formed as well as weakened or lost.

Concept 49.1 Nervous systems consist of circuits of neurons and supporting cells

LO 49.1: Describe the overall structural and functional organization of nervous systems.

1. This concept begins with a look at the evolution of nervous systems. As you read, consider how new information ties into your knowledge of animal diversity from Chapters 32 and 33. To master the vocabulary in this concept, define these terms:

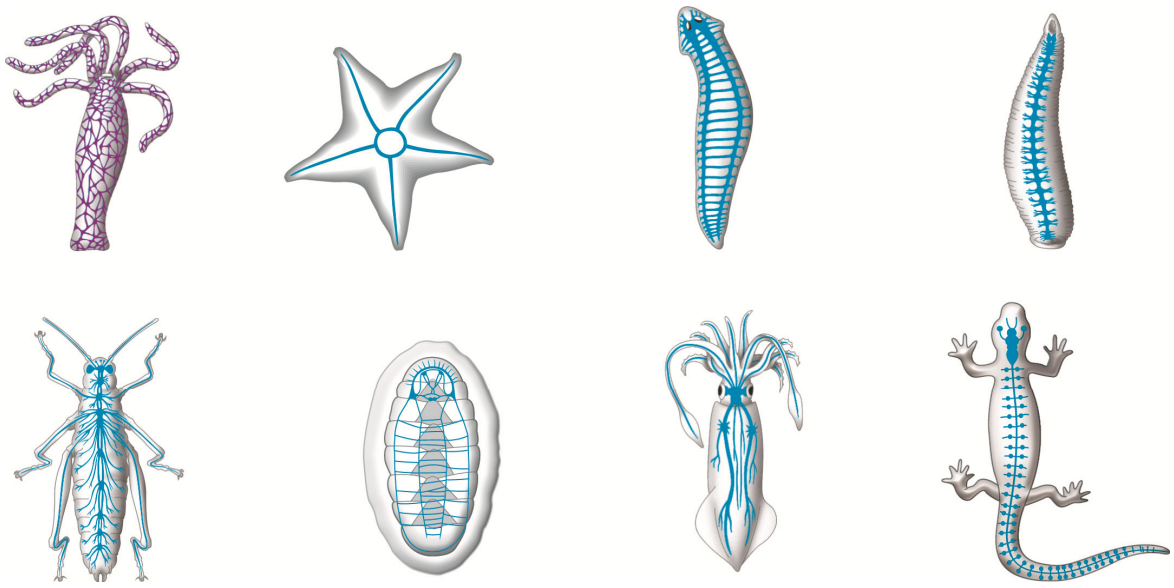
   nerve net

   nerve

   cephalization

   ganglia

2. Refer to Figure 49.2, and you will see modifications and progression in arrangement of neurons, leading to clustering of sense organs and sensory neurons at the anterior end of the organism, called *cephalization.* For the animals below, give the common name of the organism and its phylum. Also label the important features of its nervous system.



3. What are the two components of the vertebrate *central nervous system* (CNS)?

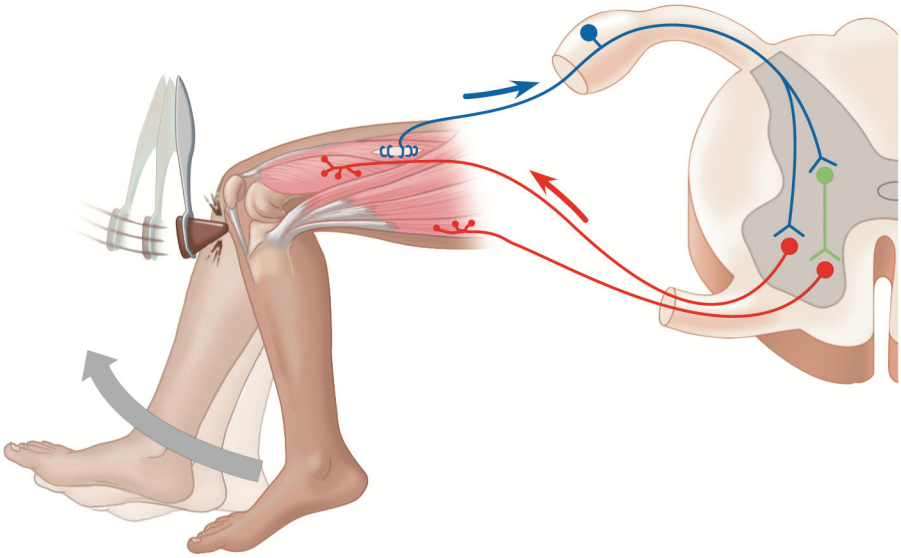
4. What is the function of *cerebrospinal fluid* in mammals? Where is it found?

5. Distinguish between *white matter* and *gray matter*.

6. A *reflex* is the body's automatic response to certain stimuli. Give two examples of reflex responses.

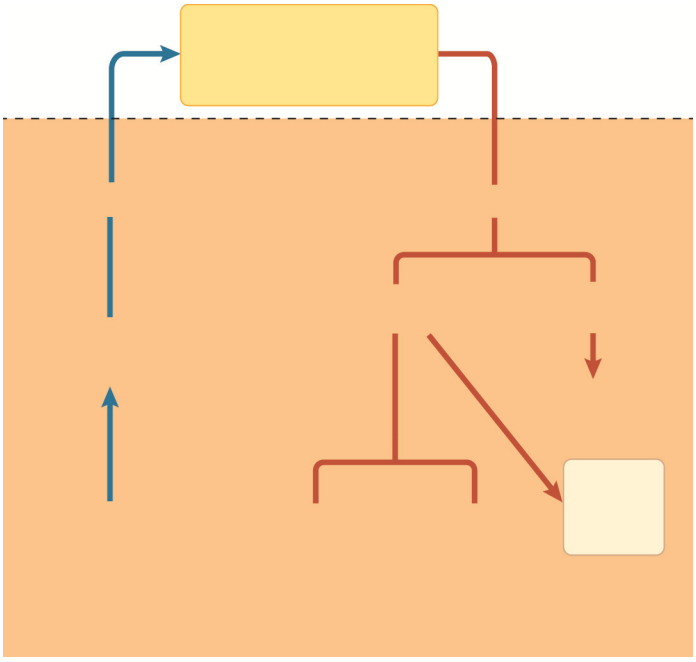
7. A reflex arc is illustrated and explained in Figure 49.5 in your text. Note that the brain is not involved in this reflex which allows a response before your brain is aware of the stimulus. What is the evolutionary value of this?

8. It is important for you to understand this pathway, so take some time with the following figure. Label the following: *stimulus*, *sensors*, *sensory neuron*, *interneuron*, *spinal cord*, *gray matter*, *white matter*, *motor neuron*, and *effector (muscle)*.



9. What makes up the *peripheral nervous system* (PNS)? What is the function of the PNS?

10. Figure 49.6 shows the branches of the *peripheral nervous system*. Label these branches. Which branch is sometimes called the "voluntary nervous system"? Which one is often termed "involuntary"? Include these terms on the following diagram. Finally, add all other information shown in your text for this diagram.



11. Distinguish between *afferent neurons* and *efferent neurons*.

12. What is a descriptive phrase for activation of the sympathetic branch?

13. What phrase can be used to describe the activation of the parasympathetic division?

14. What would be the effect of stimulation of the sympathetic nervous system on heart rate?

    What would be the effect of stimulation of the parasympathetic nervous system on peristalsis?

15. Concept Check Question 1 in your text asks: Which division of your autonomic nervous system would likely be activated if you learned that an exam you had forgotten about would start in 5 minutes? Explain your answer.

16. Now, take the question above a step further, and describe the specific physiological responses that would occur.

17. *Neurons* conduct nerve impulses. What are the specialized support cells that have other functions, including myelination, structural support, and protection?

Concept 49.2 The vertebrate brain is regionally specialized

LO 49.2: Review the relationship of structure to function for major brain regions.

18. What is the function of each of the three major vertebrate brain regions?

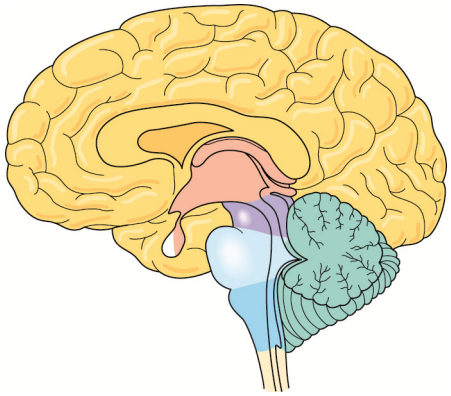
    a. forebrain

    b. midbrain

    c. hindbrain

19. Study Figure 49.10 on p. 1091. Describe three different changes that are seen in the relative sizes of brain regions or total brain size in different animal groups. Give the evolutionary value of each change.

20. Using Figure 49.11 in your text, label the following structures on the figure of the brain, and give a primary function of each labeled structure.



brainstem

a. midbrain

b. pons

c. medulla oblongata

cerebrum

cerebellum

thalamus

hypothalamus

pituitary gland

21. How are the left cerebral cortex and the right cerebral cortex connected?

22. What would be affected in a brain injury to the right cerebral cortex?

23. What are two interesting things we know about the brain's role in each of the following?

a. arousal and sleep

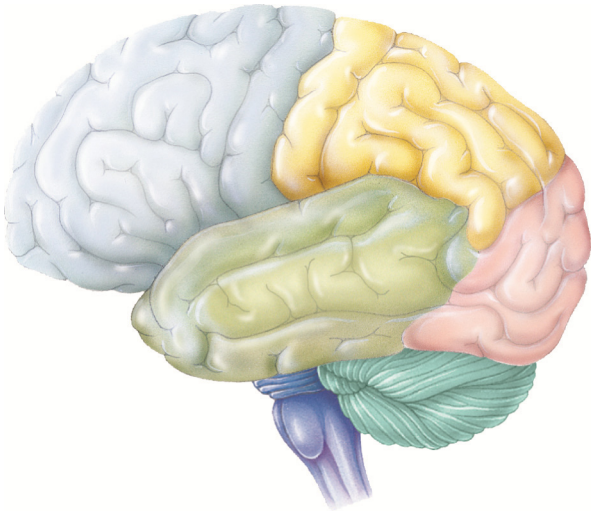
b. biological clock

c. emotions

Concept 49.3 The cerebral cortex controls voluntary movement and cognitive functions

LO 49.3: Discuss the function of the cerebral cortex in processing, integrating, and transmitting information.

24. Label the four lobes of the cerebrum. Describe a function of each lobe.



a. frontal lobe

b. parietal lobe

c. temporal lobe

d. occipital lobe

25. There are a number of ways scientists have learned what brain regions are active during different activities. Some can be used on living patients, but much information has come from studying the brains of people postmortem.

What occurs when *Broca's area* is damaged?

How does damage to *Wernicke's area* affect language?

What was learned through Phineas Gage's horrific accident?

Concept 49.4 Changes in synaptic connections underlie memory and learning

LO 49.4: Summarize how changes in the number and strength of synapses provide a basis for learning and memory.

26. What three processes establish the basic network of neurons and connections within the nervous system?

27. What is *neuronal plasticity*?

28. Neuronal plasticity is essential to the formation of memories. Where in the brain are short-term memories stored? How are memories made long-term?

Concept 49.5 Many nervous system disorders can now be explained in molecular terms

LO 49.5: Use examples to illustrate how changes in molecular pathways can lead to disorders of the nervous system.

29. Disorders of the nervous system result in more hospitalizations in the United States than do heart disease or cancer. In the past, these disorders often resulted in institutionalization of people afflicted for the rest of their lives, but today many disorders can be treated with medication. What two variables are being investigated as contributing to nervous system disorders?

30. What behaviors characterize *schizophrenia*?

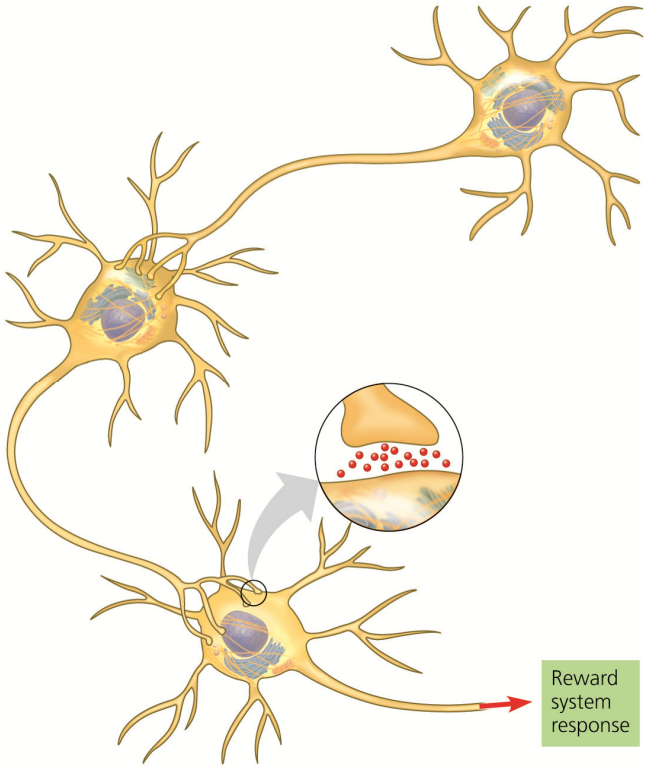
31. What is a current hypothesis regarding the role of dopamine in schizophrenia? What evidence supports this?

32. *Major depressive disorder* and *bipolar disorder* can be treated with drug therapies. Distinguish between the behaviors associated with each disorder.

33. There are many addictive drugs that affect the brain's reward system. What characterizes addictive behavior?

34. What are four drugs that lead to addictive behavior?

35. What is the common feature of these addictive drugs? Use Figure 49.24 to describe how opioids, nicotine and cocaine contribute to this.



36. *Alzheimer's disease* is a progressive form of dementia and results in two characteristic features in the brain. Describe each.

β-amyloid plaques

***tau* protein tangles**

37. Like Alzheimer's disease, *Parkinson's disease* has no cure at present. Explain how *L-dopa* is used in its treatment.

Test Your Understanding, p. 1106.

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