Nerve Reflexes

This exercise describes the organization of the human nervous system and relates it to the concept of the *reflex arc.* The first activity describes the nature of the reflex arc and the manner in which it elicits a response called a *reflex* in an effector. The remainder of the exercise challenges you to demonstrate some simple reflexes that are often used in clinical situations to assess the condition of the nervous system.

Before you begin

- ❑ Read the appropriate chapter in your textbook.
- ❑ Set your learning goals. When you finish this exercise, you should be able to:
  - ❑ outline the features of a reflex arc and be able to apply this model to specific nerve pathways
  - ❑ demonstrate several nerve reflexes in a human subject
- ❑ Prepare your materials:
  - ❑ rubber reflex mallet
  - ❑ sterile cotton balls
  - ❑ penlight
- ❑ Read the directions and safety tips for this exercise *carefully* before starting any procedure

A. Organization of nerve pathways

An often-used model of nerve pathways is the **reflex arc.** A reflex arc is a way of visualizing the direction of transmission of nerve signals (action potentials). For each step that follows, find the reflex arc featured in the diagram of a simple reflex arc in Figure 22-1.

❑ 1 The arc begins with a **receptor,** a specialized cell or cell projection, which is stimulated by a change in its environment. For example, some receptors in the skin are sensitive to heat, others are sensitive to pressure.

❑ 2 If stimulation of the receptor was significant enough to initiate an action potential in the **afferent neuron,** the signal is transmitted toward the CNS. The afferent, or sensory, neuron brings the signal into the brain or spinal cord.

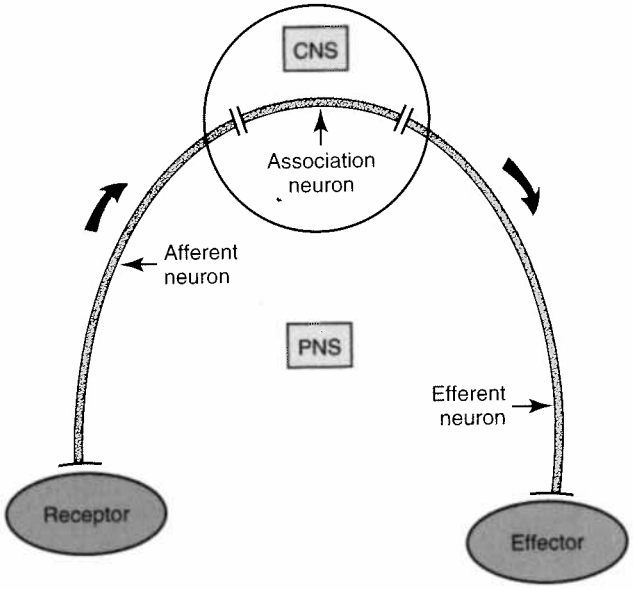

Figure 22-1 A simple three-neuron reflex arc. *Red arrows* indicate direction of nerve transmission.

❑ 3 At the peak of the arc, where the signal is "turned around," the afferent neuron may synapse directly with an **efferent neuron** (forming a **two-neuron arc**). Often an **association neuron** synapses with the afferent neuron and transmits the signal to an efferent neuron. This is a **three-neuron arc.**

❑ 4 The efferent, or motor, neuron then proceeds to an **effector.** An effector is a muscle or gland innervated by a motor nerve. The effector responds in some way to nerve signals, perhaps by contracting or secreting a chemical.

Synthesizing the component parts of the reflex arc, we see that a stimulus at the receptor results in a reaction by an effector. A simple example is a pinprick that causes a reflexive withdrawal of the pricked limb. Reflexes may be more complex, with sensory information being relayed to several different points in the CNS before triggering a motor response. Also, more than one sensory neuron may **converge** on a single association neuron, or multiple motor neurons may **diverge** from a single association neuron. Autonomic reflexes typically involve two efferent neurons, whereas somatomotor reflexes involve only one efferent neuron.

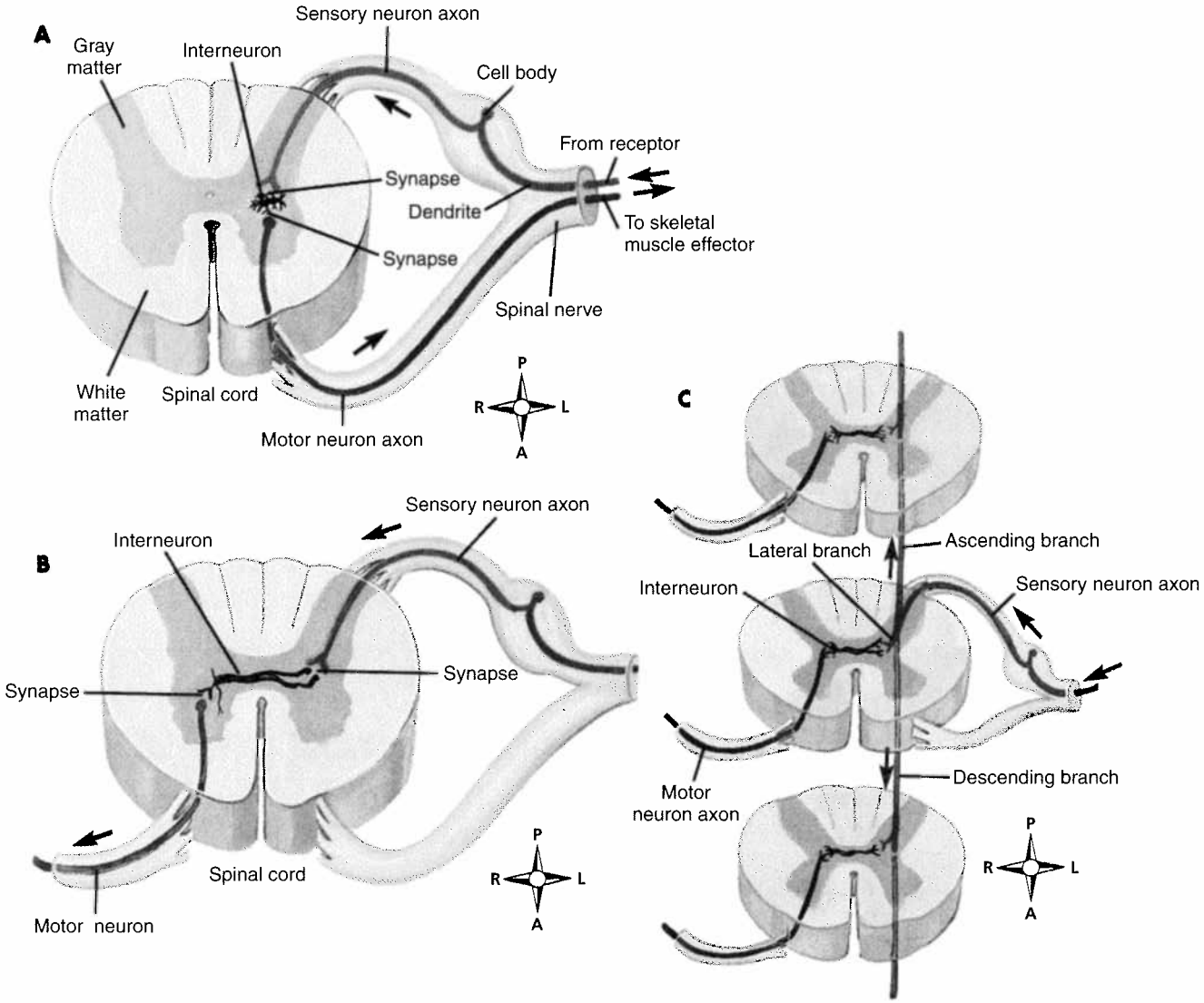

Figure 22-2 Examples of reflex arcs. **A,** Three-neuron ipsilateral reflex arc. Sensory information enters and motor information leaves on the same side of the CNS. **B,** Three-neuron contralateral reflex arc. Sensory information enters on the side of the CNS opposite the side from which motor information exits. **C,** Intersegmental contralateral reflex arc. Divergent branches of a sensory neuron bring information to several segments of the CNS at the same time. Motor information leaves each segment on the opposite side of the CNS.

Figure 22-2 shows that reflex arcs can become quite complicated. Carefully study this figure (and the description beneath it), noting the different pathways efferent and afferent neurons may take in the human nervous system.

Afferent and efferent neurons generally form bundles of parallel fibers called **nerves** (in the PNS) or **tracts** (in the CNS). Nerves are supported by fibrous connective tissue membranes similar to those found in skeletal muscle organs (Figure 22-3). See Lab Exercise 21 for more details of nerve structure.

B. Stretch reflex demonstrations

Examples of reflexes can be seen in clinical tests performed in patients suspected of having some type of nerve damage. If the reflex shows an abnormal reaction or no reaction at all, damage to some component of the reflex arc is suspected. This activity demonstrates several reflexes that are categorized as *stretch* reflexes. Other types of simple reflexes are demonstrated in later activities.

❑ 1 The **patellar reflex,** or *knee-jerk reflex,* is mediated by a two-neuron arc centered in the spinal cord. Have the subject sit on a table with the legs dangling above

the floor. Tap the knee sharply with a reflex mallet at the ligament just inferior to the patella (kneecap). The tap stretches a quadriceps muscle in the anterior thigh, stimulating *stretch receptors* located in the muscle. In response to the increased stretch, which normally would only occur when the muscle load has suddenly increased, the muscle contracts and extends the lower leg. In this demonstration, such a reaction seems strange, but in normal circumstances the patellar reflex allows the quadriceps muscle to reflexively increase its strength of contraction in response to increased load (Figure 22-4, *A*).

HINT

Possible abnormal spinal reflex results:

- **hyperflexia** (exaggerated response) results from damaged or diseased motor areas in the CNS
- **hypoflexia** (inhibited response) results from degeneration of nerve pathways, voluntary motor control, and other factors

❑ 2 The **biceps reflex** is a spinal reflex that involves nerves C5 and C6. Have the subject sit with the elbow flexed at about 90 degrees and palm facing downward. Put your thumb on the biceps (brachii) tendon at the inside angle of the elbow and press gently. Tap your thumb with a reflex mallet. Flexion of the elbow is the normal response.

❑ 3 The **Achilles reflex** is a spinal reflex that results in plantar flexion of the foot. Have the subject kneel on a chair, facing away from you, with the toes pointing toward the floor. Tap the middle of the Achilles (calcaneal) tendon with a reflex mallet. Is the response normal?

❑ 4 The **triceps reflex** is another stretch reflex. Have the subject lie on a table, with an arm across the abdomen. Supporting the subject's arm with the elbow flexed at a 90-degree angle, sharply tap the posterior surface of the upper arm just proximal to the olecranon (Figure 22-4, *B*). The lower arm should extend as the triceps brachii muscle reflexively contracts. How do you explain this response?

C. Cutaneous reflexes

Cutaneous reflexes are those that result from the stimulation of cutaneous (skin) receptors.

❑ 1 The **plantar reflex** involves cutaneous receptors rather than deep receptors in muscles or tendons. Position the subject's bare foot with the lateral surface resting on a table or chair. Demonstrate this reflex by firmly sweeping the handle of the mallet along the lateral region of the sole (Figure 22-4, *C*). In a normal adult, the toes flex. In a **Babinski response,** the toes extend and move apart. The Babinski response is normal in infants in whom the nerves have not fully myelinated, but the response is abnormal in adults.

❑ 2 Another cutaneous reflex is the **abdominal reflex.** Begin the abdominal reflex demonstration by having the subject lie on a clean, flat surface. Expose the skin of the abdomen. Use the handle of the reflex mallet to sweep gently along the anterior, lateral aspect of the skin. Move in a superior-to-inferior direction. What is the response of the abdominal muscles?

D. Cranial reflexes

Another type of reflex is mediated by the brain. For example, the *pupillary reflexes* demonstrated in Step 1 involve cranial nerves and autonomic reflex centers.

❑ 1 In a dimly lit area, demonstrate the **pupillary reflexes,** which are centered in the brainstem. Have the subject stare straight ahead, with a hand held vertically between the eyes. Shine a penlight in the subject's left eye (from 5 to 7 cm away). Normally, the light receptors in the eye receive the bright light and trigger a reflexive response by the muscles in the iris. Does the pupil increase or decrease in diameter? What is the advantage of this response? The right pupil may also exhibit a reflexive response, even though light is not shown on it. Does the right pupil increase or decrease in diameter? What advantage is gained by this *consensual* reflex?

❑ 2 Demonstrate the **corneal reflex,** which involves the fifth cranial nerve. Begin the corneal reflex demonstration by having the subject stand facing at a 90-degree angle to you. While the subject stares straight ahead, quickly move a clean, sterile cotton ball toward the surface of one eye. *Do not actually touch the eye, however.* What is the reaction? What survival advantage does this reflex have?

COLORING EXERCISE
Using colored pens or pencils, shade in the figure and accompanying labels in contrasting colors of your choice as indicated by the red numerals.

Reflex Arc

RECEPTOR 1
AFFERENT NEURON 2
INTERNEURON 3
EFFERENT NEURON 4
EFFECTOR 5
DORSAL SPINAL NERVE ROOT 6
DORSAL ROOT GANGLION 7
VENTRAL SPINAL NERVE ROOT 8
SPINAL NERVE 9
BRANCH OF SPINAL NERVE 10

Spinal Cord

WHITE MATTER 11
GRAY MATTER 12

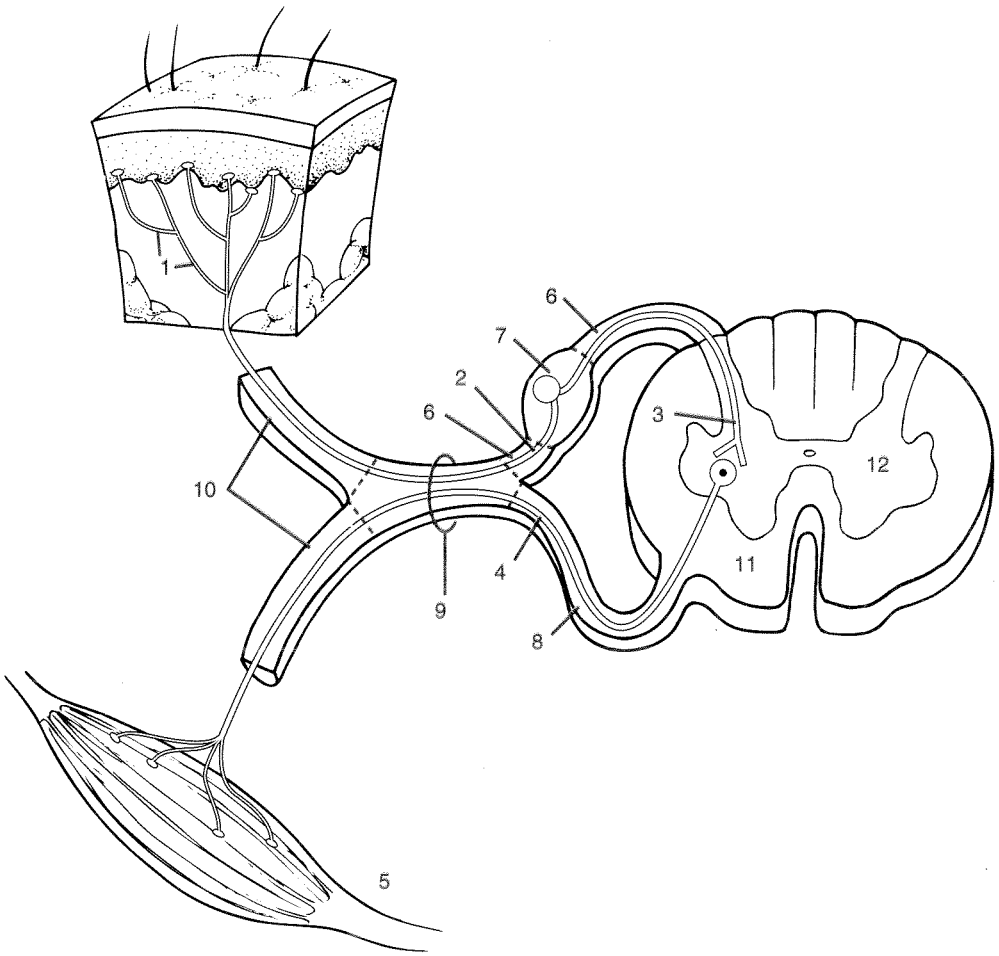

Figure 22-3 Example of a spinal reflex arc.

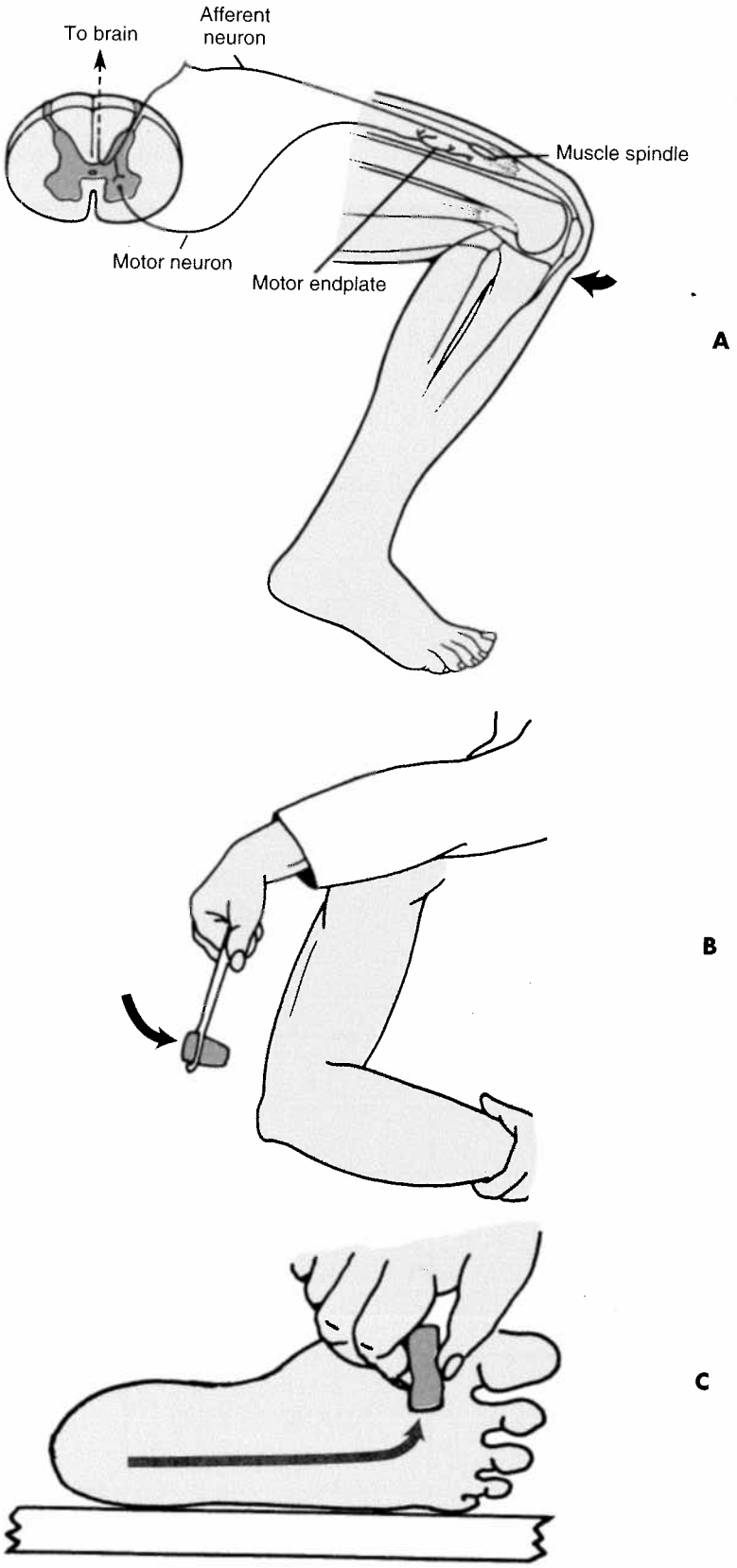

Figure 22-4 **A,** The patellar reflex arc. *Arrow* indicates tapping point. **B,** Tapping point for triceps reflex. **C,** Demonstrating plantar reflex.

Name: _____ **Date:** _____ **Section:** _____

LAB REPORT 22

Nerve Reflexes

Record your data and interpretations of the reflex tests. Be sure to indicate the function each may have.

Reflex	Results		Explanation/Discussion
	Left	Right	
Patellar	❑ normal ❑ hyperflexia ❑ hypoflexia ❑ no response	❑ normal ❑ hyperflexia ❑ hypoflexia ❑ no response	
Biceps	❑ normal ❑ hyperflexia ❑ hypoflexia ❑ no response	❑ normal ❑ hyperflexia ❑ hypoflexia ❑ no response	
Achilles	❑ normal ❑ hyperflexia ❑ hypoflexia ❑ no response	❑ normal ❑ hyperflexia ❑ hypoflexia ❑ no response	
Triceps	❑ normal ❑ hyperflexia ❑ hypoflexia ❑ no response	❑ normal ❑ hyperflexia ❑ hypoflexia ❑ no response	
Plantar	❑ normal ❑ Babinski response ❑ no response	❑ normal ❑ Babinski response ❑ no response	
Abdominal	❑ normal ❑ hyperflexia ❑ hypoflexia ❑ no response	❑ normal ❑ hyperflexia ❑ hypoflexia ❑ no response	
Pupillary	❑ dilation ❑ constriction ❑ no response	❑ dilation ❑ constriction ❑ no response	
Corneal	❑ response ❑ no response	❑ response ❑ no response	

Put in Order

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

Fill-in

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

Put in Order (put these components of the reflex arc in the order in which nerve signals pass through them)

association neuron
effector
motor neuron
receptor
sensory neuron

Fill-in (complete each statement with the correct term)

1. In infants, the ___?___ response is normal when testing the plantar reflex.
2. When testing the plantar reflex in an adult, extension of the toes may indicate damage to the ___?___ somewhere along the reflex arc.
3. In the ___?___ reflex, a muscle contracts when the load increases.
4. The center of the patellar reflex is in the ___?___.
5. A stretch reflex involving the biceps brachii muscle causes ___?___ of the elbow if the biceps muscle is stretched.
6. In the triceps reflex demonstration, the triceps muscle was the effector, and one or more ___?___ were the receptors.
7. If the Achilles (calcaneal) tendon is tapped, one would expect the ankle to ___?___.
8. When suddenly illuminated with a penlight, the pupil of the eye normally ___?___ (dilates/constricts).
9. ___?___ reflexes result from the stimulation of sensory receptors in the skin.
10. ___?___ reflexes are centered in the brain and involve cranial nerves.