

## Laboratory Exercise

# 27

## Reflex Arc and Reflexes

### Materials Needed

Textbook  
Rubber percussion hammer

A reflex arc represents the simplest type of nerve pathway found in the nervous system. This pathway begins with a receptor at the dendrite end of a sensory (afferent) neuron. The sensory neuron leads into the central nervous system and may communicate with one or more interneurons. Some of these interneurons, in turn, communicate with motor (efferent) neurons, whose axons (nerve fibers) lead outward to effectors.

Thus, when a sensory receptor is stimulated by a change occurring inside or outside the body, nerve impulses may pass through a reflex arc, and, as a result, effectors may respond. Such an automatic, subconscious response is called a *reflex*.

A *stretch reflex* involves a single synapse (monosynaptic) between a sensory and a motor neuron within the gray matter of the spinal cord. Examples of stretch reflexes include the patellar, calcaneal, biceps, triceps, and plantar reflexes. Other more complex *withdrawal reflexes* involve interneurons in combination with sensory and motor neurons; thus they are polysynaptic. Examples of withdrawal reflexes include responses to touching hot objects or stepping on sharp objects.

Reflexes demonstrated in this lab are stretch reflexes. When a muscle is stretched by a tap over its tendon, stretch receptors (proprioceptors) called *muscle spindles* are stretched within the muscle, which initiates an impulse over a reflex arc. A sensory (afferent) neuron conducts an impulse from the muscle spindle into the gray matter of the spinal cord, where it synapses with a motor (efferent) neuron, which conducts the impulse to the effector muscle. The stretched muscle responds by contracting to resist or reverse further stretching. These stretch reflexes are important to maintaining proper posture, balance, and movements. Observations of many of these reflexes in clinical tests on patients may indicate damage to a level of the spinal cord or peripheral nerves of the particular reflex arc.

### Purpose of the Exercise

To review the characteristics of reflex arcs and reflex behavior and to demonstrate some of the reflexes that occur in the human body.

### LEARNING OUTCOMES

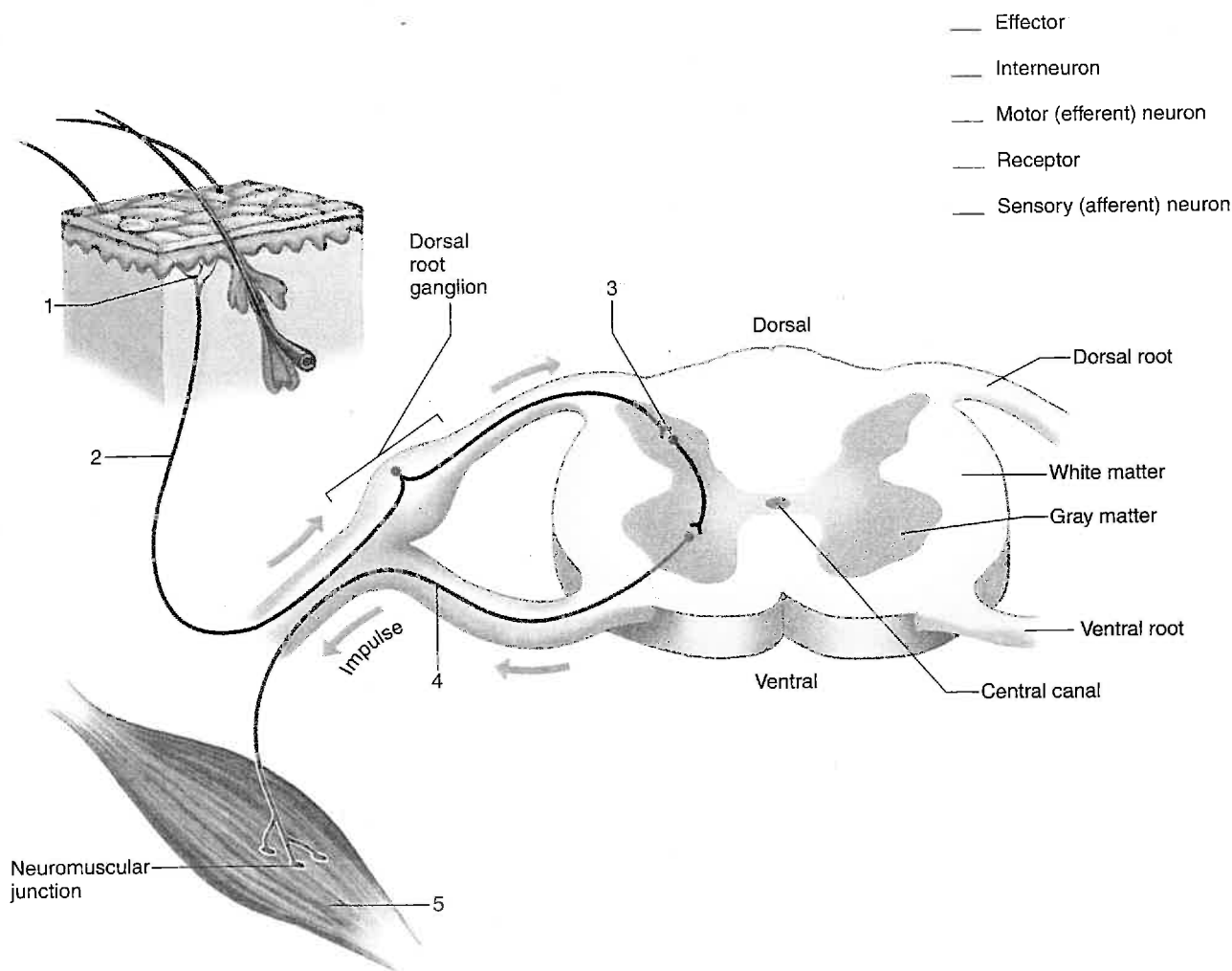
After completing this exercise, you should be able to

- 1 Describe the components of a reflex arc.
- 2 Demonstrate and record stretch reflexes that occur in humans.
- 3 Analyze the components and patterns of stretch reflexes.

### EXPLORE

#### Procedure—Reflex Arc and Reflexes

1. Review the section entitled “Reflex Arcs” in chapter 11 of the textbook and “Proprioception” in chapter 12 of the textbook.
2. As a review activity, label figure 27.1.
3. Complete Part A of Laboratory Report 27.
4. Work with a laboratory partner to demonstrate each of the reflexes listed. (See fig. 27.2 also.) *It is important that muscles involved in the reflexes be totally relaxed to observe proper responses.* If a person is trying too hard to experience the reflex or is trying to suppress the reflex, assign a multitasking activity while the stimulus with the rubber hammer occurs. For example, assign a physical task with the upper limbs along with a complex mental activity during the patellar (knee-jerk) reflex. After each demonstration, record your observations in the table provided in Part B of the laboratory report.
  - a. *Patellar (knee-jerk) reflex.* Have your laboratory partner sit on a table (or sturdy chair) with legs relaxed and hanging freely over the edge without touching the floor. Gently strike your partner’s patellar ligament (just below the patella) with the blunt side of a rubber percussion hammer



**Figure 27.1** Label this diagram of a withdrawal (polysynaptic) reflex arc by placing the correct numbers in the spaces provided. Reflexes demonstrated in this lab are stretch (monosynaptic) reflex arcs and lack the interneuron. **1**

(fig. 27.2a). The normal response is a moderate extension of the leg at the knee joint.

- b. *Calcaneal (ankle-jerk) reflex.* Have your partner kneel on a chair with back toward you and with feet slightly dorsiflexed over the edge and relaxed. Gently strike the calcaneal tendon (just above its insertion on the calcaneus) with the blunt side of the rubber hammer (fig. 27.2b). The normal response is plantar flexion of the foot.
- c. *Biceps (biceps-jerk) reflex.* Have your partner place a bare arm bent about 90° at the elbow on the table. Press your thumb on the inside of the elbow over the tendon of the biceps brachii, and gently strike your thumb with the rubber hammer (fig. 27.2c). Watch the biceps brachii for a response. The response might be a slight twitch of the muscle or flexion of the forearm at the elbow joint.
- d. *Triceps (triceps-jerk) reflex.* Have your partner lie supine with an upper limb bent about 90° across

the abdomen. Gently strike the tendon of the triceps brachii near its insertion just proximal to the olecranon process at the tip of the elbow (fig. 27.2d). Watch the triceps brachii for a response. The response might be a slight twitch of the muscle or extension of the forearm at the elbow joint.

- e. *Plantar reflex.* Have your partner remove a shoe and sock and lie supine with the lateral surface of the foot resting on the table. Draw the metal tip of the rubber hammer, applying firm pressure, over the sole from the heel to the base of the large toe (fig. 27.2e). The normal response is flexion (curling) of the toes and plantar flexion of the foot. If the toes spread apart and dorsiflexion of the great toe occurs, the reflex is the abnormal *Babinski reflex* response (normal in infants until the nerve fibers have complete myelination). If the Babinski reflex occurs later in life, it may indicate damage to the corticospinal tract of the CNS.

5. Complete Part B of the laboratory report.



(a) Patellar (knee-jerk) reflex



(b) Calcaneal (ankle-jerk) reflex

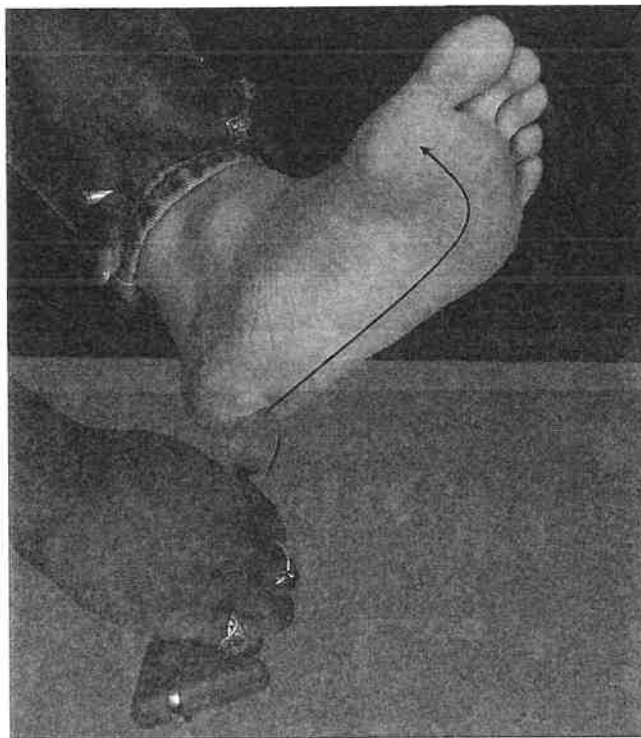


(c) Biceps reflex

**Figure 27.2** Demonstrate each of the following reflexes: (a) patellar reflex; (b) calcaneal reflex; (c) biceps reflex; (d) triceps reflex; and (e) plantar reflex.



(d) Triceps reflex



(e) Plantar reflex

**Figure 27.2** *Continued.*