Laboratory Exercise 61

Nerve Impulse Stimulation

Materials Needed

Textbook
Live frog
Dissecting tray
Dissecting instruments
Frog Ringer's solution
Electronic stimulator
Filter paper
Glass rod
Glass plate
Ring stand and ring
Microscope slides
Bunsen burner
Ice
1% HCl
1% NaCl

For Learning Extension:
2% Novocain solution (procaine hydrochloride)

Safety

- Wear disposable gloves when handling the frogs and chemicals.
- Keep loose hair and clothes away from the Bunsen burner.
- Wear heat-resistant gloves when heating the glass rod.
- Dispose of gloves, frogs, and chemicals as instructed.
- Wash your hands before leaving the laboratory.

A nerve cell usually is polarized due to an unequal distribution of ions on either side of its membrane. When such a polarized membrane is stimulated at or above its threshold intensity, a wave of action potentials is triggered to move in all directions away from the site of stimulation. This wave constitutes a nerve impulse, and if it reaches a muscle, the muscle may respond by contracting.

Purpose of the Exercise

To review the characteristics of a nerve impulse and to investigate the effects of certain stimuli on a nerve.

LEARNING OUTCOMES

After completing this exercise, you should be able to

1. Describe the structures and the events that lead to the stimulation of a nerve impulse.
2. Determine the threshold voltage to stimulate a nerve impulse.
3. Test the effects of various factors on a nerve-muscle preparation.
4. List four types of factors that can stimulate a nerve impulse.

EXPLORE

Procedure—Nerve Impulse Stimulation

1. Review the section entitled "Cell Membrane Potential" in chapter 10 of the textbook.
2. Complete Part A of Laboratory Report 61.
3. Obtain a live frog, and pith its brain and spinal cord as described in Procedure C of Laboratory Exercise 60.

Alternative Procedure

An anesthetizing agent, tricaine methane sulfonate, can be used to prepare frogs for this lab. This procedure eliminates the need to pith frogs.

4. Place the pithed frog in a dissecting tray and remove the skin from its hindlimb, beginning at the waist, as described in Procedure C of Laboratory Exercise 60. (As the skin is removed, keep the exposed tissues moist by flooding them with frog Ringer's solution.)

5. Expose the frog's sciatic nerve. To do this, follow these steps:
   - **a.** Use a glass rod to separate the gastrocnemius muscle from the adjacent muscles.
   - **b.** Locate the calcaneal (Achilles) tendon at the distal end of the gastrocnemius, and cut it with scissors.
   - **c.** Place the frog ventral surface down, and separate the muscles of the thigh to locate the sciatic nerve. The nerve will look like a silvery white thread passing through the thigh, dorsal to the femur (fig. 61.1).
   - **d.** Dissect the nerve to its origin in the spinal cord.
   - **e.** Use scissors to cut the nerve at its origin, and carefully snip off all of the branch nerves in the thigh, leaving only its connection to the gastrocnemius muscle.
   - **f.** Use a scalpel to free the proximal end of the gastrocnemius.
   - **g.** Carefully remove the nerve and attached muscle, and transfer the preparation to a glass plate supported on the ring of a ring stand.
   - **h.** Use a glass rod to position the preparation so that the sciatic nerve is hanging over the edge of the glass plate. (Be sure to keep the preparation moistened with frog Ringer's solution at all times.)
6. Determine the threshold voltage and the voltage needed for maximal muscle contraction by using the electronic stimulator, as described in Procedure D of Laboratory Exercise 60.
7. Expose the cut end of the sciatic nerve to each of the following conditions, and observe the response of the gastrocnemius muscle. Add frog Ringer's solution after each of the experiments.
   - **a.** Firmly pinch the end of the nerve between two glass microscope slides or pinch using forceps.
   - **b.** Touch the cut end with a glass rod that is at room temperature.
   - **c.** Touch the cut end with a glass rod that has been cooled in ice water for 5 minutes.
   - **d.** Touch the cut end with a glass rod that has been heated in the flame of a Bunsen burner. Wear heat-resistant gloves for this procedure.
   - **e.** Dip the cut end in 1% HCl.
   - **f.** Dip the cut end in 1% NaCl.
8. Complete Part B of the laboratory report.

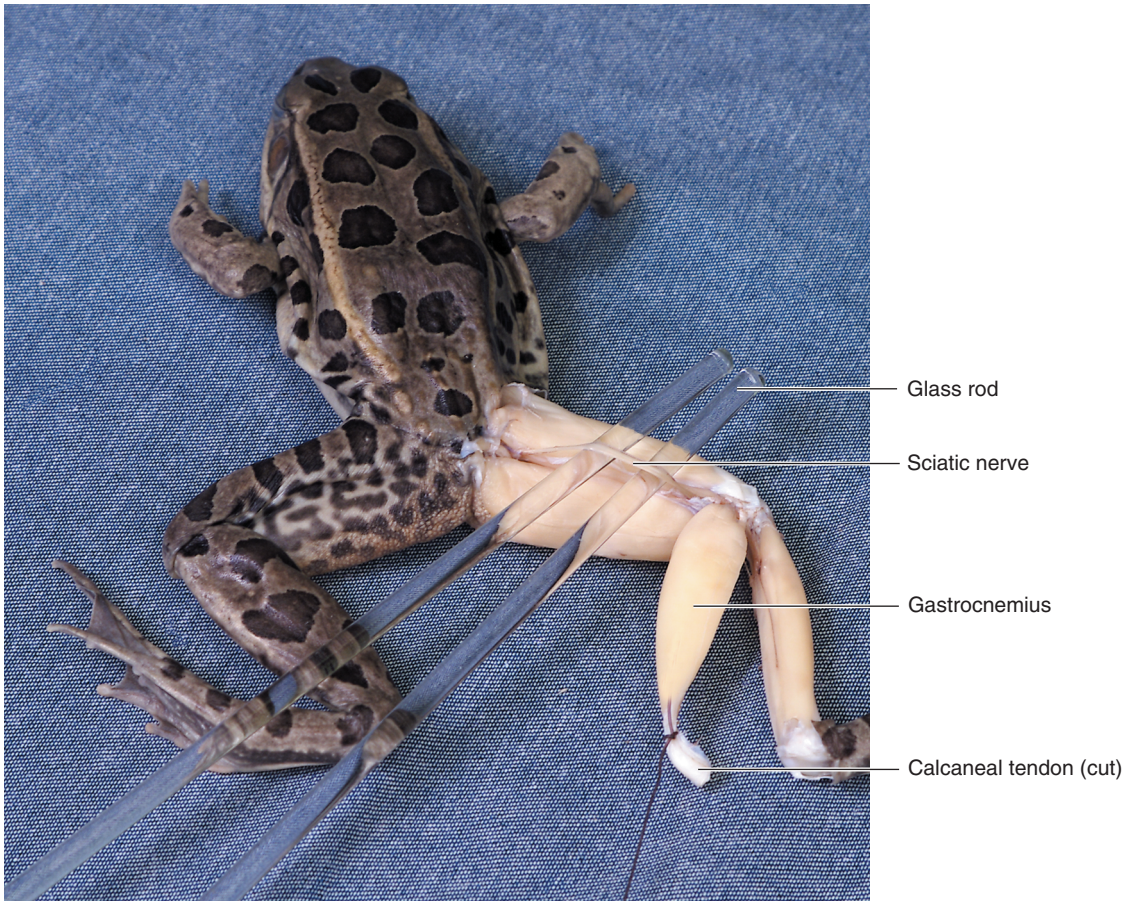

Figure 61.1 The sciatic nerve appears as a silvery white thread between the muscles of the thigh.

Learning Extension

Test the effect of Novocain on a frog sciatic nerve. To do this, follow these steps:

1. Place a nerve-muscle preparation on a glass plate supported by the ring of a ring stand, as before.
2. Use the electronic stimulator to determine the voltage needed for maximal muscle contraction.
3. Saturate a small piece of filter paper with 2% Novocain solution, and wrap the paper around the midsection of the sciatic nerve.
4. At 2-minute intervals, stimulate the nerve, using the voltage needed for maximal contraction until the muscle fails to respond.
5. Remove the filter paper, and flood the nerve with frog Ringer's solution.
6. At 2-minute intervals, stimulate the nerve until the muscle responds again. How long did it take for the nerve to recover from the effect of the Novocain?

_____

Notes

Name _____

Date _____

Section _____

The A corresponds to the indicated Learning Outcome(s) listed at the beginning of the laboratory exercise.

Laboratory Report 61

Nerve Impulse Stimulation

Part A Assessments

Complete the following statements:

1. _____ ions tend to pass through cell membranes more easily than sodium ions. A1
2. When a nerve cell is at rest, there is a relatively greater concentration of _____ ions outside of its membrane. A1
3. When sodium ions are actively transported outward through a nerve cell membrane, _____ ions are transported inward. A1
4. The difference in electrical charge between the inside and the outside of a nerve cell membrane is called the _____. A1
5. If the resting potential becomes less negative in response to stimulation, the cell membrane is said to be _____. A1
6. As a result of an additive phenomenon called _____, the threshold potential of a membrane may be reached. A1
7. Following depolarization, potassium ions diffuse outward and cause the cell membrane to become _____. A1
8. An action potential is a rapid sequence of changes involving depolarization and _____. A1
9. The moment following the passage of an action potential during which a threshold stimulus will not trigger another impulse is called the _____. A1
10. Muscle fiber contraction and nerve impulse conduction are similar in that both are _____ responses. A1
11. Myelin contains a high proportion of _____. A1
12. Nodes of Ranvier occur between adjacent _____. A1
13. The type of conduction in which an impulse seems to jump from node to node is called _____. A1
14. The greater the diameter of a nerve fiber, the _____ the impulse travels. A1

Part B Assessments

1. What was the threshold voltage for the frog sciatic nerve? A2 _____
2. What was the voltage needed for maximal contraction of the gastrocnemius muscle? A2 _____
3. Complete the following table: A3

Factor Tested	Muscle Response	Effect on Nerve
Pinching		
Glass rod (room temperature)		
Glass rod (cooled)		
Glass rod (heated)		
1% HCl		
1% NaCl		

4. Summarize the results of these tests. A4

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