

# 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 OBJECTIVES

After completing this exercise, you should be able to

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

## PROCEDURE

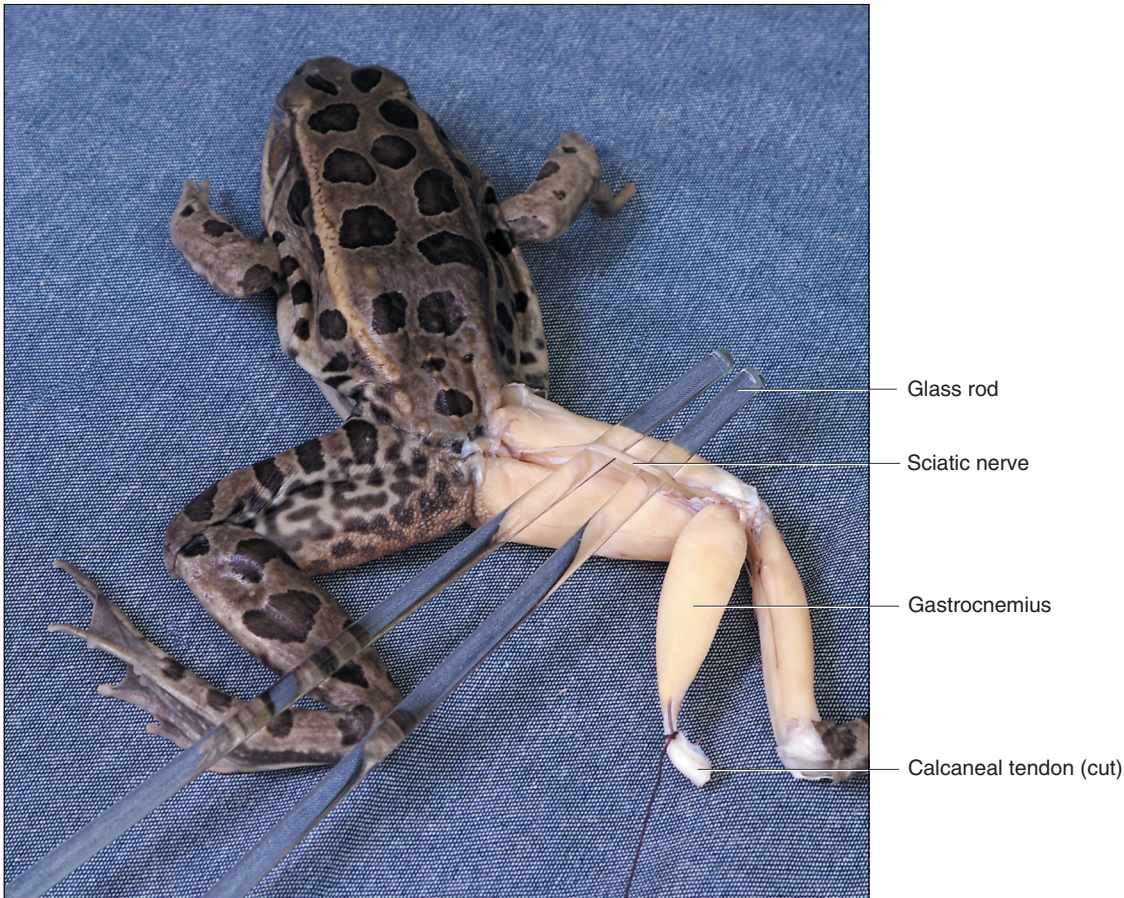
1. Review a textbook section on *cell membrane potential*.
2. Complete Part A of Laboratory Report 63.
3. Obtain a live frog, and pith its brain and spinal cord as described in Procedure C of Laboratory Exercise 62.

## 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 62. (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. 63.1).
  - 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.

**Figure 63.1** The sciatic nerve appears as a silvery white thread between the muscles of the thigh.



- 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 62.
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.



### LEARNING EXTENSION

**T**est 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 mid-section 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?

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# NERVE IMPULSE STIMULATION

## PART A

Complete the following statements:

1. \_\_\_\_\_ ions tend to pass through cell membranes more easily than sodium ions.
2. When a nerve cell is at rest, there is a relatively greater concentration of \_\_\_\_\_ ions outside of its membrane.
3. When sodium ions are actively transported outward through a nerve cell membrane, \_\_\_\_\_ ions are transported inward.
4. The difference in electrical charge between the inside and the outside of a nerve cell membrane is called the \_\_\_\_\_ potential.
5. As a result of an additive phenomenon called \_\_\_\_\_, the threshold potential of a membrane may be reached.
6. An action potential is a rapid sequence of changes involving \_\_\_\_\_ and repolarization.
7. The moment following the passage of an action potential during which a threshold stimulus will not trigger another impulse is called the \_\_\_\_\_ period.
8. Myelin contains a high proportion of \_\_\_\_\_.
9. Nodes of Ranvier occur between adjacent \_\_\_\_\_.
10. The type of conduction in which an impulse seems to jump from node to node is called \_\_\_\_\_.
11. The greater the diameter of a nerve fiber, the \_\_\_\_\_ the impulse travels.

## PART B

1. What was the threshold voltage for the frog sciatic nerve? \_\_\_\_\_
2. What was the voltage needed for maximal contraction of the gastrocnemius muscle? \_\_\_\_\_

3. Complete the following table:

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

4. Write a statement to summarize the results of these tests.

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