MAIN VERSION

GLOBAL EDITION

Human Anatomy & Physiology Laboratory Manual

TWELFTH EDITION

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Anatomy and Physiology Laboratory Safety Guidelines*

1. Upon entering the laboratory, locate exits, fire extinguisher, fire blanket, chemical shower, eyewash station, first aid kit, containers for broken glass, and materials for cleaning up spills.
2. Do not eat, drink, smoke, handle contact lenses, store food, or apply cosmetics or lip balm in the laboratory. Restrain long hair, loose clothing, and dangling jewelry.
3. Students who are pregnant, are taking immunosuppressive drugs, or have any other medical conditions (e.g., diabetes, immunological defect) that might necessitate special precautions in the laboratory must inform the instructor immediately.
4. Wearing contact lenses in the laboratory is inadvisable because they do not provide eye protection and may trap material on the surface of the eye. Soft contact lenses may absorb volatile chemicals. If possible, wear regular eyeglasses instead.
5. Use safety glasses in all experiments involving liquids, aerosols, vapors, and gases.
6. Decontaminate work surfaces at the beginning and end of every lab period, using a commercially prepared disinfectant or 10% bleach solution. After labs involving dissection of preserved material, use hot soapy water or disinfectant.
7. Keep all liquids away from the edge of the lab bench to avoid spills. Clean up spills of viable materials using disinfectant or 10% bleach solution.
8. Properly label glassware and slides.
9. Use mechanical pipetting devices; mouth pipetting is prohibited.
10. Wear disposable gloves when handling blood and other body fluids, mucous membranes, and nonintact skin, and when touching items or surfaces soiled with blood or other body fluids. Change gloves between procedures. Wash hands immediately after removing gloves. (**Note:** Cover open cuts or scrapes with a sterile bandage before donning gloves.)
11. Place glassware and plasticware contaminated by blood and other body fluids in a disposable autoclave bag for decontamination by autoclaving, or place them directly into a 10% bleach solution before reuse or disposal. Place disposable materials such as gloves, mouthpieces, swabs, and toothpicks that have come into contact with body fluids into a disposable autoclave bag, and decontaminate before disposal.
12. To help prevent contamination by needlestick injuries, use only disposable needles and lancets. Do not bend the needles and lancets. Needles and lancets should be placed promptly in a labeled, puncture-resistant, leakproof container and decontaminated, preferably by autoclaving.
13. Do not leave heat sources unattended.
14. Report all spills or accidents, no matter how minor, to the instructor.
15. Never work alone in the laboratory.
16. Remove protective clothing before leaving the laboratory.

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*Adapted from:

Biosafety in Microbiological and Biomedical Laboratories (BMBL), Fifth Edition. 2007. U.S. Government Printing Office. Washington, D.C. www.cdc.gov/od/OHS/biosfty/bmbl5/bmbl5toc.htm

Centers for Disease Control. 1996. "Universal Precautions for Prevention of Transmission of HIV and Other Bloodborne Infections." Washington, D.C. www.cdc.gov/ncidod/dhqp/bp_universal_precautions.html

Johnson, Ted, and Christine Case. 2010. *Laboratory Experiments in Microbiology,* Ninth Edition. San Francisco: Pearson Benjamin Cummings.

School Chemistry Laboratory Safety Guide. 2006. U.S. Consumer Product Safety Commission. Bethesda, MD. www.cpsc.gov/CPSCPUB/PUBS/NIOSH2007107.pdf

Neuron Anatomy

4. Match the following anatomical terms (column B) with the appropriate description or function (column A).

Column A

_____ 1. region of the cell body from which the axon originates

_____ 2. secretes neurotransmitters

_____ 3. receptive regions of a neuron (2 terms)

_____ 4. insulates the nerve fibers

_____ 5. site of the nucleus and most important metabolic area

_____ 6. involved in the transport of substances within the neuron

_____ 7. essentially rough endoplasmic reticulum, important metabolically

_____ 8. impulse generator and transmitter

Column B

a. axon

b. axon terminal

c. axon hillock

d. cell body

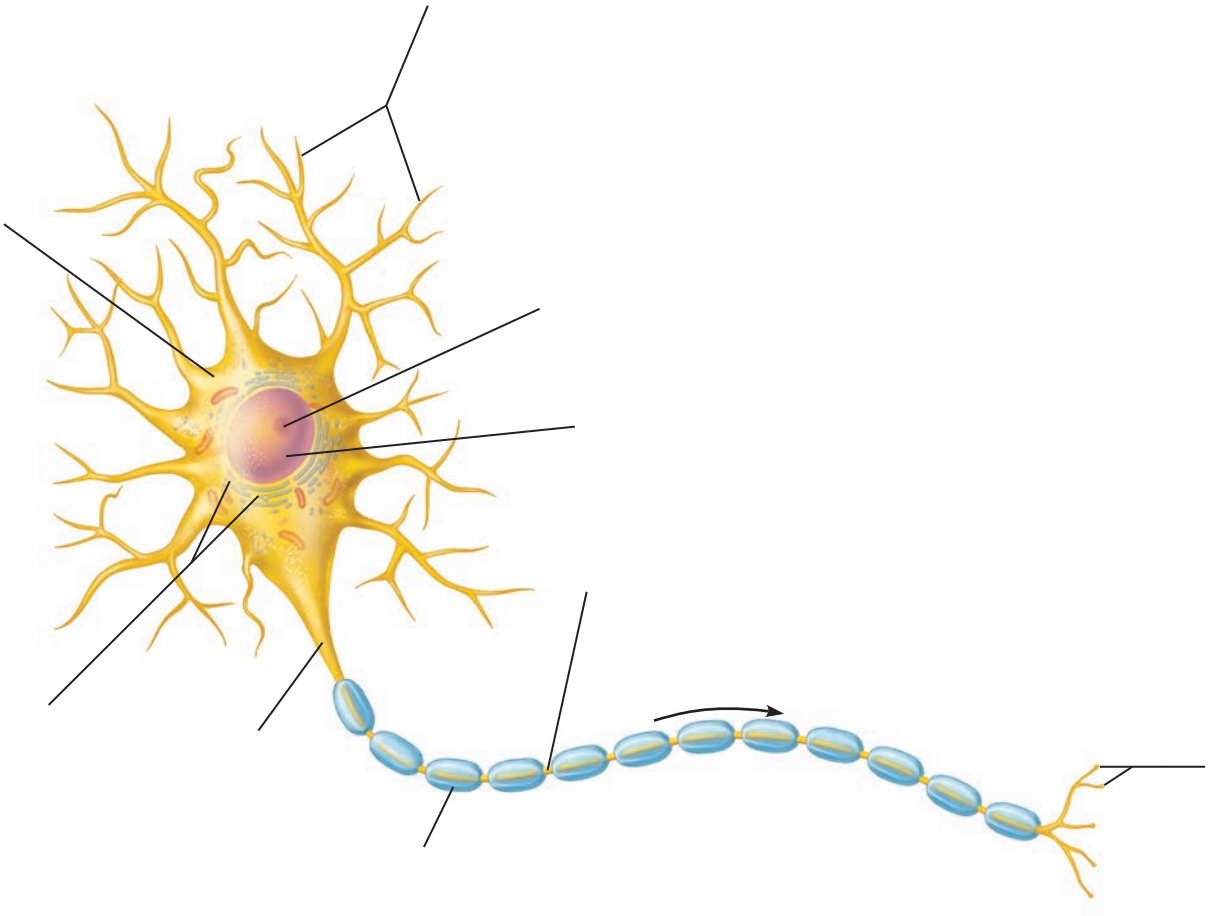
f. chromatophilic substance

g. dendrite

h. myelin sheath

i. neurofibril

5. Label the following structures on the diagram of a multipolar neuron shown below: cell body, nucleus, nucleolus, chromatophilic substance, dendrites, initial segment of axon, myelin sheath, myelin sheath gaps, and axon terminals.



6. What name is given to gaps present in the myelin sheath? _____

7. What anatomical characteristic determines whether a particular neuron is classified as unipolar, bipolar, or multipolar?

_____

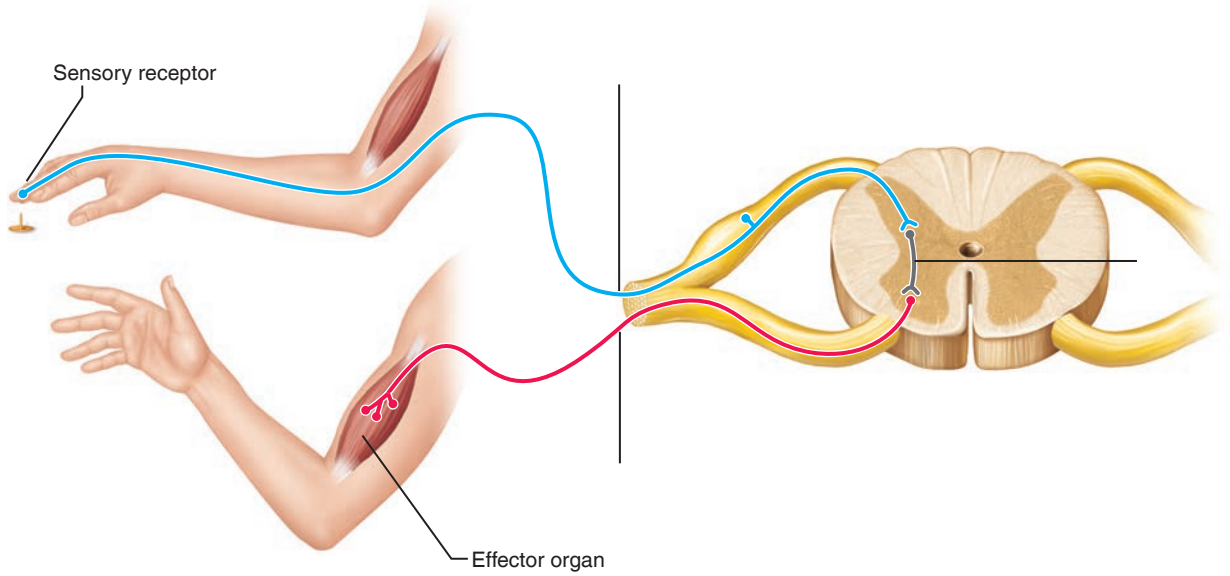
Make a simple line drawing of each type here.

Unipolar neuron	Bipolar neuron	Multipolar neuron

8. Correctly identify the sensory (afferent) neuron, interneuron, and motor (efferent) neuron in the figure below.

Which of these neuron types is/are unipolar? _____

Which is/are most likely multipolar? _____



9. Describe the anatomy of a synapse.

_____

_____

Structure of a Nerve

10. What is a nerve? _____

_____

11. State the location of each of the following connective tissue coverings.

endoneurium: _____

perineurium: _____

epineurium: _____

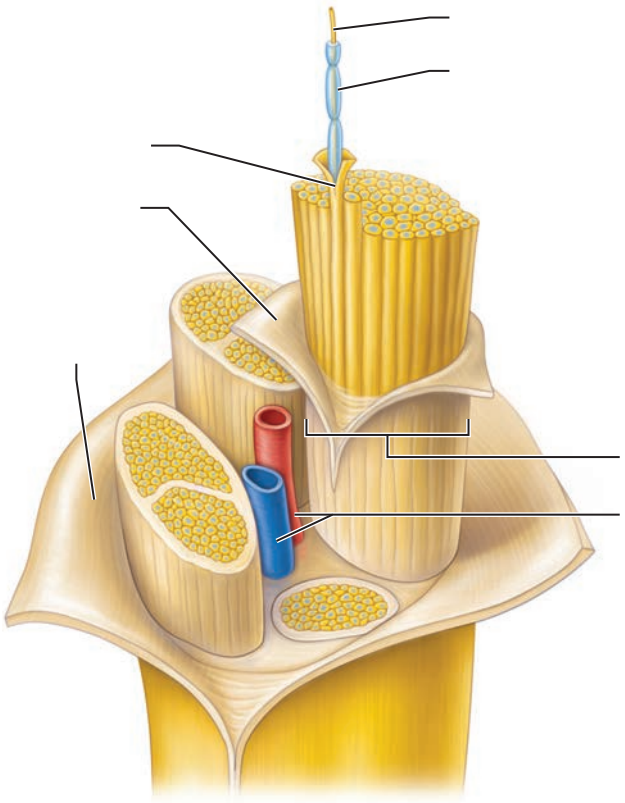
12. What forms a nerve fascicle? _____

_____

13. Define *mixed nerve*. _____

_____

14. Identify all indicated parts of the nerve section.



15. Multiple sclerosis is a condition in which the immune system attacks the myelin sheath. Based on your knowledge of the myelin sheath, what affect do you expect multiple sclerosis to have on nerve transmissions?

_____

16. Peripheral neuropathy has a variety of causes. Worldwide, the most common cause is leprosy, also known as Hansen's disease. Would you expect peripheral neuropathy to cause damage to tracts or to nerves? _____

Why? _____

EXERCISE 16 Neurophysiology of Nerve Impulses: Frog Subjects

Learning Outcomes

- Describe the resting membrane potential in neurons.
- Define *depolarization*, *repolarization*, *action potential*, and *relative refractory period* and *absolute refractory period*.
- Describe the events that lead to the generation and conduction of an action potential.
- Explain briefly how a nerve impulse is transmitted from one neuron to another, and how a neurotransmitter may be either excitatory or inhibitory to the recipient cell.
- Define *compound action potential*, and discuss how it differs from an action potential in a single neuron.
- Describe the preparation used to examine contraction of the frog gastrocnemius muscle.
- List various substances and factors that can stimulate neurons.

Pre-Lab Quiz

Instructors may assign these and other Pre-Lab Quiz questions using Mastering A&P™

1. Circle the correct underlined term. Excitability / Conductivity is the ability to transmit nerve impulses to other neurons.
2. When a neuron is stimulated, the membrane becomes more permeable to Na^+ ions, which diffuse into the cell and cause:
   a. depolarization
   b. hyperpolarization
   c. repolarization
3. As an action potential progresses, the permeability to Na^+ decreases, and the permeability to this ion increases:
   a. Ca^{2+} **b.** K^+ **c.** Na^+
4. The period of time when the neuron is totally insensitive to further stimulation and cannot generate another action potential is:
   a. absolute refractory period **c.** repolarization
   b. membrane potential **d.** threshold
5. What muscle and nerve will you need to isolate to study the physiology of nerve fibers?
   a. gastrocnemius and sciatic
   b. sartorius and femoral
   c. triceps brachii and radial

Neurons are **excitable**; they respond to stimuli by producing an electrical signal. Excited neurons communicate—they transmit electrical signals to neurons, muscles, and glands, a property called **conductivity**. In a resting neuron, the interior of the cell membrane is slightly more negatively charged than the cell exterior (Figure 16.1). The difference in electrical charge produces a **resting membrane potential** across the membrane that is measured in millivolts.

Go to Mastering A&P™ > Study Area to improve your performance in A&P Lab.

> Lab Tools > PhysioEx 10.0

Instructors may assign new Building Vocabulary coaching activities, Pre-Lab Quiz questions, Art Labeling activities, Practice Anatomy Lab Practical questions (PAL), PhysioEx activities, and more using the Mastering A&P™ Item Library.

Materials

- *Rana pipiens**
- Dissecting instruments and tray
- Disposable gloves
- Ringer's solution (frog) in dropper bottles at room temperature
- Thread
- Glass rods or probes
- Glass plates or slides
- Ring stand and clamp
- Stimulator; platinum electrodes
- Forceps
- Filter paper
- 0.01% hydrochloric acid (HCl) solution
- Sodium chloride (NaCl) crystals
- Heat-resistant mitts
- Bunsen burner
- Safety goggles

* Instructor to provide freshly pithed frogs (*Rana pipiens*) for student experimentation.

PEx PhysioEx™ 10.0 Computer Simulation Ex. 3 on p. PEx-35.

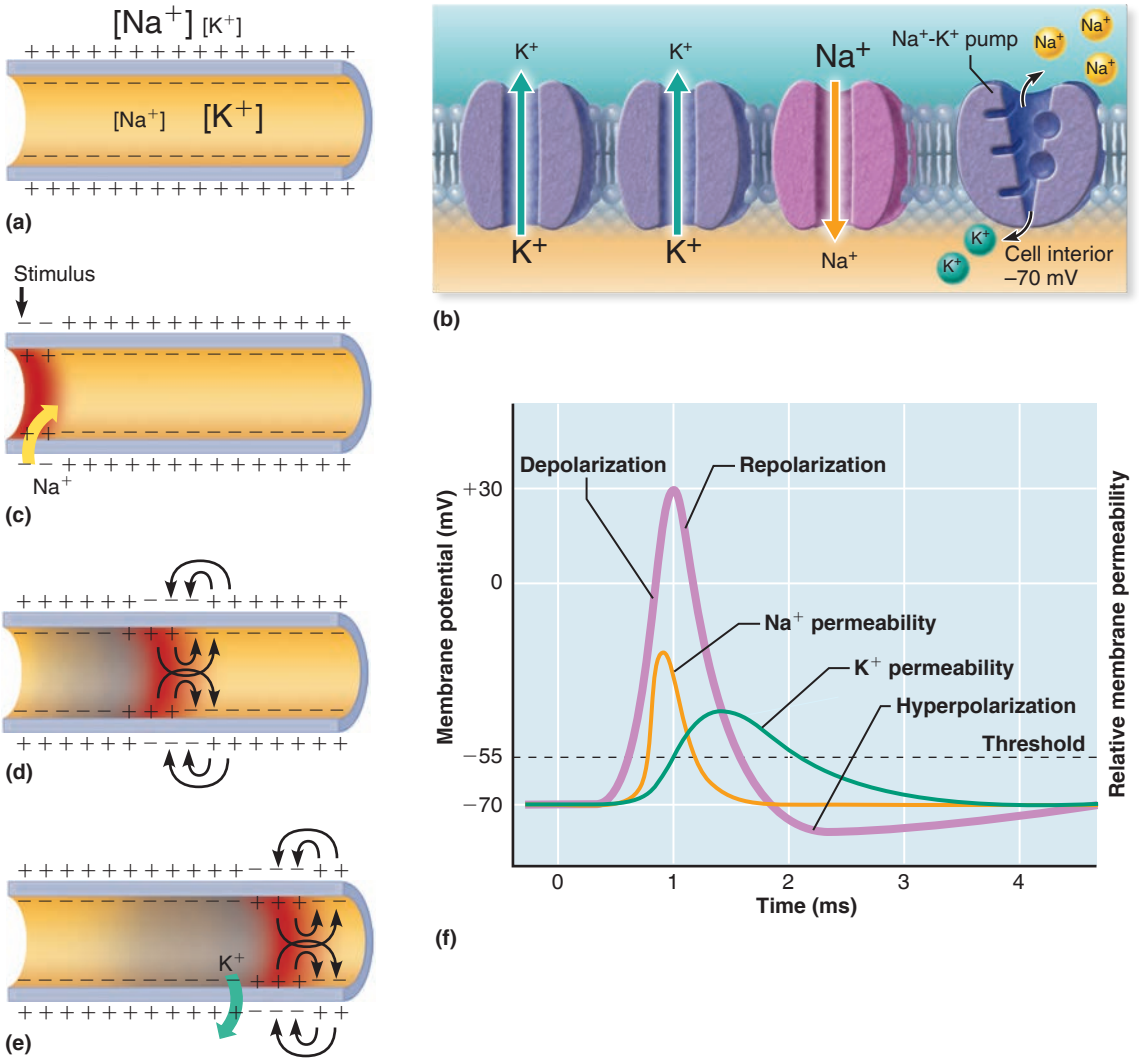


Figure 16.1 The action potential. **(a)** Resting membrane potential (RMP). There is an excess of positive ions at the external cell surface, with Na^+ the predominant extracellular fluid ion and K^+ the predominant intracellular ion. **(b)** Na^+ ions leak into the cell, and K^+ ions leak out. The RMP is maintained by the active sodium-potassium pump. **(c)** Depolarization—reversal of the RMP. Application of a stimulus changes the membrane permeability, and Na^+ ions are allowed to diffuse rapidly into the cell. **(d)** Generation of the action potential. If the stimulus reaches threshold, the depolarization wave spreads rapidly along the entire length of the membrane. **(e)** Repolarization—reestablishment of the RMP. The negative charge on the internal plasma membrane surface and the positive charge on its external surface are reestablished by diffusion of K^+ ions out of the cell, proceeding in the same direction as in depolarization. **(f)** The action potential is caused by permeability changes in the plasma membrane. The purple line shows the changes to the membrane potential over time. The yellow and green lines show the changes to the permeability of Na^+ and K^+, respectively, over time.

Instructors may assign this figure as an Art Labeling Activity using Mastering A&P™

As in most cells, the predominant intracellular cation is K^+; Na^+ is the predominant cation in the extracellular fluid. In a resting neuron, Na^+ leaks into the cell and K^+ leaks out. The resting membrane potential is maintained by the sodium-potassium pump, which transports Na^+ back out of the cell and K^+ back into the cell.

The Action Potential

When a neuron receives an excitatory stimulus, the membrane becomes more permeable to sodium ions, and Na^+ diffuses down its electrochemical gradient into the cell. As a result, the interior of the membrane becomes less negative (Figure 16.1c), an event called **depolarization**. If the stimulus is great enough to depolarize the the axon to **threshold**, an **action potential** is generated.

When the threshold voltage is reached, the membrane permeability to Na^+ increases rapidly (Figure 16.1f). As the neuron depolarizes, the polarity of the membrane reverses: the interior surface now becomes more positive than the exterior (Figure 16.1d). As the membrane permeability to Na^+ falls, the permeability to K^+ increases, and K^+ diffuses down its electrochemical gradient and out of the cell (Figure 16.1e). Once again the interior of the membrane becomes more negative than the exterior. This event is called **repolarization**. As you can see, the action potential is a brief reversal of the neuron's membrane potential.

The period of time when Na^+ permeability is rapidly changing and maximal, and the period immediately following when Na^+ permeability becomes restricted, together correspond to a time when the neuron is insensitive to further stimulation and cannot generate another action potential. This period is called the **absolute refractory period**. As Na^+ permeability is gradually restored to resting levels during repolarization, an especially strong stimulus to the neuron may provoke another action potential. This period of time is the **relative refractory period**. Restoration of the resting membrane potential restores the neuron's normal excitability.

Once generated, the action potential propagates along the entire length of the axon. It is never partially transmitted. Furthermore, it retains a constant amplitude and duration; the action potential is not small when a stimulus is small and large when a stimulus is large. Since the action potential of a given neuron is always the same, it is said to be an all-or-none response. When an action potential reaches the axon terminals, it usually causes neurotransmitter to be released. The neurotransmitter may be excitatory or inhibitory to the next cell in the transmission chain, depending on the receptor types on that cell.

Physiology of Nerves

The sciatic nerve is composed of a bundle of axons that vary in diameter. An electrical signal recorded from a nerve represents the summed electrical activity of all the axons in the nerve. This summed activity is called a **compound action potential**. Unlike an action potential in a single axon, the compound action potential varies in shape according to which axons are producing action potentials. When a nerve is stimulated by external electrodes, as in our experiments, the largest axons reach threshold first and generate action potentials. Higher-intensity stimuli are required to produce action potentials in smaller axons.

In this laboratory session, you will investigate the functioning of a nerve by subjecting the sciatic nerve of a frog to various types of stimuli.

DISSECTION

Isolating the Gastrocnemius Muscle and Sciatic Nerve

1. Don gloves and safety glasses. Obtain a pithed frog from your instructor, and bring it to your laboratory bench. Also obtain dissecting instruments, a tray, thread, two glass rods or probes, and frog Ringer's solution from the supply area.

2. Prepare the sciatic nerve as illustrated (Figure 16.2). Place the pithed frog on the dissecting tray, dorsal side down. Make a cut through the skin around the circumference of the frog approximately halfway down the trunk, and then pull the skin down over the muscles of the legs. Open the abdominal cavity, and push the abdominal organs to one side to expose the origin of the glistening white sciatic nerve, which arises from

Text continues on next page. →

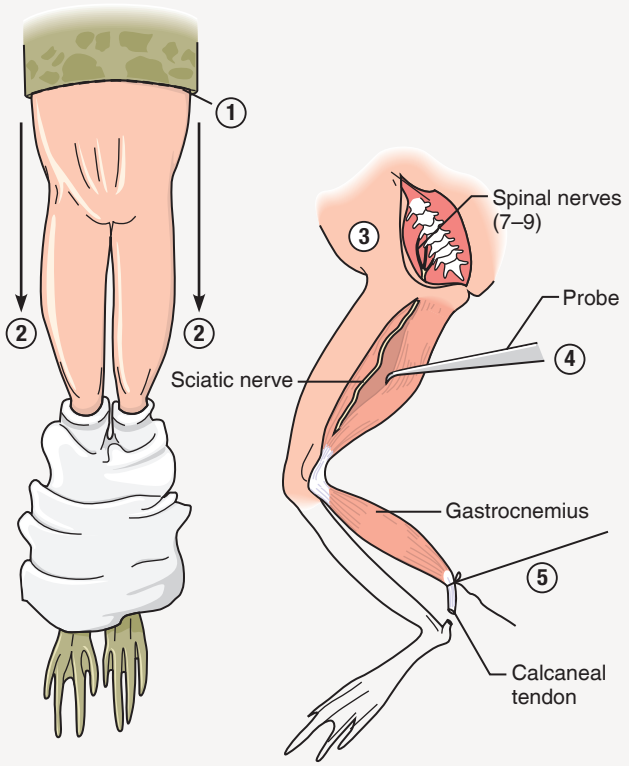


Figure 16.2 Removal of the sciatic nerve and gastrocnemius muscle. (1) Cut through the frog's skin around the circumference of the trunk. (2) Pull the skin down over the trunk and legs. (3) Make a longitudinal cut through the abdominal musculature, and expose the roots of the sciatic nerve (arising from spinal nerves 7–9). Ligate the nerve and cut the roots proximal to the ligature. (4) Use a glass probe to expose the sciatic nerve beneath the posterior thigh muscles. (5) Ligate the calcaneal tendon, and cut it free distal to the ligature. Release the gastrocnemius muscle from the connective tissue of the knee region.