Nerve Tissue

This exercise is the first of 11 that challenge you to investigate the human **nervous system.** Before going any further, it is best to lay a foundation by discussing the overall organization of this system.

The nervous system is composed of two major divisions: the **central nervous system (CNS)** and the **peripheral nervous system (PNS).** The CNS includes the brain and spinal cord; the PNS includes all the **nerves** that conduct impulses to and from the CNS. Often the nervous system is instead subdivided into the **afferent division** and the **efferent division.** The afferent division includes nerves and tracts leading *toward* the CNS—the *sensory nerves* and *sensory tracts.* The efferent division includes nerves and tracts leading *away from* the CNS—the *motor nerves* and *motor tracts.* The efferent division can be further subdivided into the **somatic motor nervous system (SMNS)** and the **autonomic nervous system (ANS).** Although both efferent divisions carry nerve signals away from the brain and spinal cord, they differ in their final destination. Somatic motor nerves end at skeletal muscles, whereas autonomic nerves innervate cardiac muscle, smooth muscle, and glands. (The ANS also includes sensory pathways that provide feedback information about autonomic receptors.)

This exercise is an investigation of the cells of the nervous system. Exercise 22 will continue the study of the organization of the nervous system with an exploration of concepts of the *reflex arc.*

Before you begin

❑ Read the appropriate chapter in your textbook and Exercise 9 in this Lab Manual.

❑ Set your learning goals. When you finish this exercise, you should be able to:
- ❑ describe the structural components of a typical neuron and identify them on a model or chart
- ❑ name the three structural categories of neurons and identify their principal locations
- ❑ identify specimens of *multipolar* and *bipolar* neurons
- ❑ identify a figure illustrating *unipolar* neurons
- ❑ name the major categories of neuroglia and identify their principal locations
- ❑ identify specimens of figures illustrating neuroglia
- ❑ describe the structure of a typical peripheral nerve

❑ Prepare your materials:
- ❑ models or charts:
  multipolar neuron
  unipolar neuron
  nerve c.s.
- ❑ microscope
- ❑ prepared microslides:*
  spinal cord smear (multipolar neurons)
  retina c.s. (bipolar neurons)
  peripheral nerve (myelinated) c.s.
  spinal cord c.s.

❑ Read the directions and safety tips for this exercise *carefully* before starting any procedure.

SAFETY FIRST!
Observe the usual safety precautions when using the microscope.

A. The neuron

As you already know from your study of nervous tissue histology (Exercise 9), the **neuron** (Figure 21-1) is the cell type that conducts impulses, or **action potentials.** The **neuroglia,** on the other hand, support the neurons in any number of ways. Neurons can be *unipolar,* having a single projection from the cell body; *bipolar,* having two projections from the cell body; or *multipolar,* having many projections (see Activity B). In this activity, you will find as many of the listed neuron structures as possible on a multipolar neuron model (or chart) and in a slide of multipolar neurons (spinal cord smear).

❑ 1 Locate the cell body, or **soma.** It is an enlarged area filled with cytoplasm and containing the nucleus and organelles called **Nissl bodies.**

❑ 2 The soma forms a cone-shaped projection, or **axon hillock,** as it projects to become the **axon.** The axon is one of two types of neuron projections (fibers). The axon usually conducts action potentials away from the cell body.

❑ 3 The axon may be wrapped with a series of neuroglial cells called **Schwann cells.** Schwann cells wrap like tape around the axons of some peripheral nerves, each spiraling around a fiber to form a multilayered coating. The inner layers of the Schwann cell are filled with the fatty white substance called **myelin.** Because the Schwann cells are found in series, they form a segmented *sheath of Schwann,* or **myelin sheath.** The gaps between the Schwann cells are termed **nodes of Ranvier.** The outer wrapping of each Schwann cell is normal cytoplasm, with organelles and a nucleus. In the case described, the axon is called a **white fiber,** or **myelinated fiber.** A group of white fibers together is called **white matter.** Schwann cells occur only in the PNS. Within the CNS, myelinated axons are wrapped with extensions of **oligodendrocytes,** another type of neuroglial cell.

❑ 4 Schwann cells or oligodendrocytes are also associated with **unmyelinated axons,** which together with cell bodies and dendrites form **gray matter.** However, in this case, the neuroglia do not form multiple wrappings and are not partially filled with myelin.

❑ 5 **Collateral axons,** or axon branches, can be observed in some cells. Also, the distal ends of axons are often branched. These smaller, distal branches are termed **telodendria.**

❑ 6 Multipolar neurons have many projections from the soma called **dendrites.** Dendrites are branched extensions that are sensitive to stimuli from other cells. Other neurons form an association, or **synapse,** at a bump on the dendrite or cell body (soma). Stimulation of a dendrite or the cell body results in a local change in potential.

B. Structural classification of neurons

There are three categories of neurons based on their shapes (Figure 21-2):

❑ 1 **Multipolar neurons**—Multipolar neurons have multiple projections from the cell *body.* Multipolar neurons comprise most of the neurons in the CNS. Almost all motor neurons are multipolar. Examine a multipolar neuron in a prepared spinal cord smear. Note the many projections (see LABORATORY REFERENCE, Plate 28).

❑ 2 **Bipolar neurons**—Bipolar neurons have exactly two projections from the cell body. Normally, one process conducts impulses toward the cell body. Such a process is called the *dendrite.* The other process conducts impulses away from the cell body and is called the *axon.* Bipolar neurons are most commonly found in the sensory tracts of the eye (for vision) and nasal epithelium (for smell). Examine a prepared slide of the retina (the sensitive lining of the eyeball). Can you distinguish any bipolar cells? A color micrograph of a retina cross section is shown in LABORATORY REFERENCE, Plate 50.

❑ 2 **Unipolar neurons**—Unipolar neurons, also called **pseudounipolar neurons,** have one extension from the cell body; however, the single process splits near the body to become two long branches. One branch has dendrite-like endings that receive stimulation for an impulse. The remainder of that branch and all of the other branches then conduct the impulse along. The two branches together function as a single axon. Most sensory neurons are unipolar. Examine a figure or model of a unipolar neuron.

C. Types of glia

Neuroglia, or simply **glia,** are the most numerous kinds of cells in nerve tissue. The conducting cells are called **neurons.** Glia are often associated with particular neurons and support the structure or function of the neurons. A brief exploration of glia in the human nervous system is outlined in this activity.

❑ 1 **Astrocytes**—Astrocytes look like tiny stars in many preparations. They have a cell body with many elongated projections. Astrocyte projections have broad "feet" that cover blood vessels in the brain. Together with the vessel wall itself, the layer formed by the astrocyte feet forms the **blood-brain barrier.** Substances that pass in and out of the blood vessel wall must also move across the wall formed by astrocyte projections. Locate astrocytes in Figure 21-3.

❑ 2 **Microglia**—Microglia are small glial cells that develop from different tissue than other nervous tissue cells. Because of their location, they are considered along with other glial cells. Microglia are able to move to sites of damage or infection to phagocytize harmful substances. Locate microglia in Figure 21-3.

❑ 3 **Oligodendrocytes**—Like astrocytes, oligodendrocytes have many processes. Oligodendrocyte processes form a layer over axons in the CNS. This layer, called a **myelin sheath,** affects the speed of conduction in an axon. Locate oligodendrocytes in Figure 21-3.

❑ 4 **Schwann cells**—Schwann cells form myelin sheaths around axons in the PNS. Each Schwann cell wraps entirely around a single axon, rather than projecting extensions to several axons. Locate Schwann cells in Figure 21-3. Examine a prepared slide of a peripheral nerve cross section. Locate the myelin that surrounds each nerve fiber. Figure 21-4 shows a cross section of a peripheral nerve with the myelin surrounding each nerve fiber clearly visible.

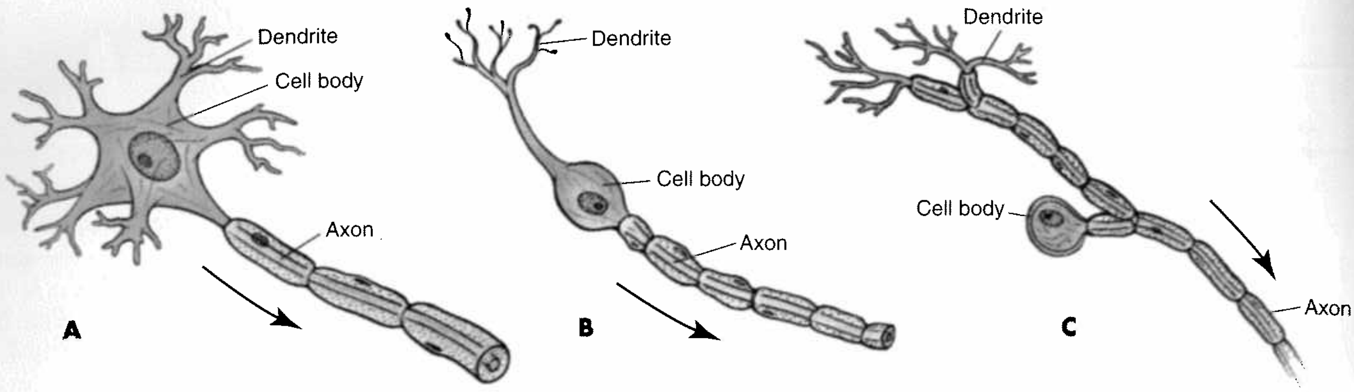


Figure 21-2 Structural classification of neurons. **A,** Multipolar neuron. **B,** Bipolar neuron. **C,** Unipolar (pseudounipolar) neuron.

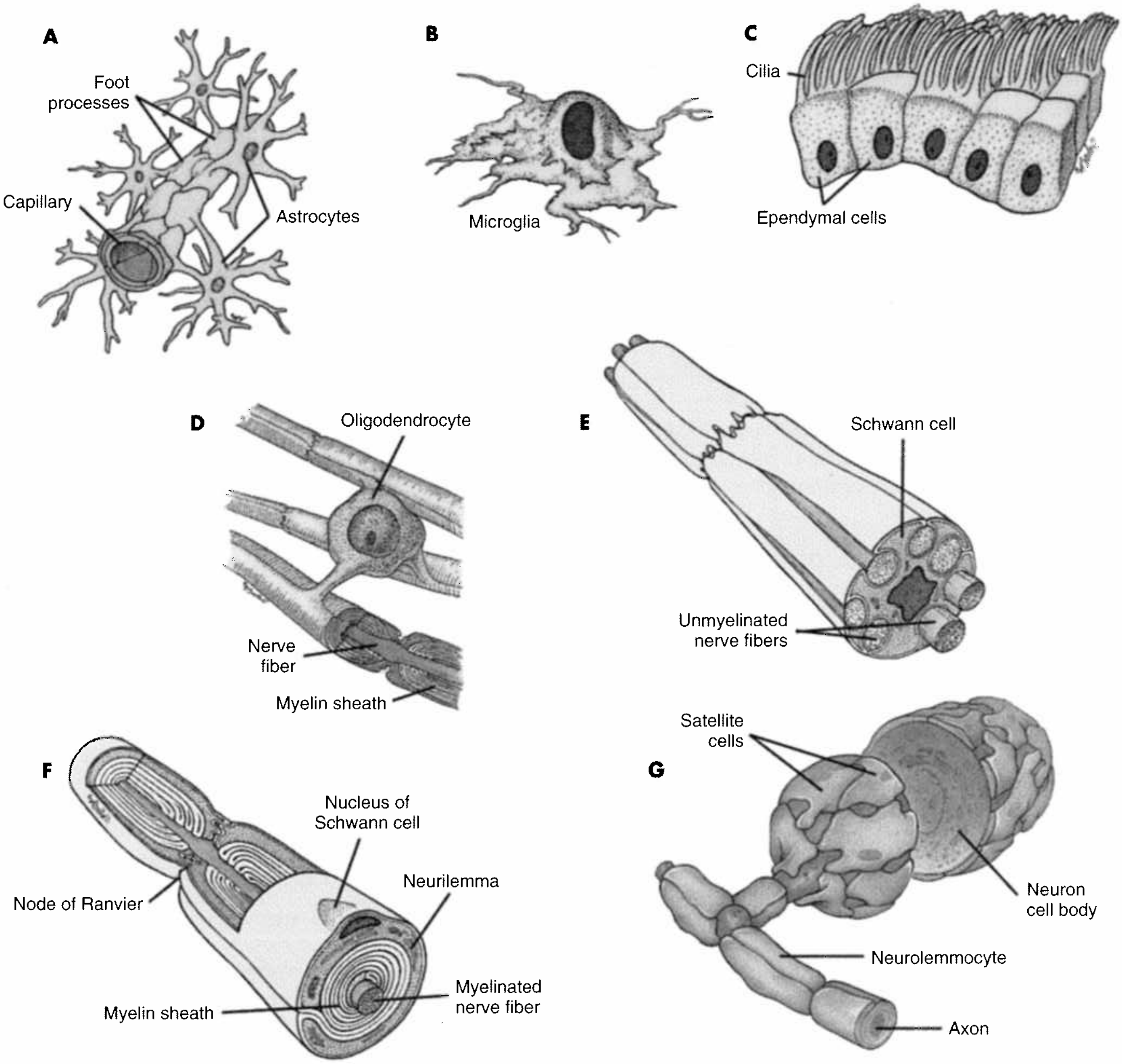


Figure 21-3 Types of glia. **A,** Astrocytes attached to the outside of a capillary blood vessel in the brain. **B,** A phagocytic microglial cell. **C,** Ciliated ependymal cells form a sheet of the type that usually lines fluid cavities in the brain. **D,** An oligodendrocyte with processes that wrap around nerve fibers in the CNS to form myelin sheaths. **E,** A Schwann cell supporting a bundle of nerve fibers in the PNS. **F,** Another type of Schwann cell wrapping around a peripheral nerve fiber to form a thick myelin sheath. **G,** Satellite cells, another type of Schwann cell, surround and support cell bodies of neurons in the PNS.

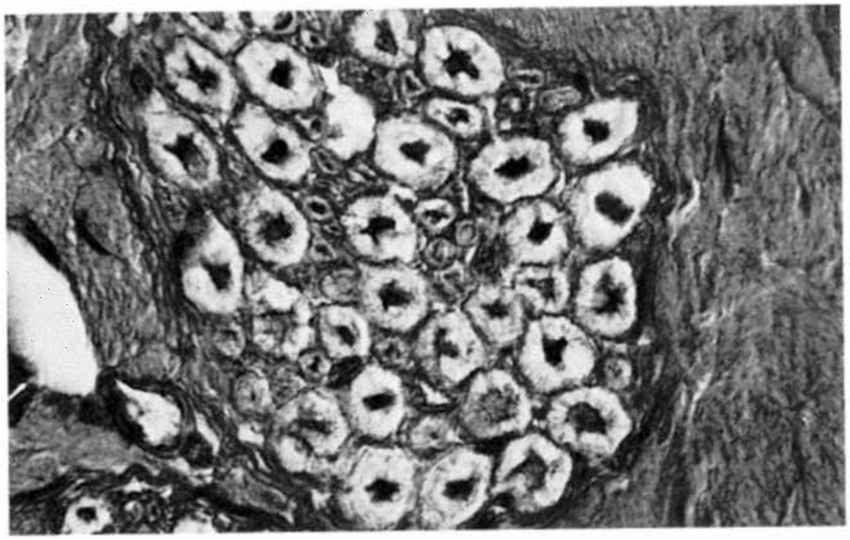


Figure 21-4 Peripheral nerve cross section. Myelin appears light gray in this micrograph (250×).

- [ ] 5 **Ependymal cells**—Ependymal cells are found lining the fluid spaces of the brain and spinal cord. Some form *cerebrospinal fluid (CSF)* and some are ciliated and assist the movement of CSF through the fluid spaces. Locate ependymal cells in Figure 21-3. Examine a prepared slide of a spinal cord cross section. Locate small ciliated ependymal cells that form the lining of the central canal. LABORATORY REFERENCE, Plate 58 shows such a cross section, but at too low a magnification to see ependymal cells clearly.

D. Nerve structure

The **nerve** is a bundle of axons that lies in the PNS. The coloring exercise in Figure 21-5 and the steps outlined in the following describe the essential structure of the peripheral nerve. Locate these features in a model, diagram, and/or a prepared microslide of a peripheral nerve cross section (see Figure 21-4).

- [ ] 1 **Epineurium**—The epineurium is a fibrous membrane that forms a sheath around the entire bundle c structures that make up the nerve.
- [ ] 2 **Perineurium**—The perineurium is a fibrous structur that is essentially an inward continuation of the epineurium. Acting as a sort of "inner wrapping" or "packing material," the perineurium segregates the nerve fibers (axons) within the nerve into groupings called **fascicles.**
- [ ] 3 **Endoneurium**—Just as the perineurium is an inwar extension of the epineurium, the endoneurium is an inward extension of the perineurium. The endoneurium is a fibrous membrane that covers each individ ual axon (and its sheath of Schwann) within each fascicle.

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.

The Multipolar Neuron

SOMA 1
- NUCLEUS 2
- NUCLEOLUS 3
- MITOCHONDRION 4
- GOLGI APPARATUS 5
- NISSL BODIES 6
- AXON HILLOCK 7

DENDRITE 8

AXON 9

SCHWANN CELLS 10

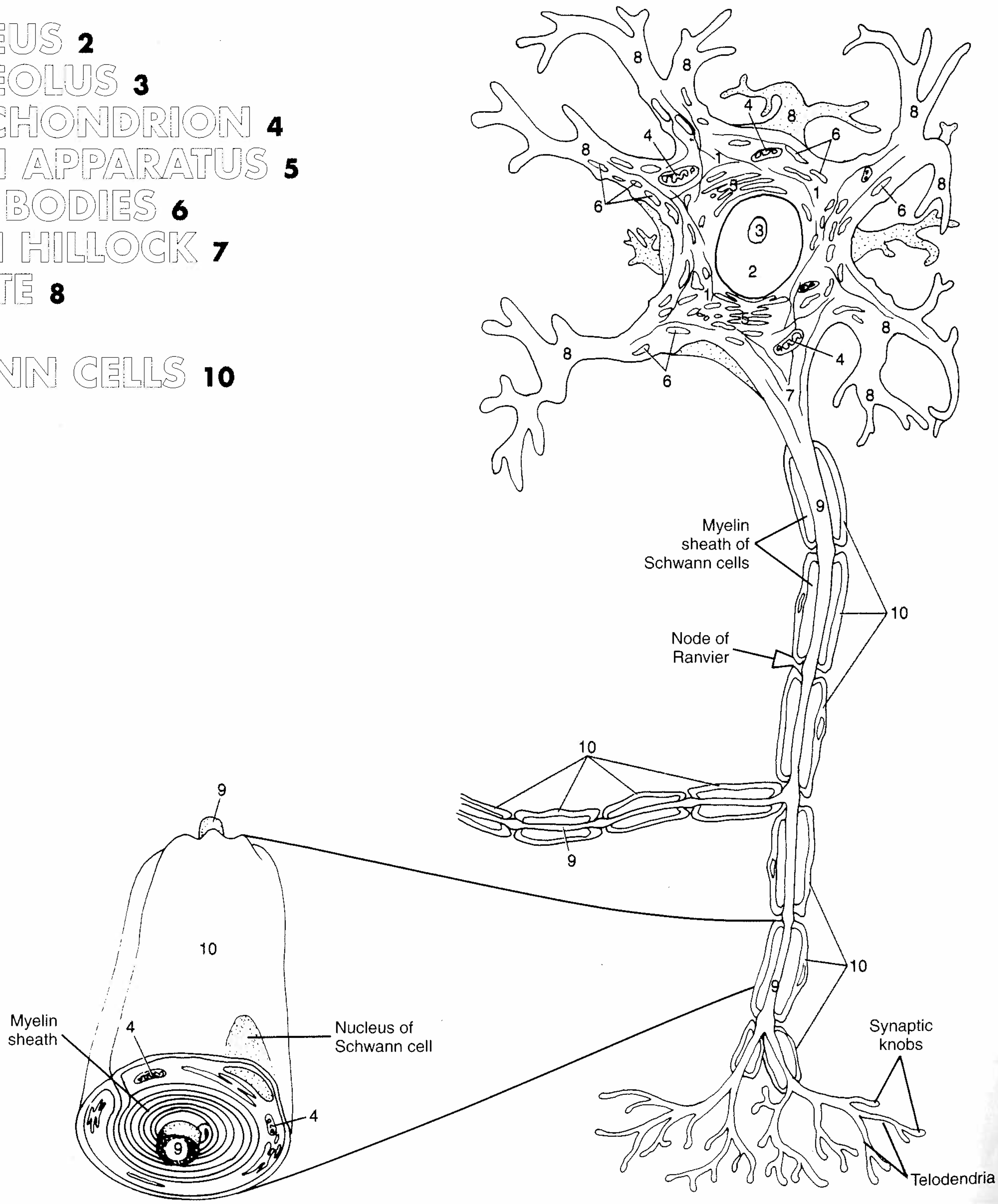


Figure 21-1 Structure of a typical neuron.

Name: ______________________ Date: __________ Section: ________

LAB REPORT 21

Nerve Tissue

Fill in this table summarizing your examination of a multipolar neuron model. Check off each structure as it is identified. For functions, refer to a reference book or your textbook.

Identification	Structure	Function(s)
❑	soma	
❑	Nissl bodies	
❑	axon hillock	
❑	axon	
❑	Schwann cells	
❑	nodes of Ranvier	
❑	collateral axon	
❑	telodendria	
❑	dendrite	

Specimen: *multipolar neurons*

Total Magnification: ______

Specimen: *bipolar neurons*

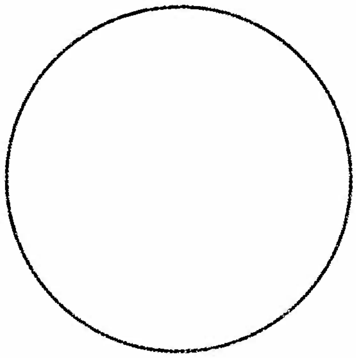
Total Magnification: ______

Specimen: *unipolar neurons*

Total Magnification: ______

Specimen: *Schwann cells*

Total Magnification: ______



Specimen: *Schwann cells*

Total Magnification: ______

Fill-in

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________
6. ______________________________
7. ______________________________
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16. ______________________________
17. ______________________________
18. ______________________________
19. ______________________________
20. ______________________________

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

1. The soma forms a cone-shaped __?__ as it projects to form an axon.
2. __?__ are small, distal branches of an axon.
3. Either Schwann cells or extensions of __?__ can form myelin sheaths.
4. The gaps between segments of a myelin sheath are called __?__.
5. A group of myelinated fibers may form a region of nerve tissue called __?__ matter.
6. The __?__ neuron connects an afferent neuron to an efferent neuron.
7. A junction between two neurons, or between a neuron and effector, is called a(n) __?__.
8. A bundle of parallel neurons encased in fibrous connective tissue is called a(n __?__ (in the PNS).
9. A bundle of parallel neurons in the CNS is called a(n) __?__.
10. An action potential traveling down a myelinated axon travels __?__ (faster/slower) than in an unmyelinated axon.
11. Unmyelinated nerve tissue is called __?__ matter.
12. __?__ neurons have exactly two projections from the cell body.
13. __?__ neurons have multiple dendrites and a single axon extending from the cell body.
14. In __?__ neurons, a single process from the cell body diverges to form two lon branches—one acting as a dendrite, the other as an axon.
15. Schwann cells form myelin sheaths in the __?__ nervous system.
16. Oligodendrocytes form myelin sheaths in the __?__ nervous system.
17. Neuroglial cells called __?__ cells line the fluid spaces of the brain.
18. Small glial cells that phagocytize harmful matter are called __?__ .
19. __?__ are ciliated neuroglia that assist the circulation of CSF.
20. Of the two major types of cell in nerve tissue __?__ is the most numerous.