One of the most prominent characteristics of nervous tissue is the great flexibility with which it responds to various stimuli. This unique feature of the nervous system can easily be appreciated in light of its histology. Basically, the nervous system is built up of billions of neurons that are connected to each other by means of processes—dendrites and axons—of variable length and arrangement. The nervous tissue thus forms a complicated network of pathways and neuronal circuits for the transmission chemoelectric impulses.

Although knowledge of the pathways in the brain and spinal cord cannot in itself explain how the nervous system works, the mapping of the central nervous connections is a prerequisite for such understanding. The study of neuronal connections and synaptic relationships, therefore, is one of the most active areas of research in the nervous system, and the modern neuroscientist is fortunate enough to have a large number of sophisticated light and electron microscopic techniques available.
Although basic information about the gross anatomic features of the brain and the spinal cord has accumulated through centuries of observation, it was not until the light microscope was refined in the 19th century that a successful study of the histologic structure of the nervous system was begun. At this same time, techniques for the preparation and staining of histologic sections were developed that made it possible to visualize the different components of the nervous tissue and to study the distribution of neurons and the relationships between their processes.

Another great step forward in defining the structure of the nervous system occurred in the mid-20th century with the introduction of the electron microscope. In contrast with the light microscope, which shows only a few components of nervous tissue, the electron microscope displays, with a high degree of magnification and resolution, all the different structures present in a section.

**The Neuron**

In spite of great variability in size and configuration, all neurons have in common certain morphologic features, which reflect the fact that nervous tissue functions as a communication system. To provide for efficient communication, the neurons have processes, dendrites and axons. The dendrites and axons usually receive input from specialized terminals of axons. The axon, of which there is one per neuron, is specialized to conduct nerve impulses (Fig. 2, Chapter 1). Transmission of the signal from one neuron to another neuron, or to an effector organ (muscle or gland), occurs at specialized contact regions called synapses.

**Cell Body**

The cell body consists of a large nucleus and the surrounding cytoplasm, the perikaryon. It is the trophic center of the neuron and the function and survival of the axon and dendrites are dependent on the integrity of the cell body.

The classic light microscopic method for the study of the cell body is the Nissl method, which relies on the use of basic dyes such as cresyl violet. Besides showing the form of the cell body, the Nissl method selectively stains the nucleus and one of the most characteristic cell components of the neuron, the Nissl bodies (Fig. 80). The Nissl bodies are basophilic and in the light microscope appear as dust-like material or as small or large granules. The Nissl substance is present in the cell body and the proximal dendrites, but it is conspicuously absent from the axon as well as from the axon hillock, which is the pale, conical shaped region from which the axon extends. Electron microscopic studies show that the Nissl substance (Fig. 80A) consists of concentrations of granular or rough endoplasmic reticulum (RER) and free polyribosomes (Fig. 80B). The ribosomes are important organelles for the synthesis of proteins, which are in great demand for the maintenance of the elaborate neuronal processes. In neurons, some of the cisterns of the endoplasmic reticulum have an unusually narrow lumen and are closely opposed to the plasma membrane (subsurface cisterns).

The appearance of the Nissl substance is one of the most valuable features for the identification and evaluation of neurons in both normal and pathologic materials because the Nissl patterns vary between different types of neurons. Motor neurons, for instance, have large Nissl bodies (Fig. 80A), whereas sensory neurons have smaller ones (Fig. 80C), and small neurons often contain dust-like Nissl substance. The appearance of the Nissl substance also varies with the activity of the cell. The Nissl bodies gradually diminish in neurons subjected to functional stress, and they disintegrate when the axon is injured or sectioned. The latter phenomenon, known as chromatolysis, is often part of a general cell change in response to axonal injury. Besides chromatolysis, such retrograde cell reaction generally includes swelling of the cell and displacement of its nucleus to the periphery of the perikaryon (Fig. 80D).

Neurons impregnated with one of the classic silver methods, e.g., the Bielschowsky method, display another characteristic structure, the neurofibril. The neurofibrils apparently represent bundles of 10-nm thick neurofilaments and microtubules on which silver has been deposited. Neurofibrils are usually seen in the perikaryon between the Nissl bodies and in the large dendrites and axons.

In addition to Nissl substance, neurofilaments, and microtubules, the nerve cell body contains other organelles that are commonly found in cells, e.g., Golgi apparatus, mitochondria, and various inclusions (Figs. 81A and B). The electron micrograph reveals that the chromatin-rich nucleus,