Collectively, the full system of structures and organs composed of neural tissue. Depending on the focus, various schemes exist for dividing up the nervous system. The most common anatomical division is into the central nervous system (brain and spinal cord) and the peripheral nervous system (the rest). Other taxonomies focus on function and the division into the somatic nervous system and autonomic nervous system, with the former subserving voluntary, conscious sensory and motor functions and the latter the visceral, automatic and nonvolitional.

Anatomy and Function

In vertebrates the system has two main divisions, the central and the peripheral nervous systems. The central nervous system consists of the brain and spinal cord. Linked to these are the cranial, spinal, and autonomic nerves, which, with their branches, constitute the peripheral nervous system. The brain might be compared to a computer and its memory banks, the spinal cord to the conducting cable for the computer's input and output, and the nerves to a circuit supplying input information to the cable and transmitting the output to muscles and organs.

The nervous system is built up of nerve cells, called neurons, which are supported and protected by other cells. Of the 200 billion or so neurons making up the human nervous system, approximately half are found in the brain. From the cell body of a typical neuron extend one or more outgrowths (dendrites), threadlike structures that divide and subdivide into ever smaller branches. Another, usually longer structure called the axon also stretches from the cell body. It sometimes branches along its length but always branches at its microscopic tip. When the cell body of a neuron is chemically stimulated, it generates an impulse that passes from the axon of one neuron to the dendrite of another; the junction between axon and dendrite is called a synapse. Such impulses carry information throughout the nervous system. Electrical impulses may pass directly from axon to axon, from axon to dendrite, or from dendrite to dendrite.

So-called white matter in the central nervous system consists primarily of axons coated with light-colored myelin produced by certain neuroglial cells. Nerve cell bodies that are not coated with white matter are known as gray matter. Nonmyelinated axons that are outside the central nervous system are enclosed only in a tubelike neurilemma sheath composed of Schwann cells, which are necessary for nerve regeneration. There are regular intervals along peripheral axons where the myelin sheath is interrupted. These areas, called nodes of Ranvier, are the points between which nerve impulses, in
myelinated fibers, jump, rather than pass, continuously along the fiber (as is the case in unmyelinated fibers). Transmission of impulses is faster in myelinated nerves, varying from about 3 to 300 ft (1–91 m) per sec.

Both myelinated and unmyelinated dendrites and axons are termed nerve fibers; a nerve is a bundle of nerve fibers; a cluster of nerve cell bodies (neurons) on a peripheral nerve is called a ganglion. Neurons are located either in the brain, in the spinal cord, or in peripheral ganglia. Grouped and interconnected ganglia form a plexus, or nerve center. Sensory (afferent) nerve fibers deliver impulses from receptor terminals in the skin and organs to the central nervous system via the peripheral nervous system. Motor (efferent) fibers carry impulses from the central nervous system to effector terminals in muscles and glands via the peripheral system.

The peripheral system has 12 pairs of cranial nerves: olfactory, optic, oculomotor, trochlear, trigeminal, abducent, facial, vestibulo-cochlear (formerly known as acoustic), glossopharyngeal, vagus, spinal accessory, and hypoglossal. These have their origin in the brain and primarily control the activities of structures in the head and neck. The spinal nerves arise in the spinal cord, 31 pairs radiating to either side of the body: 8 cervical, 12 thoracic, 5 lumbar, 5 sacral, and 1 coccygeal.

**Autonomic Nervous System**

The autonomic nerve fibers form a subsidiary system that regulates the iris of the eye and the smooth-muscle action of the heart, blood vessels, glands, lungs, stomach, colon, bladder, and other visceral organs not subject to willful control. Although the autonomic nervous system's impulses originate in the central nervous system, it performs the most basic human functions more or less automatically, without conscious intervention of higher brain centers. Because it is linked to those centers, however, the autonomic system is influenced by the emotions; for example, anger can increase the rate of heartbeat. All of the fibers of the autonomic nervous system are motor channels, and their impulses arise from the nerve tissue itself, so that the organs they innervate perform more or less involuntarily and do not require stimulation to function.

Autonomic nerve fibers exit from the central nervous system as part of other peripheral nerves but branch from them to form two more subsystems: the sympathetic and parasympathetic nervous systems, the actions of which usually oppose each other. For example, sympathetic nerves cause arteries to contract while parasympathetic nerves cause them to dilate. Sympathetic impulses are conducted to the organs by two or more neurons. The cell body of the first lies within the central nervous system and that of the second in an external ganglion. Eighteen pairs of such ganglia interconnect by nerve fibers to form a double chain just outside the spine and running parallel to it. Parasympathetic impulses are also relayed by at least two neurons, but the cell body of the second generally lies near or within the target organ.

**The Nervous System and Reflexes**

In general, nerve function is dependent on both sensory and motor fibers, sensory stimulation evoking motor response. Even the autonomic system is activated by sensory impulses from receptors in the organ or muscle. Where especially sensitive areas or powerful stimuli are concerned, it is not always necessary for a sensory impulse to reach the brain in order to trigger motor response. A sensory neuron may link directly to a motor neuron at a synapse in the spinal cord, forming a reflex arc that performs automatically. Thus, tapping the tendon below the kneecap causes the leg to jerk involuntarily because the impulse provoked by the tap, after traveling to the spinal cord, travels directly back to the
leg muscle. Such a response is called an involuntary reflex action.

Commonly, the reflex arc includes one or more connector neurons that exert a modulating effect, allowing varying degrees of response, e.g., according to whether the stimulation is strong, weak, or prolonged. Reflex arcs are often linked with other arcs by nerve fibers in the spinal cord. Consequently, a number of reflex muscle responses may be triggered simultaneously, as when a person shudders and jerks away from the touch of an insect. Links between the reflex arcs and higher centers enable the brain to identify a sensory stimulus, such as pain; to note the reflex response, such as withdrawal; and to inhibit that response, as when the arm is held steady against the prick of a hypodermic needle.

Reflex patterns are inherited rather than learned, having evolved as involuntary survival mechanisms. But voluntary actions initiated in the brain may become reflex actions through continued association of a particular stimulus with a certain result. In such cases, an alteration of impulse routes occurs that permits responses without mediation by higher nerve centers. Such responses are called conditioned reflexes, the most famous example being one of the experiments Ivan Pavlov performed with dogs. After the dogs had learned to associate the provision of food with the sound of a bell, they salivated at the sound of the bell even when food was not offered. Habit formation and much of learning are dependent on conditioned reflexes. To illustrate, the brain of a student typist must coordinate sensory impulses from both the eyes and the muscles in order to direct the fingers to particular keys. After enough repetition the fingers automatically find and strike the proper keys even if the eyes are closed. The student has “learned” to type; that is, typing has become a conditioned reflex.

Disorders of the Nervous System

A number of diseases can significantly affect the proper functioning of the nervous system. Parkinson's disease, Huntington's disease, myasthenia gravis, and amyotrophic lateral sclerosis (commonly known as Lou Gehrig's disease) are some of the more severe diseases affecting the nervous system. Strokes, which are related to circulatory disorders, also may have permanent effects on the nervous system. Certain plant derivatives, such as belladonna, cocaine, and caffeine, have a variety of stimulatory, inhibitory, and hallucinatory effects on the nervous system.

Bibliography

See Ottoson, D., Physiology of the Nervous System (1982);
G. Chapouthier; J. J. Matras, The Nervous System and How It Functions (1986);
Kee, L. S., Introduction to the Human Nervous System (1987);
Nathan, P., The Nervous System (3d ed. 1988);

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