The nervous system

The nervous system is organized into the **central nervous system (CNS)**, consisting of the brain and spinal cord, and the **peripheral nervous system (PNS)**, consisting of nerve fibers that carry information between the CNS and the other parts of the body. The PNS is further subdivided into afferent and efferent divisions. The **afferent division** carries information to the CNS, apprising it of the external environment and providing status reports on internal activities being regulated by the nervous system. Instructions *from* the CNS are transmitted via the **efferent division** to **effector organs**—the muscles or glands that carry out the orders to bring about the desired effect.

The efferent nervous system is divided into the **somatic nervous system**, which consists of the fibers of the motor neurons that supply the skeletal muscles; and the **autonomic nervous system**, which consists of fibers that innervate smooth muscle, cardiac muscle, and glands. The latter system is further subdivided into the **sympathetic nervous system** and the **parasympathetic nervous system**, both of which innervate most of the organs supplied by the autonomic system.

In addition to the CNS and PNS, the **enteric nervous system** is an extensive nerve network in the wall of the digestive tract.

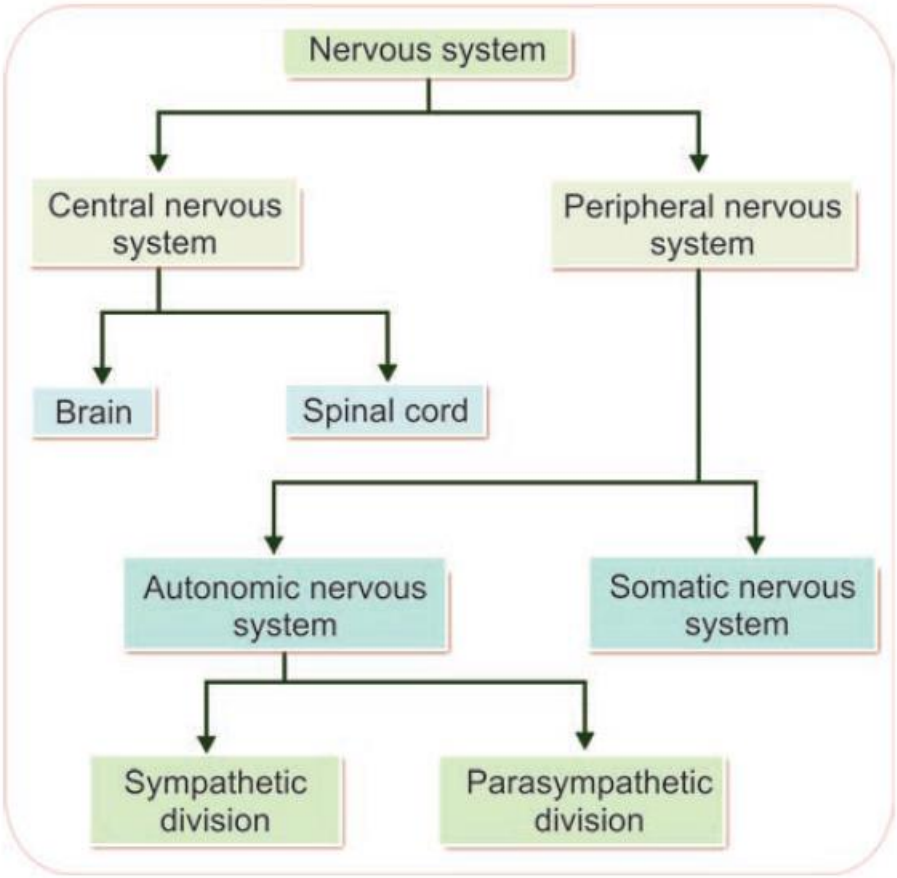


FIGURE 133.3: Organization of nervous system

Cells of the Nervous System

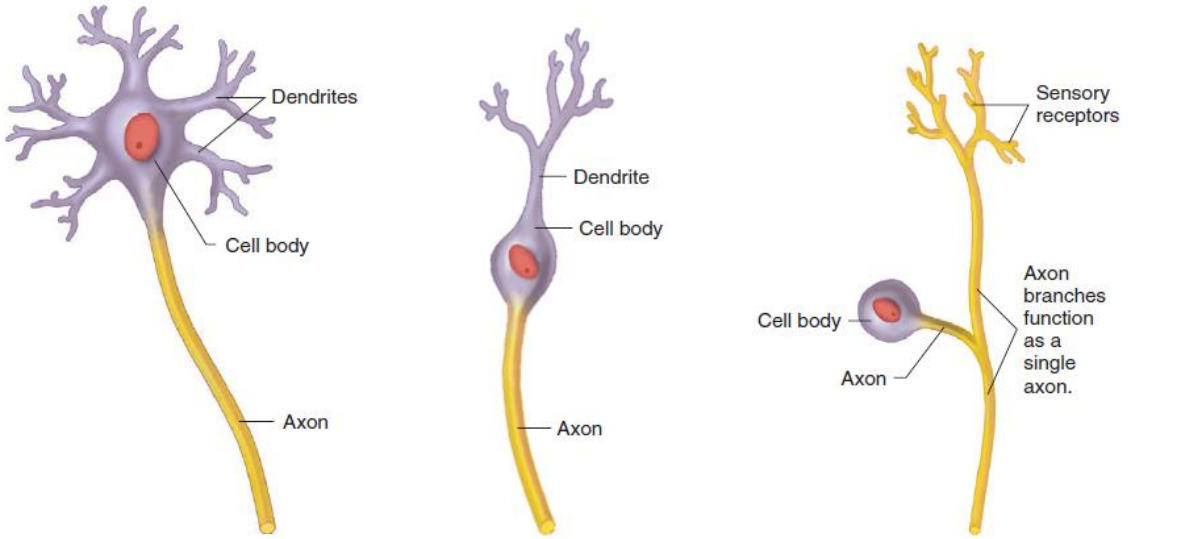
The two types of cells that make up the nervous system are neurons and supportive cells . Neurons receive stimuli, conduct action potentials, and transmit signals to other neurons or effector organs. These supportive cells are called **neuroglia**, or *glial cells*, and they support and protect neurons and perform other functions. Neuroglia account for over half of the brain's weight, and there can be 10 to 50 times more neuroglia than neurons in various parts of the brain.

Neuron Structure

Neurons, or *nerve cells*, There are three parts to a neuron: a cell body and two types of cellular projections. The cell body is called the **neuron cell body**; as with any other type of cell, the cell body's nucleus is the source of information for protein synthesis.

One type of cellular projection is called a **dendrite**, are short, often highly branched cytoplasmic extensions that are receive input from other neurons' axons and from the environment. When stimulated, they generate small electric currents, which are conducted to the neuron cell body.

The other type of cellular projection is called the **axon** , referring to the straight alignment and uniform diameter of most axons. Axons are also called *nerve fibers*. In most neurons, a single axon arises from a cone-shaped area of the neuron cell body called the **axon hillock.** An axon can remain as a single Structure , but axons can vary in length from a few millimeters to more than 1 meter. Axons terminate by branching to form small extensions with enlarged ends called **presynaptic terminals.** Within the presynaptic terminals are numerous small, membrane-bound secretory vesicles that contain chemicals called **neurotransmitters.**



(a) A **multipolar neuron** has many dendrites and an axon.

(b) A **bipolar neuron** has a dendrite and an axon.

(c) A **pseudo-unipolar neuron** appears to have an axon and no dendrites.

FIGURE 11.5 Structural Classes of Neurons

Types of Neurons

Neurons are classified according to either their function or their structure. The functional classification is based on the direction in which action potentials are conducted. **Sensory neurons** (*afferent neurons*) conduct action potentials toward the CNS; **motor neurons** (*efferent neurons*) conduct action potentials away from the CNS toward muscles or glands. **Interneurons** conduct action potentials from one neuron to another within the CNS.

The structural classification scheme is based on the arrangement of the processes that extend from the neuron cell body. The three major structural categories of neurons are multipolar, bipolar, and pseudo-unipolar.

Neuroglia of the CNS

Neuroglia are the major supporting cells in the CNS; they participate in forming a permeability barrier between the blood and the neurons, phagocytize foreign substances, produce cerebrospinal fluid, and form myelin sheaths around axons. There are four types of CNS neuroglia, each with unique structural and functional characteristics : *astrocytes*, *oligodendrocytes*, *microglia*, and *ependymal cells*

Three meningeal membranes wrap, protect, and nourish the central nervous system.

Three membranes, the **meninges**, wrap the CNS. From the outermost to the innermost layer, they are the

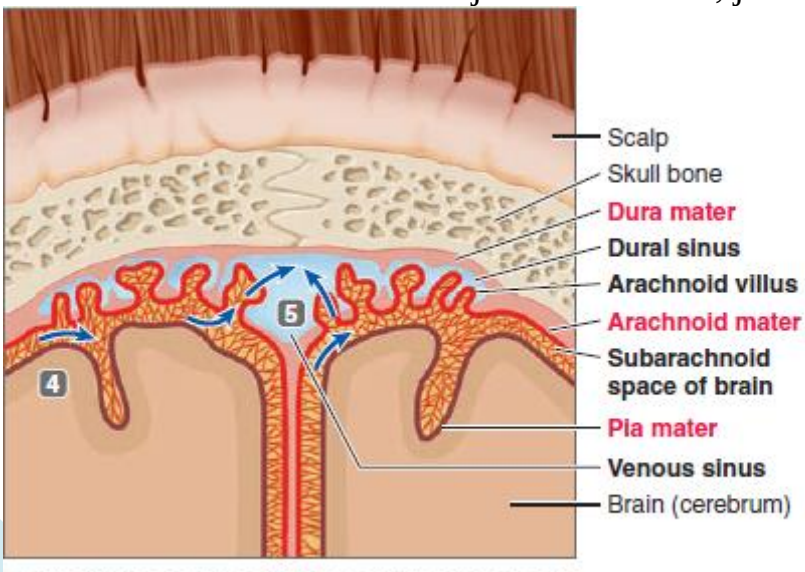
1- dura mater,

2- *arachnoid mater,*

3- *pia mater* .

CSF

Cerebrospinal fluid (CSF) surrounds and cushions the brain and spinal cord. The CSF has about the same density as the brain itself, so the brain essentially floats or is suspended in this special fluid environment. The major function of CSF is to be a shock-absorbing fluid to prevent the brain from bumping against the interior of the hard skull when the head is subjected to sudden, jarring movements.



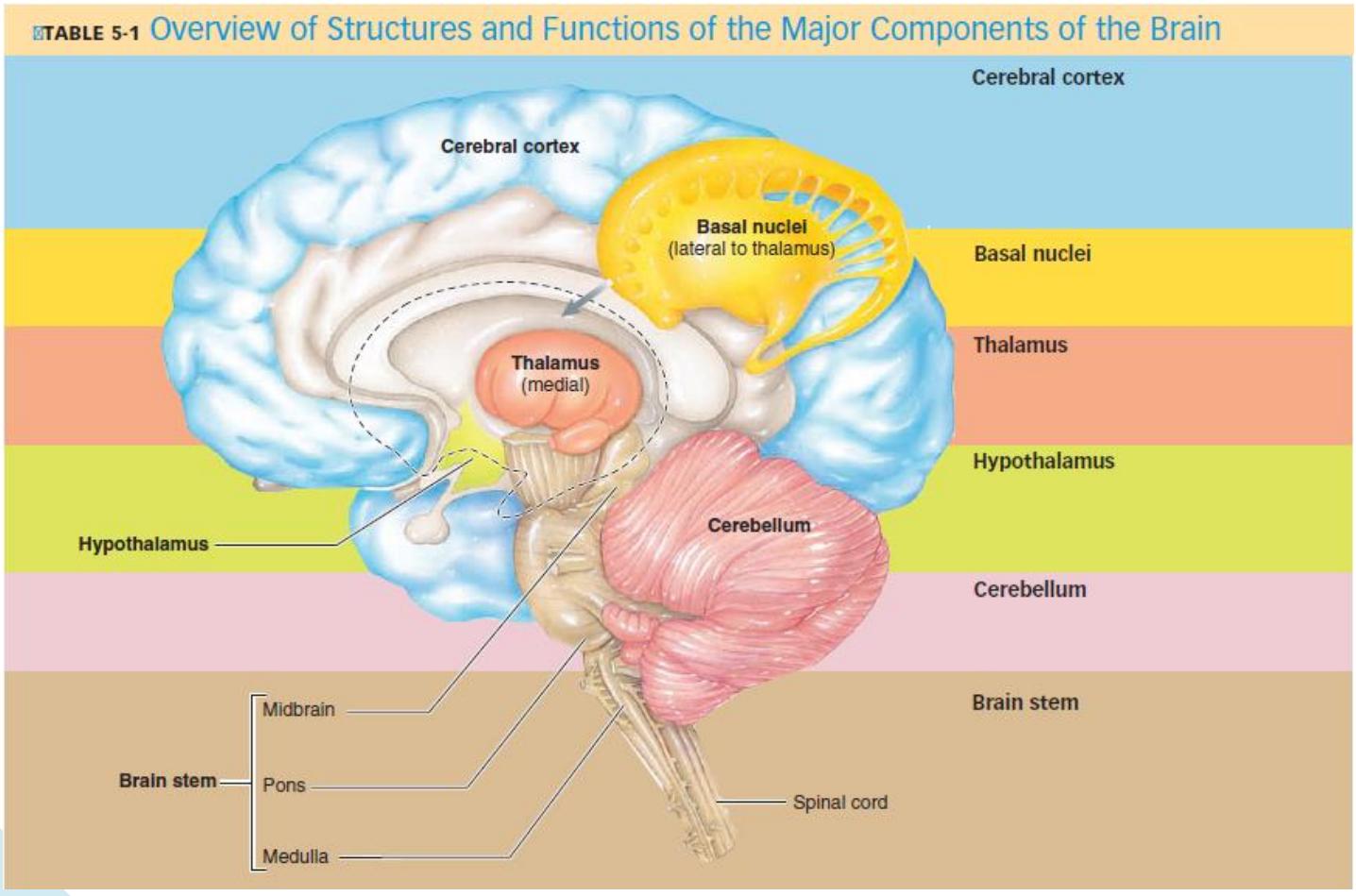
(b) Frontal section between cerebral hemispheres

Overview of the Central Nervous System

The CNS consists of the brain and spinal cord. The estimated 85 billion neurons in your brain are joined together by an estimated quadrillion synaptic connections and are assembled into complex networks that enable you to (1) subconsciously regulate your internal environment by neural means, (2) experience emotions, (3) voluntarily control your movements, (4) perceive your body and your surroundings, and (5) engage in other higher cognitive processes such as thought and memory. The term **cognition** refers to the act or process of "knowing," including both awareness and judgment.

The parts of the brain:

1. Brain stem
2. Cerebellum
3. Forebrain :
a. Diencephalon
(1) Hypothalamus
(2) Thalamus
b. Cerebrum
(1) Basal nuclei
(2) Cerebral cortex



The ***brain stem***, the oldest region of the brain, is continuous with the spinal cord. It consists of the **midbrain**, **pons**, and **medulla**. The brain stem controls many life-sustaining processes, such as respiration, circulation, and digestion, common to all vertebrates.

Attached at the top rear portion of the brain stem is the ***cerebellum***, which is concerned with maintaining proper position of the body in space and subconscious coordination of motor activity (movement). The cerebellum also plays a key role in learning skilled motor tasks, such as a dance routine.

On top of the brain stem, tucked within the interior of the cerebrum, is the ***diencephalon***. It houses two brain components: the ***hypothalamus***, which controls many homeostatic functions important in maintaining stability of the internal environment; and the ***thalamus***, which begins sensory processing.

The **cerebrum** is most highly developed in humans, where it constitutes about 80% of the total brain weight. The outer layer of the cerebrum is the highly convoluted ***cerebral cortex***, which caps an inner core that houses the ***basal nuclei***.

Cerebral Cortex

The **cerebrum** is divided into two halves, the right and left **cerebral hemispheres**. They are connected to each other by the **corpus callosum**, a thick band consisting of an estimated 300 million neuronal axons that connect the two hemispheres.

The four pairs of lobes in the cerebral cortex

Each half of the cortex divided into four major lobes: the *occipital*, *temporal*, *parietal*, and *frontal lobes*. The **occipital lobes**, located posteriorly (at the back of the head), carry out initial processing of visual input. Auditory (sound) sensation is initially received by the **temporal lobes**, located laterally (on the sides of the head).

The **parietal lobes** are primarily responsible for receiving and processing sensory input. The **frontal lobes** are responsible for three main functions: (1) voluntary motor activity, (2) speaking ability, and (3) elaboration of thought.

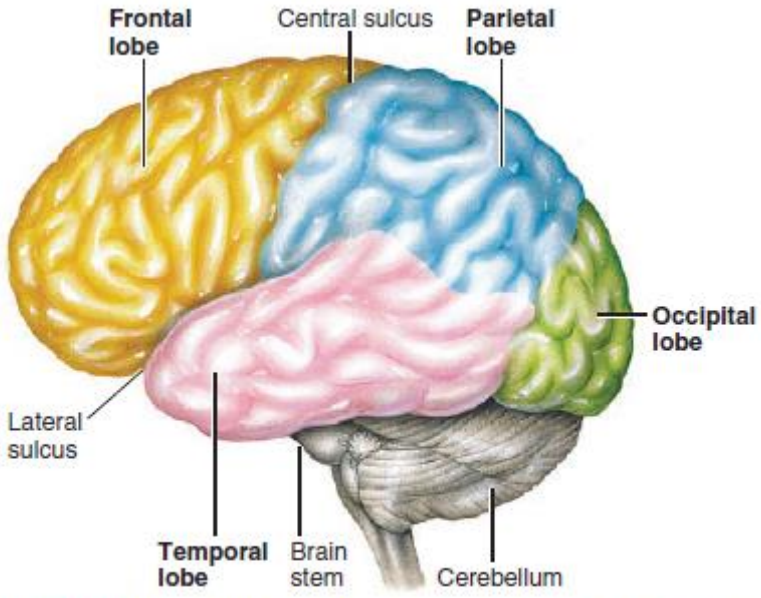


Figure 5-10 Cortical lobes. Each half of the cerebral cortex is divided into the

Spinal Cord

The **spinal cord** is a long, slender cylinder of nerve tissue that extends from the brain stem. It is about 45 cm long and 1 to 1.5 cm wide.

Exiting through a large hole in the base of the skull, the spinal cord is enclosed by the protective vertebral column as it descends through the vertebral canal. Paired **spinal nerves** emerge from the spinal cord through spaces formed between the bony, winglike arches of adjacent vertebrae.

The spinal nerves are named according to the region of the vertebral column from which they emerge: There are 8 pairs of *cervical (neck) nerves* (namely, C1 to C8), 12 *thoracic (chest) nerves*, 5 *lumbar (abdominal) nerves*, 5 *sacral (pelvic) nerves*, and 1 *coccygeal (tailbone) nerve.*

Spinal nerves carry both afferent and efferent fibers.

Afferent fibers carrying incoming signals from peripheral receptors enter the spinal cord and the efferent fibers carrying outgoing signals to muscles and glands exit through the **ventral root**.

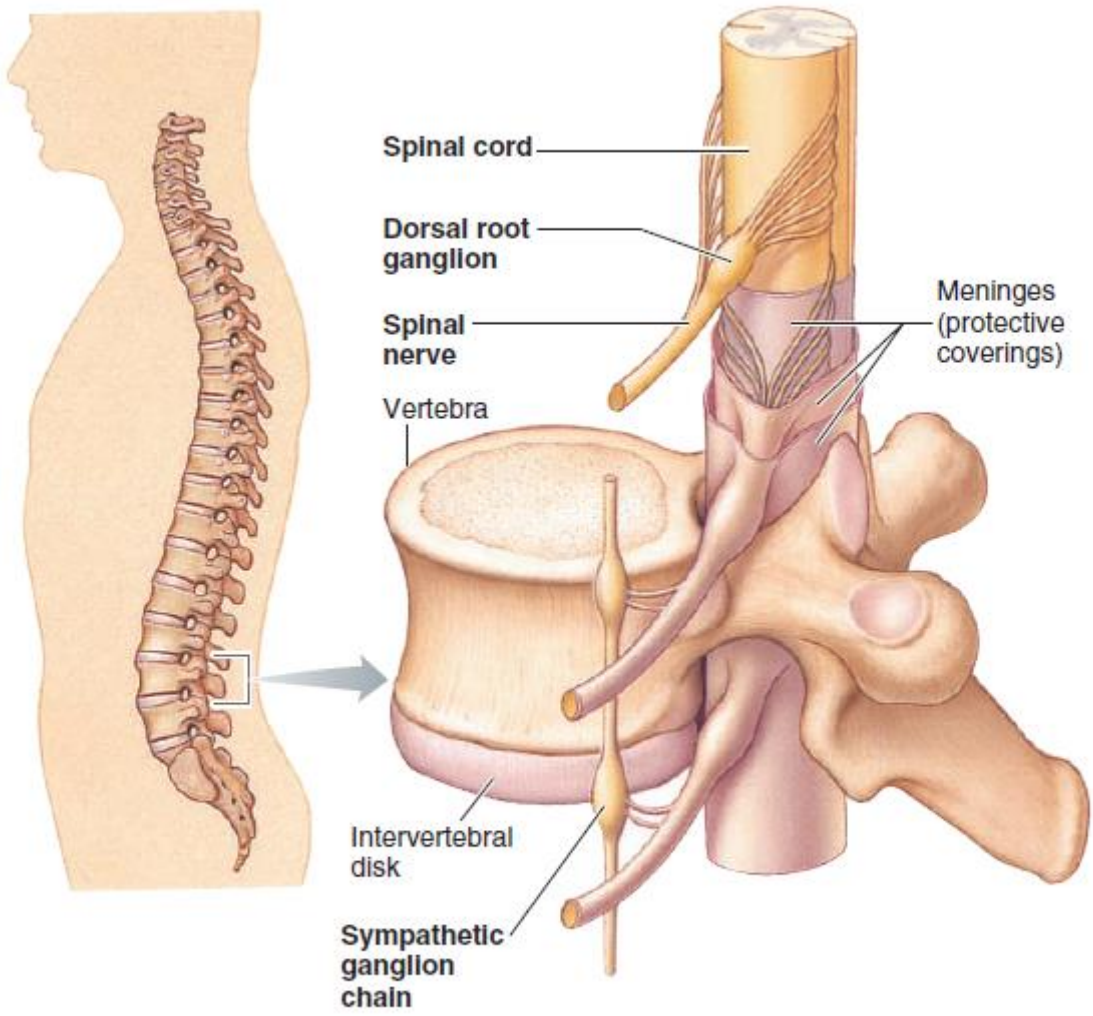


Figure 5-22 Location of the spinal cord relative to the vertebral column.