

# The Nervous System

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Medical terminology lectures

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# Connecting Body Systems–Nervous System

*The main function of the nervous system is to identify and respond to internal and external changes in the environment to maintain homeostasis. Specific functional relationships between the nervous system and other body systems are discussed below.*



## Blood, Lymph, and Immune

- Nervous system identifies changes in blood and lymph composition and provides the stimuli to maintain homeostasis.
- Nervous system identifies pathologically altered tissue and assists the immune system in containing injury and promoting healing.



## Cardiovascular

- Nervous tissue, especially the conduction system of the heart, transmits a contraction impulse.
- Nervous system identifies pressure changes on vascular walls and responds to regulate blood pressure.



## Genitourinary

- Nervous tissue in reproductive organs receives pleasure responses.
- Nervous system responds to pressure changes in bladder walls that indicate the need to void.
- Nervous system stimulates the thirst reflex when body fluid levels are low.



## Integumentary

- Sensory nervous system supplies receptors in the skin that respond to environmental stimuli.
- Autonomic nervous system regulates body temperature by controlling shivering and sweating.



## Digestive

- Nervous stimuli of digestive organs propel food by peristalsis.
- Nerve receptors in the lower colon identify the need to defecate.



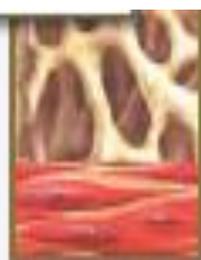
## Endocrine

- The hypothalamus regulates hormone production.



## Female reproductive

- Nervous system transmits contraction impulses needed for delivery of a fetus.
- Nervous system provides stimuli needed for lactation.
- Nervous system regulates hormones needed for the menstrual cycle.



## Musculoskeletal

- Nervous system provides impulses for contraction resulting in voluntary and involuntary movement of muscles.
- Autonomic nervous tissue responds to positional changes.



## Respiratory

- Nervous system stimulates muscle contractions that create pressure changes necessary for ventilation.
- Nervous system regulates rate and depth of breathing.

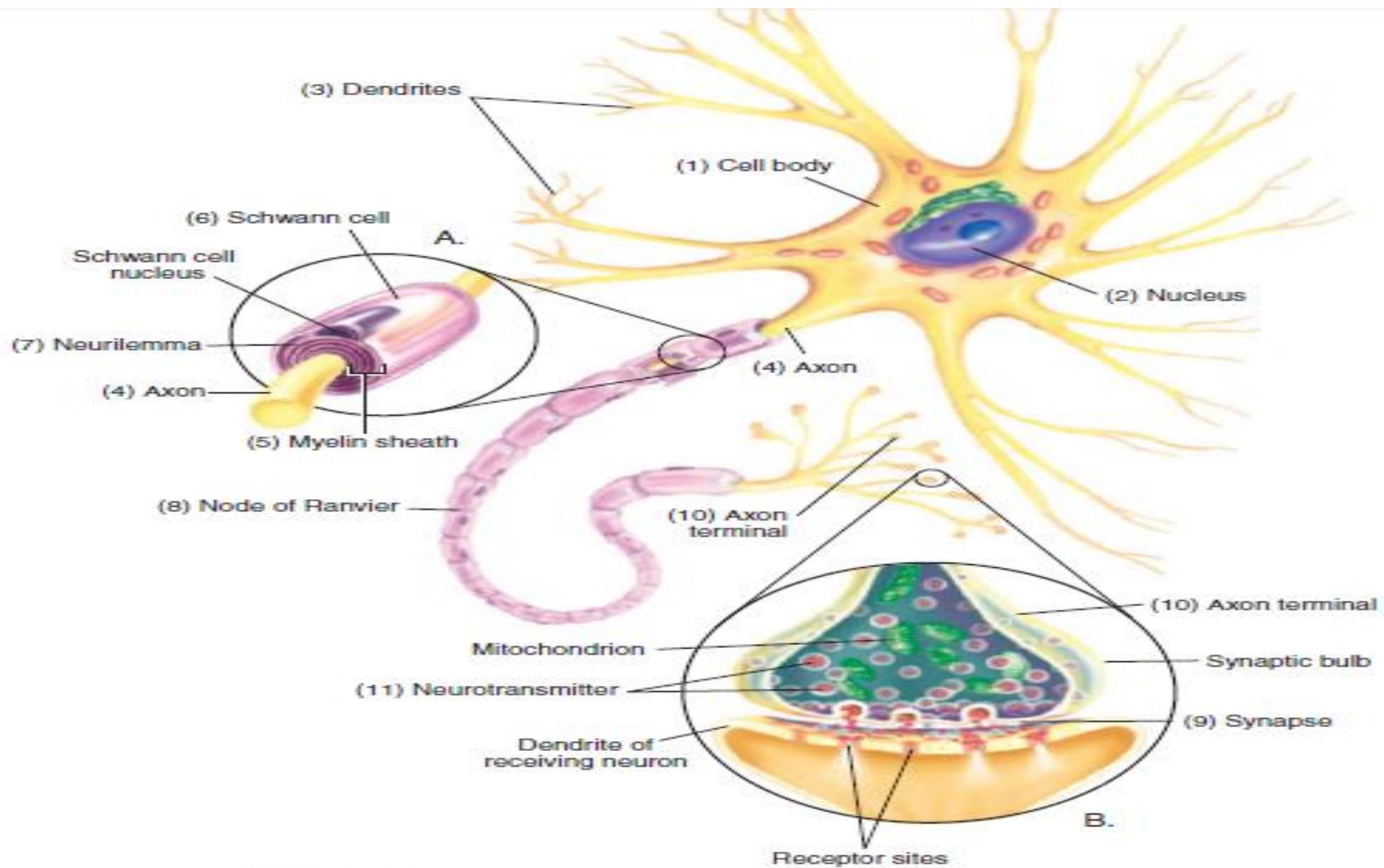
# Cellular Structure of the Nervous System

- The nervous system is composed of only two principal types of cells: **neurons** and **neuroglia**.
- **Neurons** are cells that transmit impulses. They are commonly identified by the direction the impulse travels as afferent when the direction is toward the brain or spinal cord or efferent when the direction is away from the brain or spinal cord.
- **Neuroglia** are cells that support neurons and bind them to other neurons or other tissues of the body. Although they do not transmit impulses, they provide a variety activities essential to the proper functioning of neurons.

# Neurons

## The three major structures of the neuron are:

1. **Cell body** is the enlarged structure of the neuron that contains the nucleus of the cell and various organelles.
2. **Dendrites** are branching cytoplasmic projections from the body, that carry impulses **to** the cell body.
3. **Axons** that carry impulses **from** the cell body. axons in the peripheral nervous system and the central nervous system possess a white, lipoid covering called **myelin sheath**. This covering acts as an electrical insulator that reduces the possibility of an impulse stimulating adjacent nerves. It also accelerates impulse transmission through the axon.



**Figure 14-1.** Neuron. (A) Schwann cell. (B) Axon terminal synapse.

# Neurons

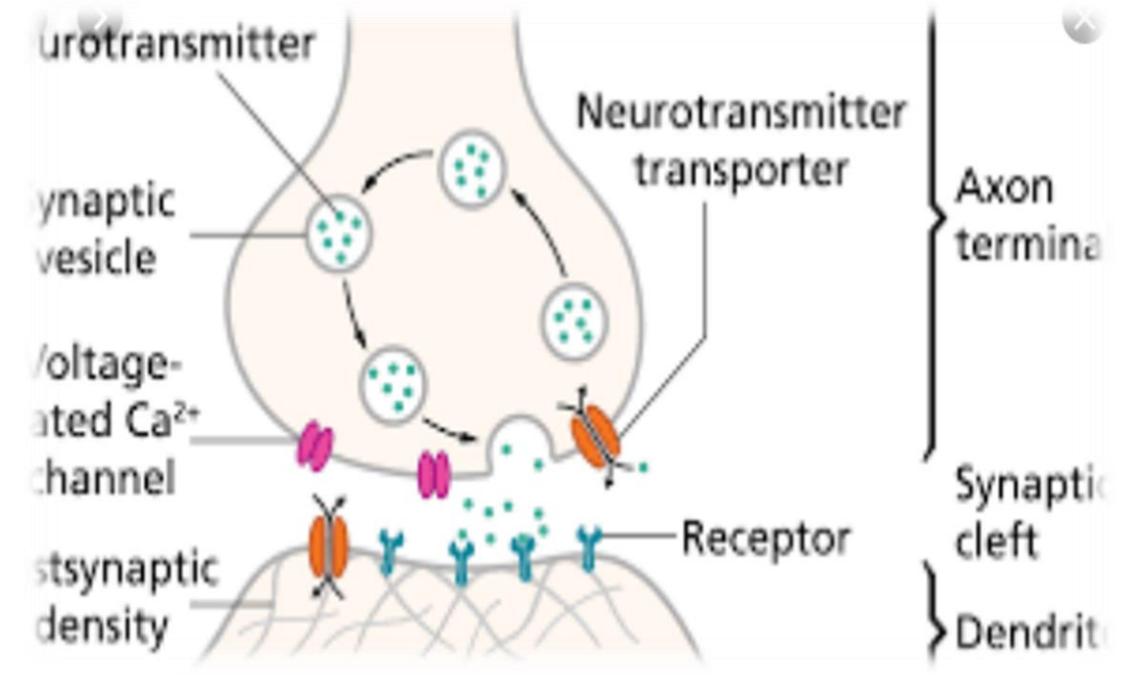
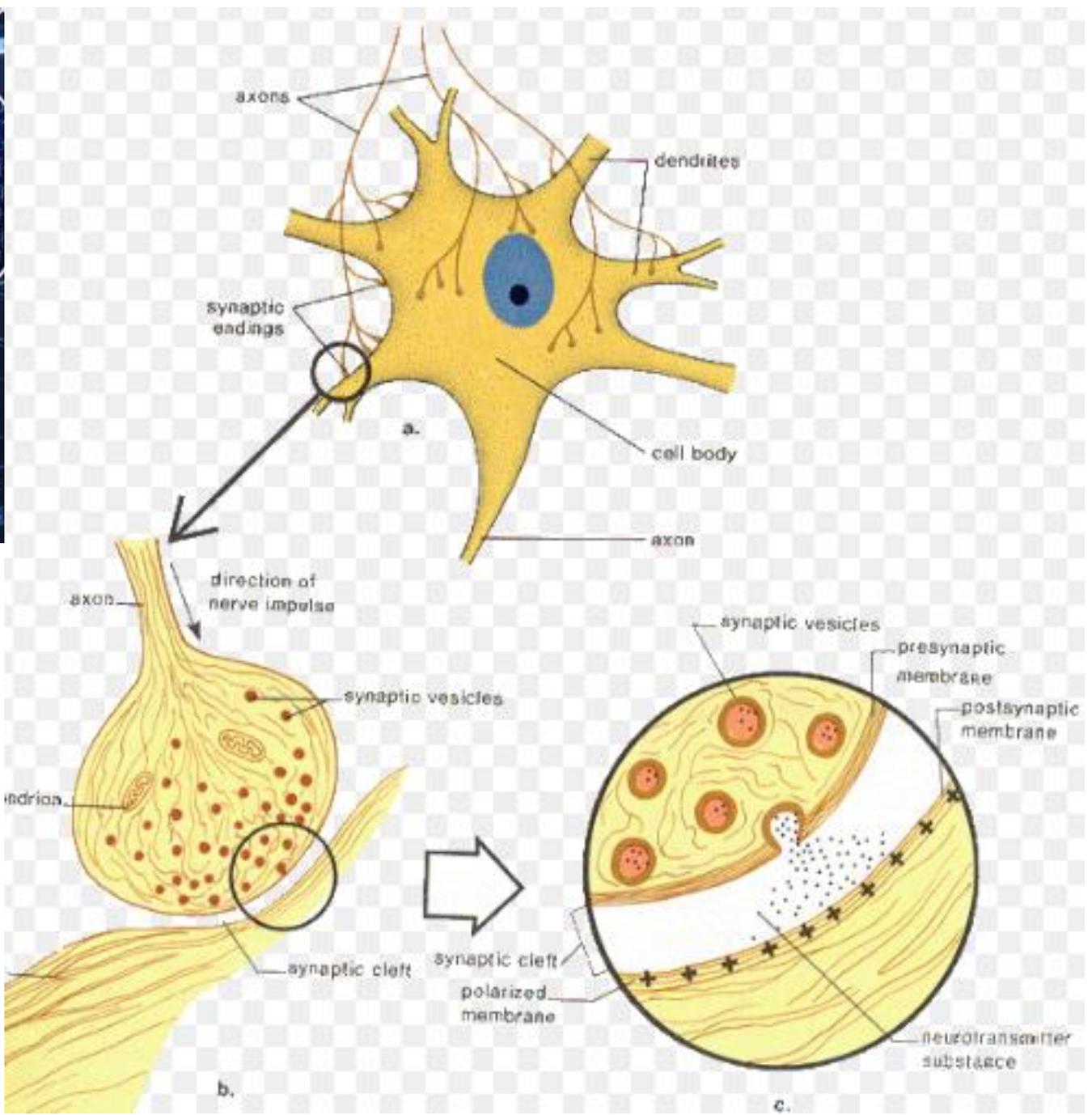
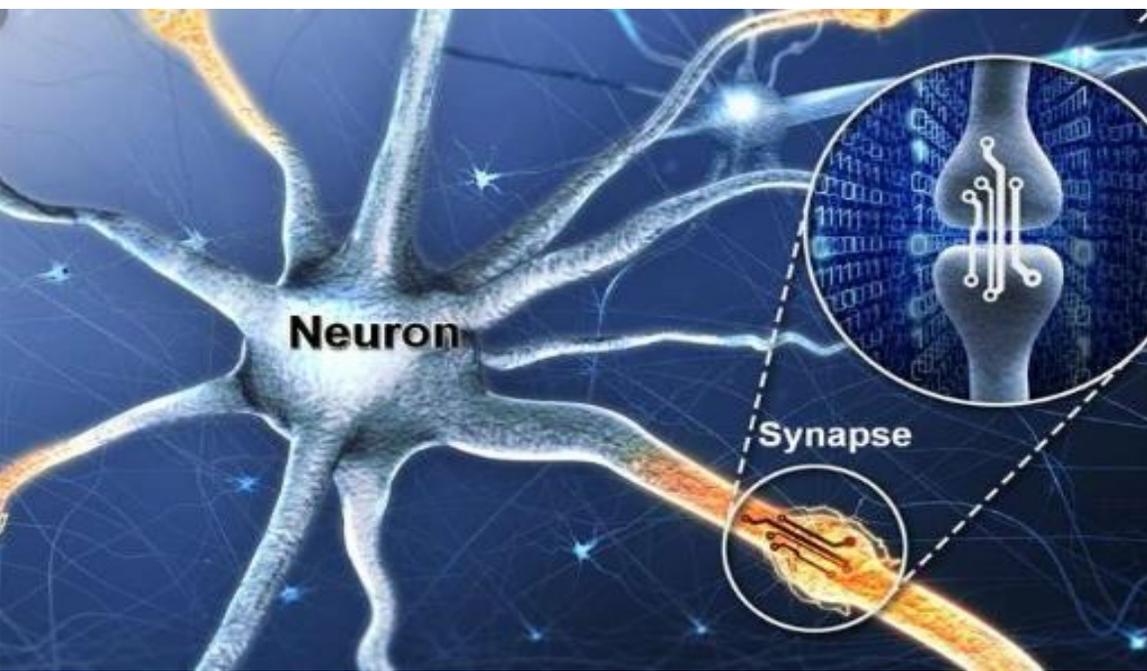
- On nerves in the peripheral nervous system myelin sheath is formed by a neuroglial cell called a **Schwann cell** that wraps tightly around the axon.
- Its exterior surface forms a thin tube called **Neurilemma**, or **neurolemma**.
- The Neurilemma does not disintegrate after an axon has been crushed or severed, as does the axon and myelin sheath, but remains intact. This intact sheath provides a pathway for possible neuron regeneration after injury.

# Neurons

- The myelin sheath covering the axons in the central nervous system is formed by **oligodendrocytes** rather than Schwann cells.
- Oligodendrocytes do not produce Neurilemma, thus injury or damage to neurons located in the **central nervous** system is **irreparable**.
- The short unmyelinated spaces between adjacent segments of myelin sheath are called **nodes of Ranvier**. These nodes help speed the transmission of impulses down the axon because an impulse jumps across the nodes at a faster rate than it is able to travel through the myelinated axon.

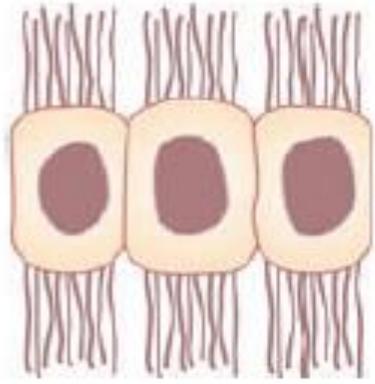
# Neurons

- The functional connection between two neurons or between a neuron and its target (muscle or gland) is a gap or space called a **synapse**.
- Impulses must travel from the **axon terminal** of one neuron to the dendrite of the next neuron or to its target by crossing this synapse.
- The impulse within the transmitting axon causes a chemical substance called a **neurotransmitter** to be released at the end of its axon.
- The neurotransmitter diffuses across the synapse and attaches to the receiving neuron at specialized receptor sites. When sufficient receptor sites are occupied, it signals an acceptance “message” and the impulse passes to the receiving neuron. The receiving neuron immediately inactivates the neurotransmitter, and prepares the site for receiving another stimulus)

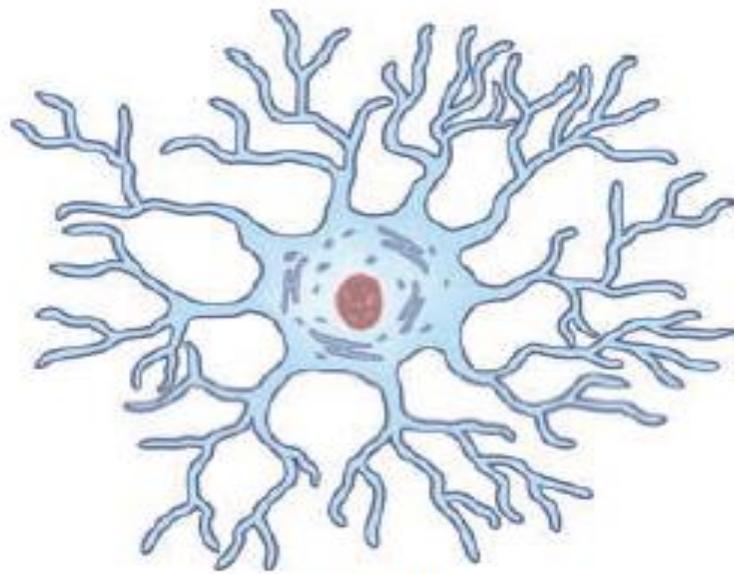


# Neuroglia

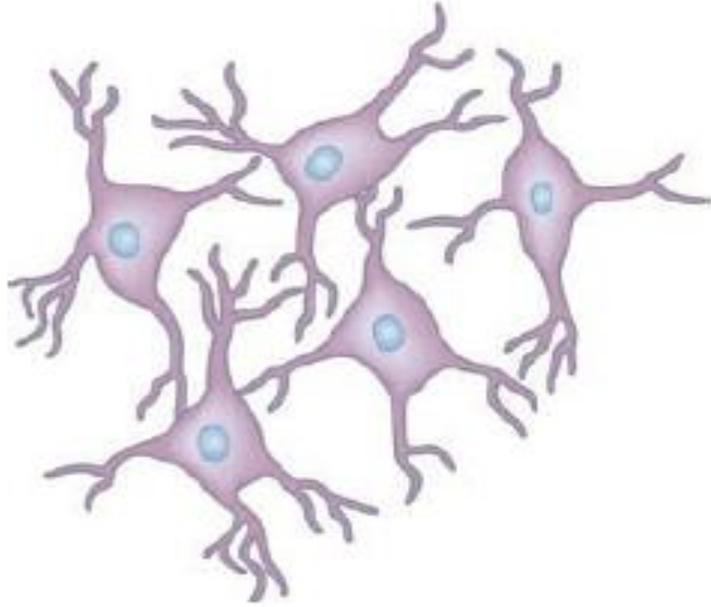
- The term neuroglia literally means **nerve glue** because these cells were originally believed to serve only one function: to bind neurons to each other and to other structures. They are now known to supply nutrients and oxygen to neurons and assist in other metabolic activities. They also play an important role when the nervous system suffers injury or infection.
- The four major types of neuroglia include:
  1. Astrocytes
  2. Oligodendrocytes
  3. Microglia
  4. Ependyma.



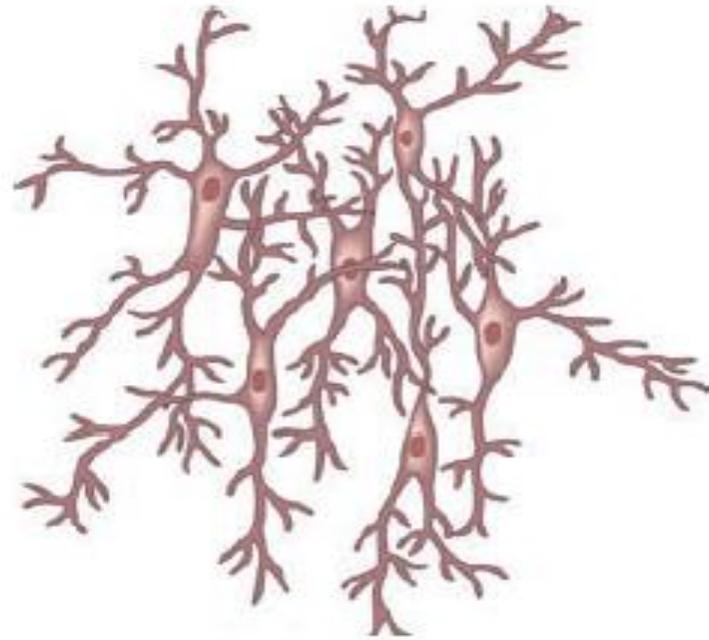
Ependymocytes



Astrocyte



Oligodendrocytes



Microglia

**Figure 14-2.** Four types of neuroglia.

# Neuroglia

- 1) **Astrocytes** are star shaped neuroglia. They provide three-dimensional mechanical support for neurons and form tight sheaths around the capillaries of the brain.
  - These sheaths provide an obstruction, called the **blood brain barrier**, that keeps large molecular substances from entering the delicate tissue of the brain. Even so, small molecules, such as water, carbon dioxide, oxygen, and alcohol, readily pass from blood vessels through the barrier and enter the interstitial spaces of the brain. Researchers must take the blood-brain barrier into consideration when developing drugs for treatment of brain disorders.
  - Astrocytes also perform mildly phagocytic functions in the brain and spinal cord.

# Neuroglia

- 2) **Oligodendrocytes**, also called ***oligodendroglia***, are responsible for developing myelin on neurons of the central nervous system.
- 3) **Microglia**, the smallest of the neuroglia, possess phagocytic properties and may become very active during times of infection.
- 4) **Ependyma** are ciliated cells that line fluid-filled cavities of the central nervous system, especially the **ventricles** of the brain. They assist in the circulation of cerebrospinal fluid (CSF).

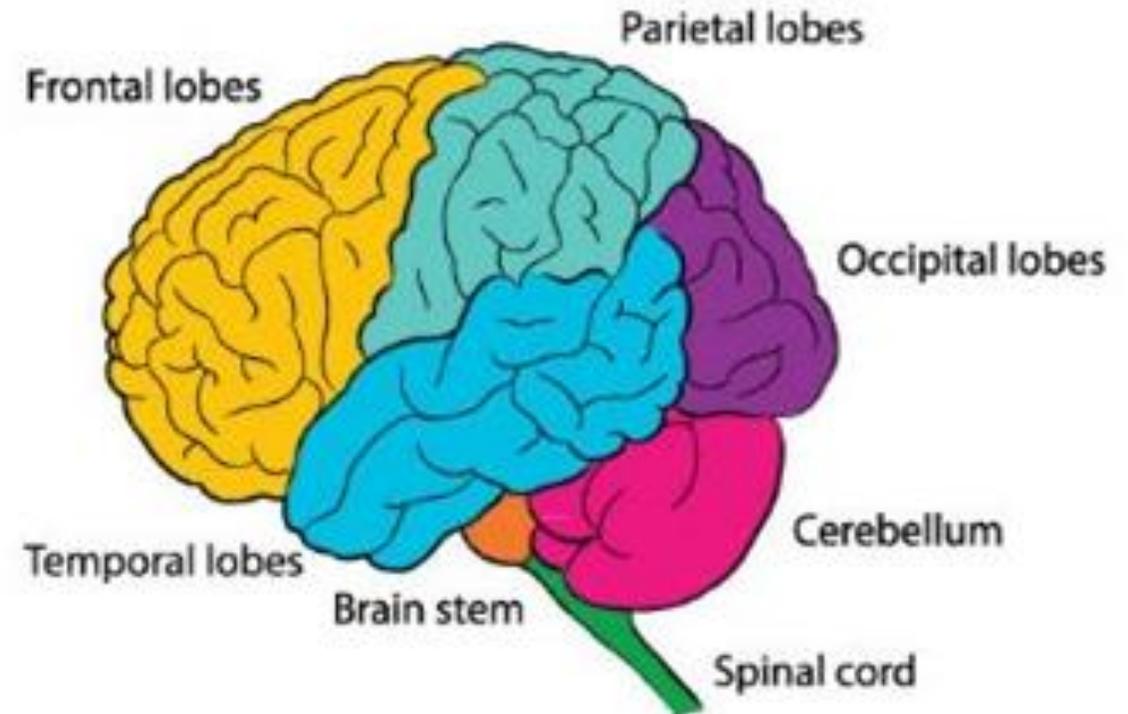
# Nervous System Divisions

The nervous system consists of two main divisions:

Table 14-1 Nervous System Structures and Functions	
<i>This table lists the structures of the nervous system along with their functions.</i>	
Structures	Function
<b>Central</b>	
Brain	Center for thought and emotion, interpretation of sensory stimuli, and coordination of body functions
Spinal cord	Main pathway for transmission of information between the brain and body
<b>Peripheral</b>	
Cranial nerves	Includes 12 pairs of nerves that emerge from the base of the skull and may act in either a motor capacity, sensory capacity, or both
Spinal nerves	Includes 31 pairs of nerves that emerge from the spine and act in both motor and sensory capacities

# Central Nervous System (CNS) -Brain

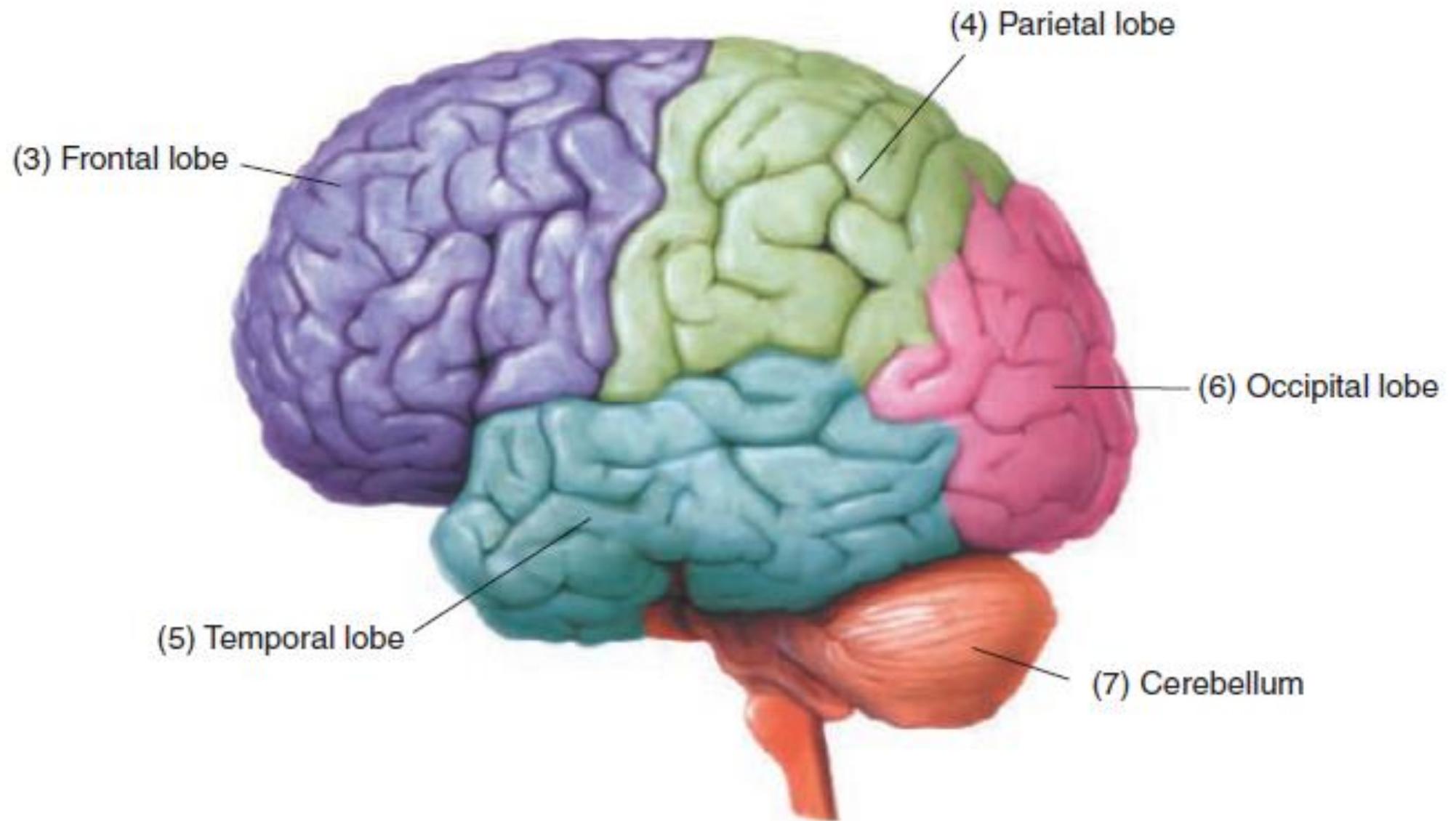
- The largest organs of the body
- The four major structures of the brain are:
  1. Cerebrum
  2. Cerebellum
  3. Diencephalon
  4. Brainstem



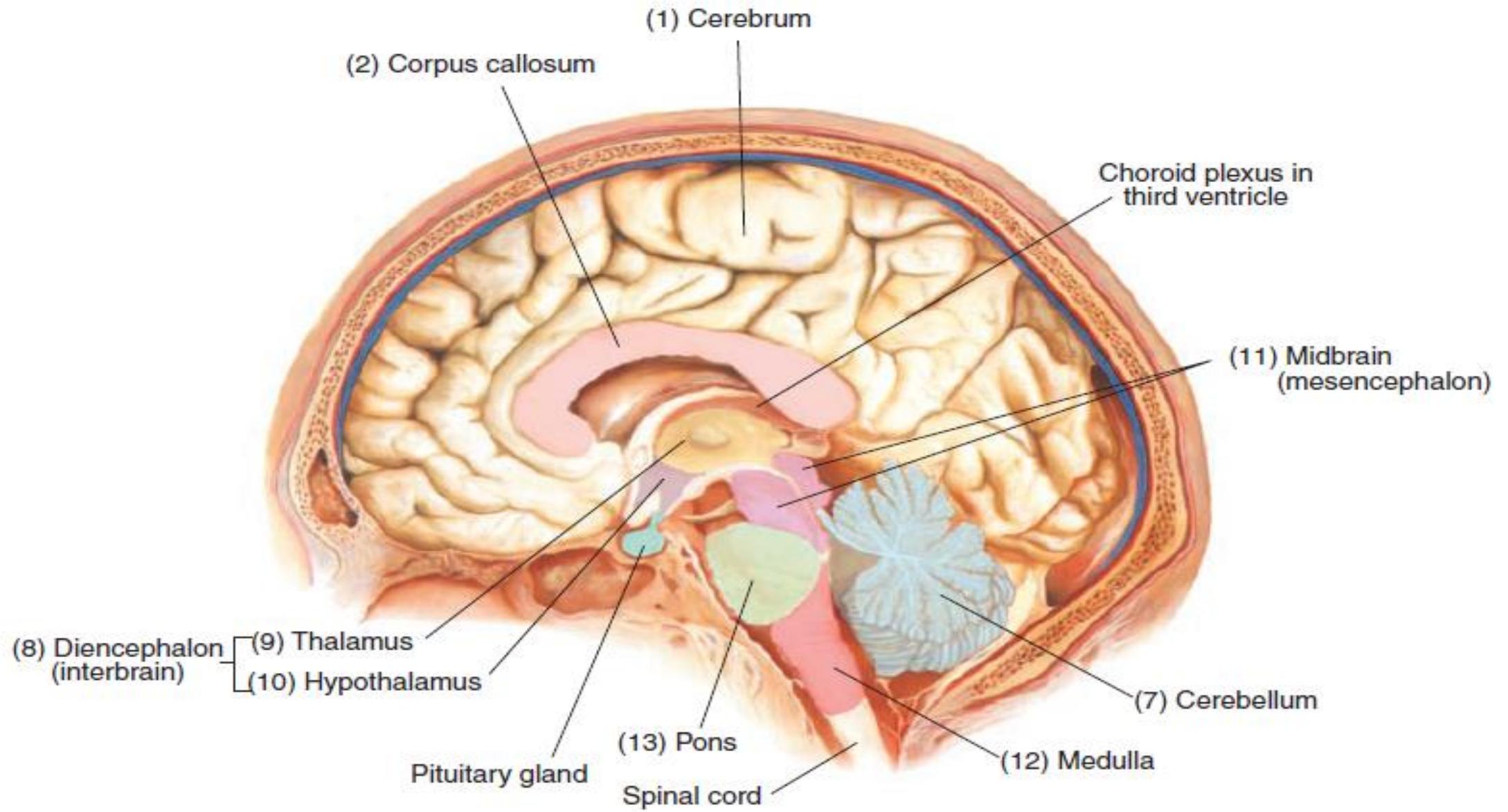
# Brain -cerebrum

- The largest and uppermost portion of the brain.
- It consists of two hemispheres, divided by a deep longitudinal fissure, or groove.
- The fissure does not completely separate the hemispheres. A structure called the **corpus callosum** joins these hemispheres, permitting communication between the right and left sides of the brain.
- Each hemisphere is divided into five lobes:

Four of these lobes are named for the bones that lie directly above them: (3) **frontal**, (4) **parietal**, (5) **temporal**, and (6) **occipital**. The fifth lobe, the **insula** can be seen only upon dissection.

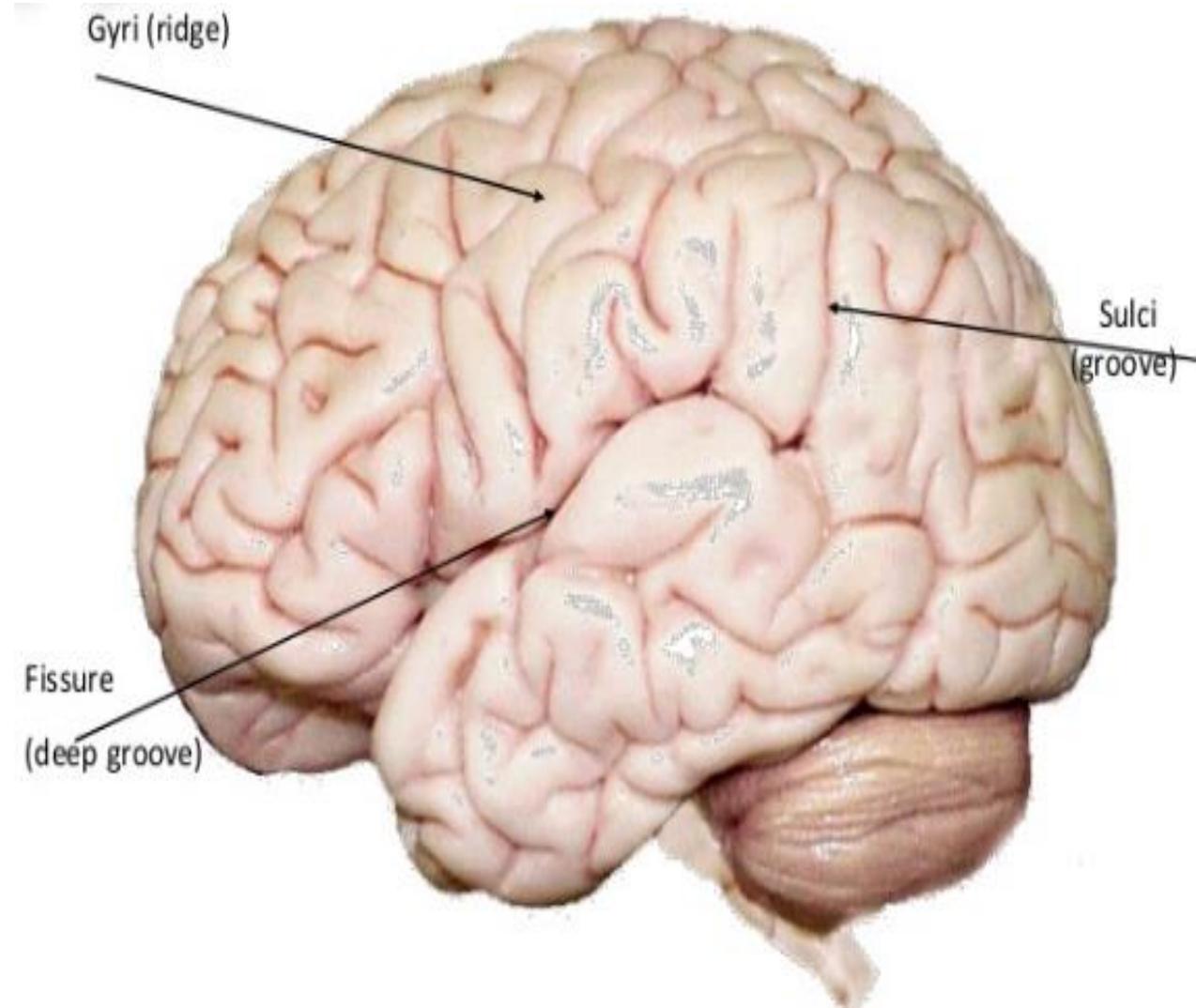


**Figure 14-3.** Brain structures.



# Brain- cerebrum

- The cerebral surface consists of numerous folds, or convolutions, called **gyri**. The gyri are separated by furrows or fissures called **sulci**.
- A thin layer called the **cerebral cortex** covers the entire cerebrum and is composed of gray matter.
- The remainder of the cerebrum is primarily composed of white matter (myelinated axons).
- Major functions of the cerebrum include sensory perception and interpretation, language, voluntary movement, memory, and the emotional aspects of behavior.



# Brain- cerebellum

- The second largest structure of the brain.
- occupies the posterior portion of the skull.
- All functions of the cerebellum involve movement. When the cerebrum initiates muscular movement, the cerebellum coordinates and refines it.
- The cerebellum also aids in maintaining equilibrium and balance.

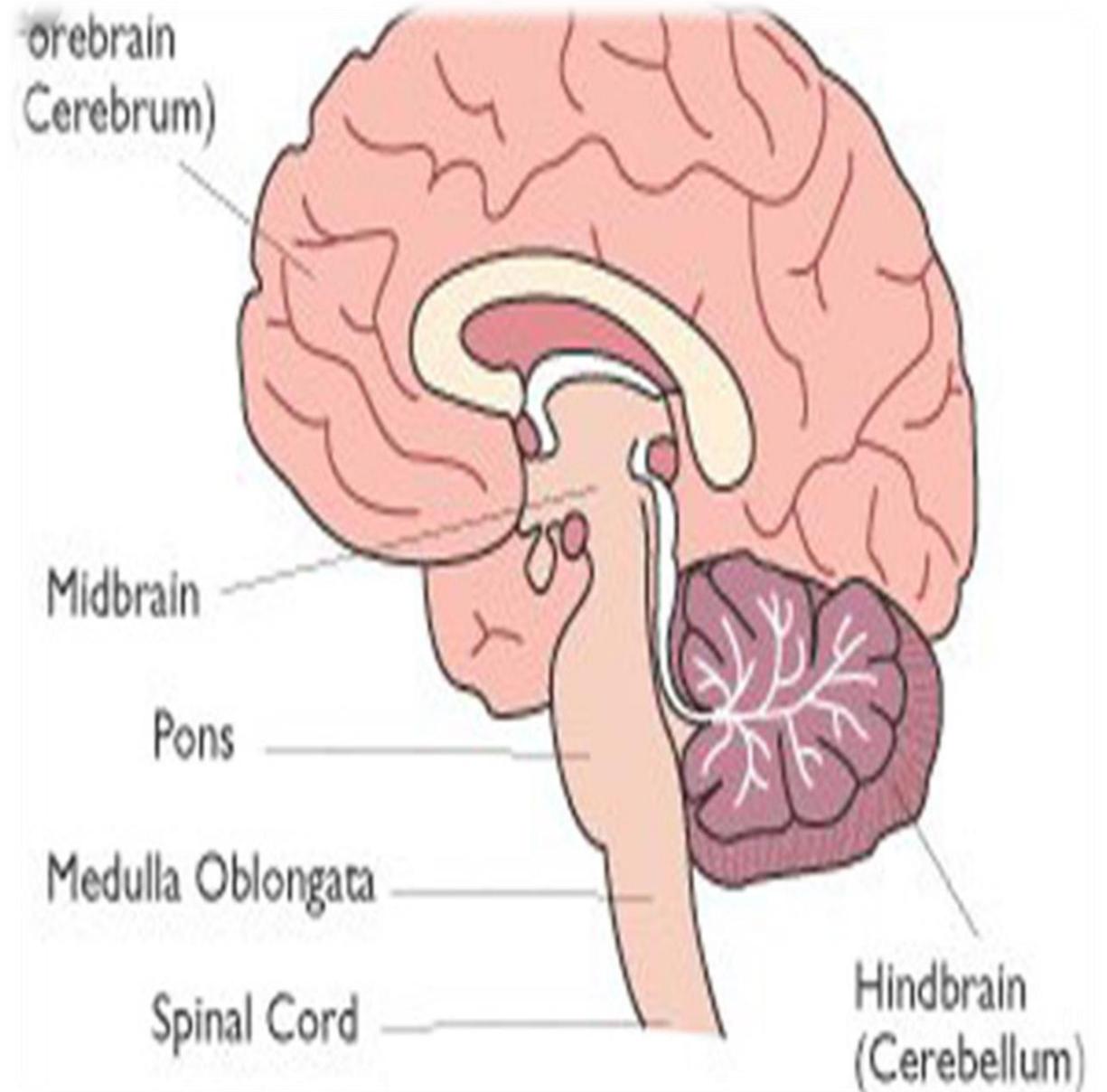


# Brain - Diencephalon

- **Diencephalon** (also called *interbrain*) is composed of many smaller structures, including:
  1. **Thalamus** receives all sensory stimuli except olfactory and processes and transmits them to the appropriate centers in the cerebral cortex. It also receives impulses from the cerebrum and relays them to efferent nerves.
  2. **Hypothalamus** regulates activities of the **autonomic nervous system (ANS)**, including impulses that regulate heartbeat, body temperature, and fluid balance. It also controls many endocrine functions.

# Brain- brain stem

- The brainstem completes the last major section of the brain.
- It is composed of three structures: the
  1. **Midbrain** (also called *mesencephalon*): separating the cerebrum from the brainstem
  2. **Medulla**, which attaches to the spinal cord
  3. **Pons**, or “bridge,” connecting the midbrain to the medulla.



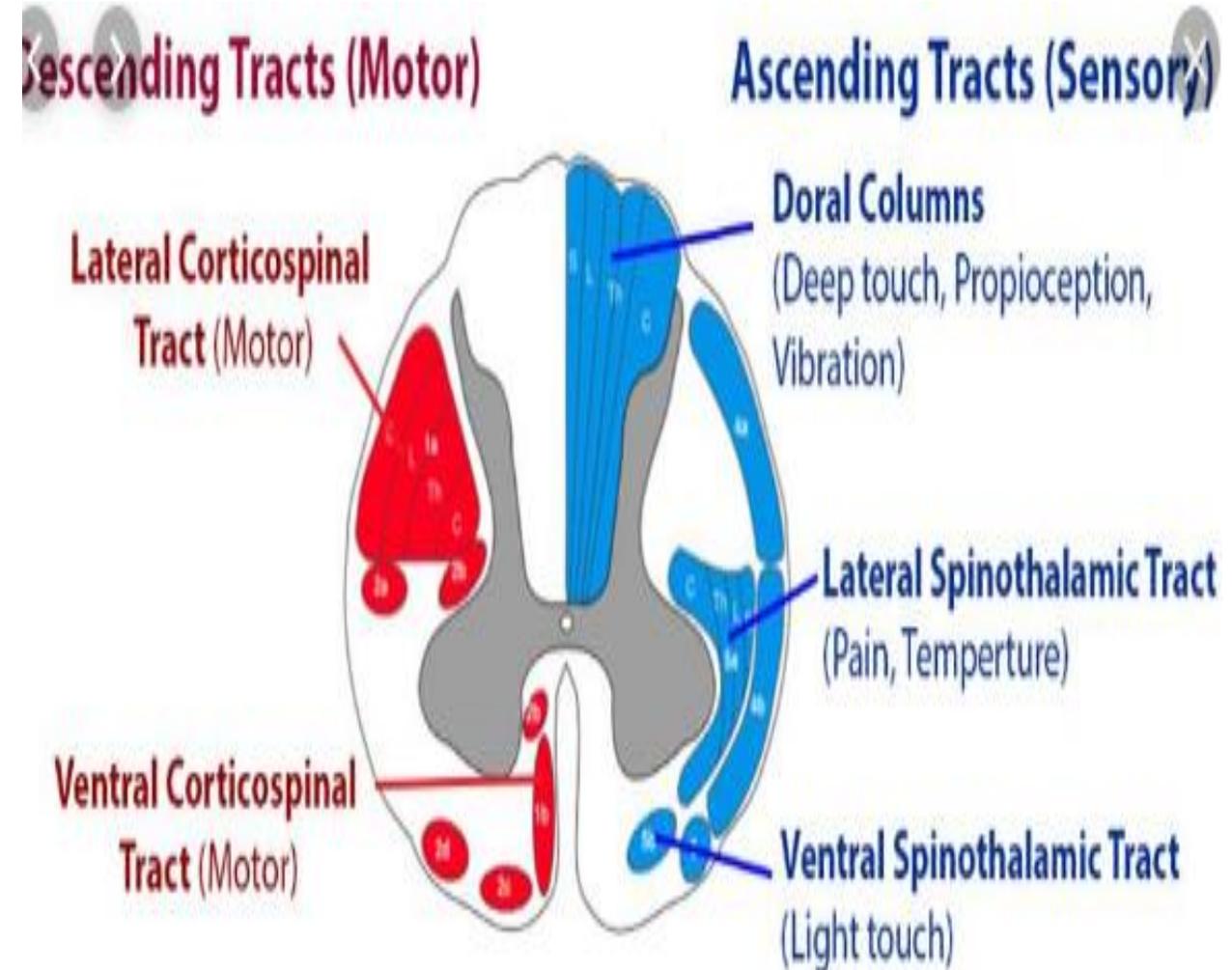
# Brain- brain stem

- The brainstem is a pathway for impulse conduction between the brain and spinal cord.
- The brainstem is the origin of 10 of the 12 pairs of cranial nerves and controls respiration, blood pressure, and heart rate.
- Because the brainstem is the site that controls the beginning of life (the initiation of the beating heart in a fetus) and the end of life (the cessation of respiration and heart activity) it is sometimes called the ***primary brain***.



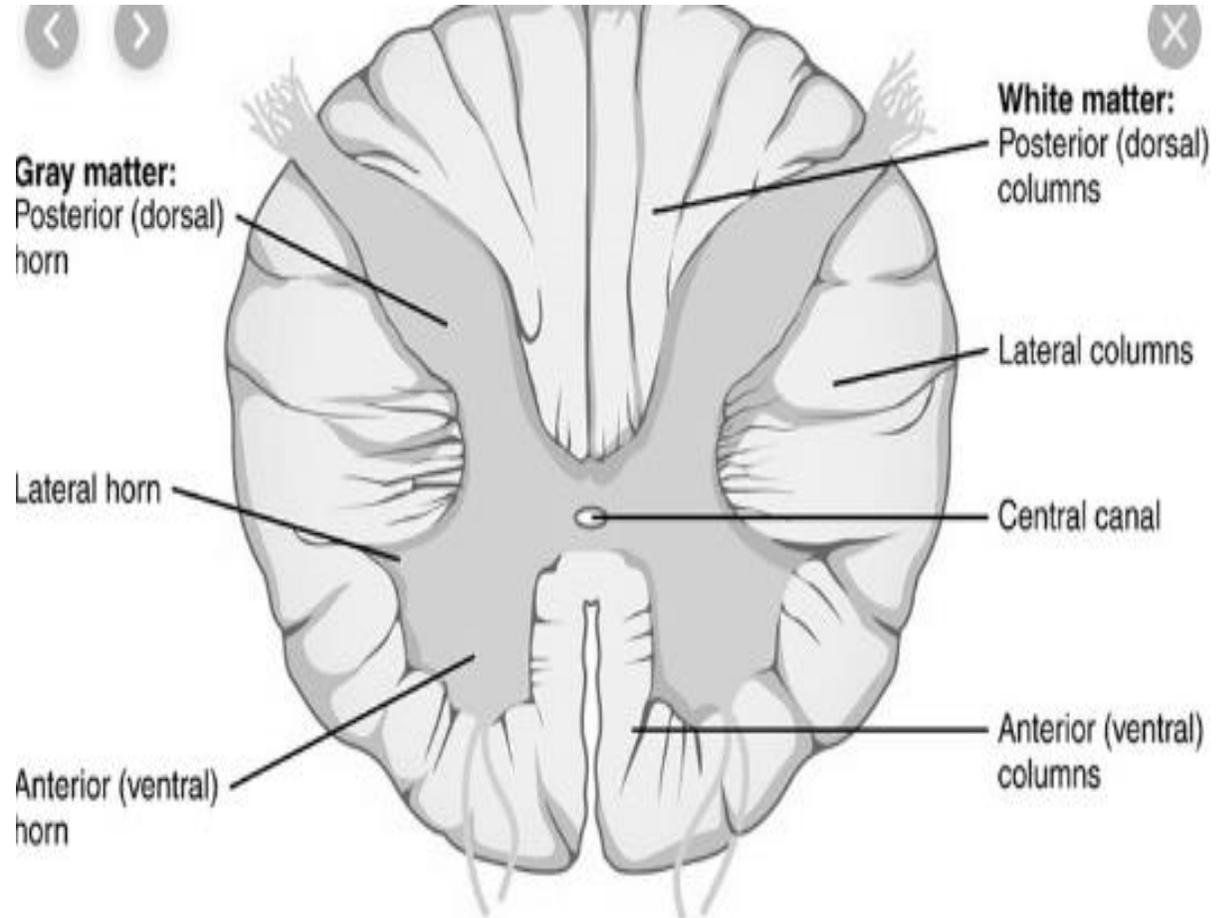
# CNS-Spinal cord

- The **spinal cord** transmits sensory impulses from the body to the brain and motor impulses from the brain to muscles and organs of the body.
- The **sensory** nerve tracts are called **ascending tracts** because the direction of the impulse is upward. Conversely, **motor** nerve tracts are called **descending tracts** because they carry impulses in a downward direction to muscles and organs.



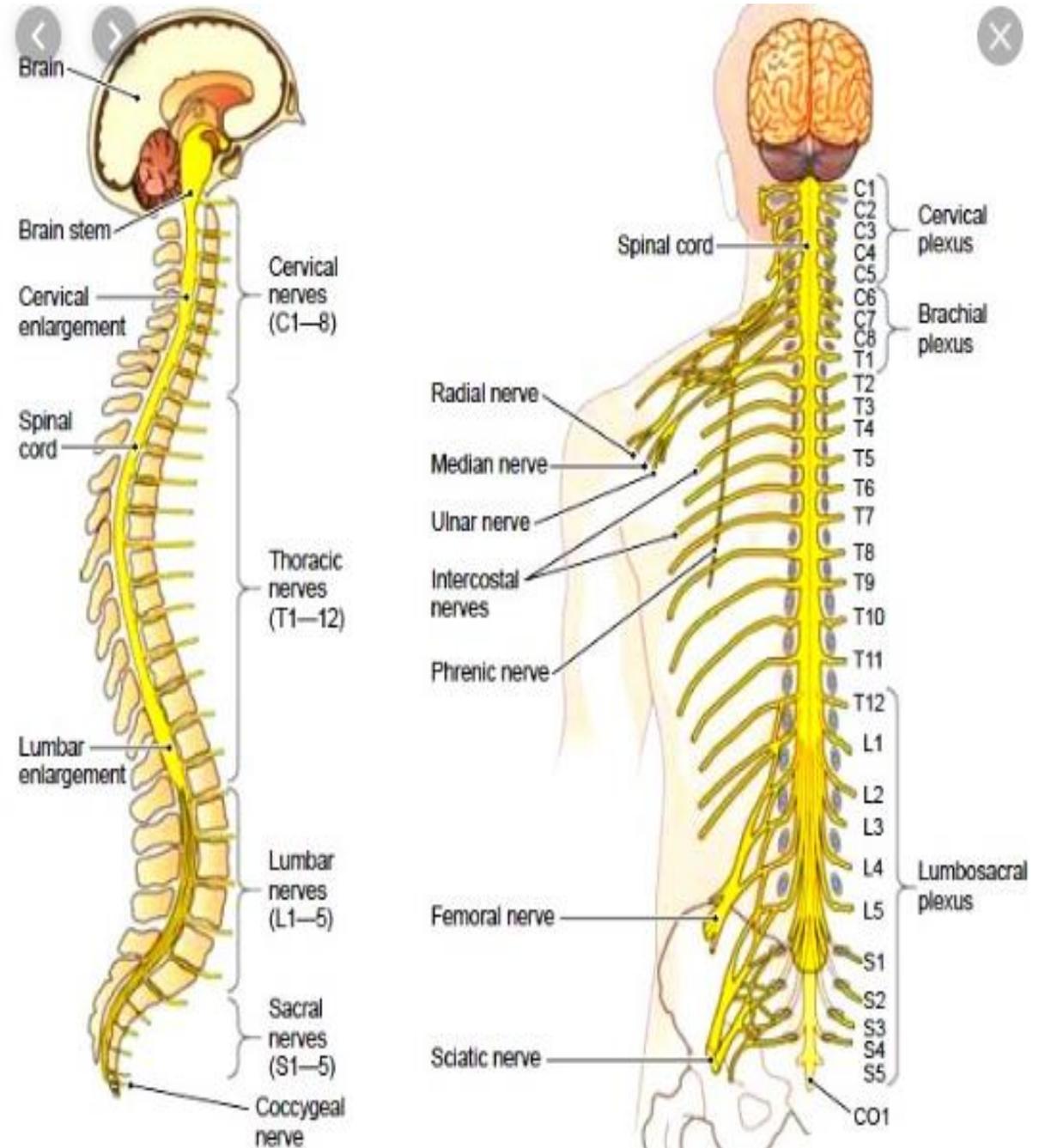
# CNS-Spinal cord

- A cross-section of the spinal cord reveals :
  1. an **inner gray matter** composed of cell bodies and dendrites and
  2. an **outer white matter** area composed of myelinated tissue of the ascending and descending tracts



# CNS-Spinal cord

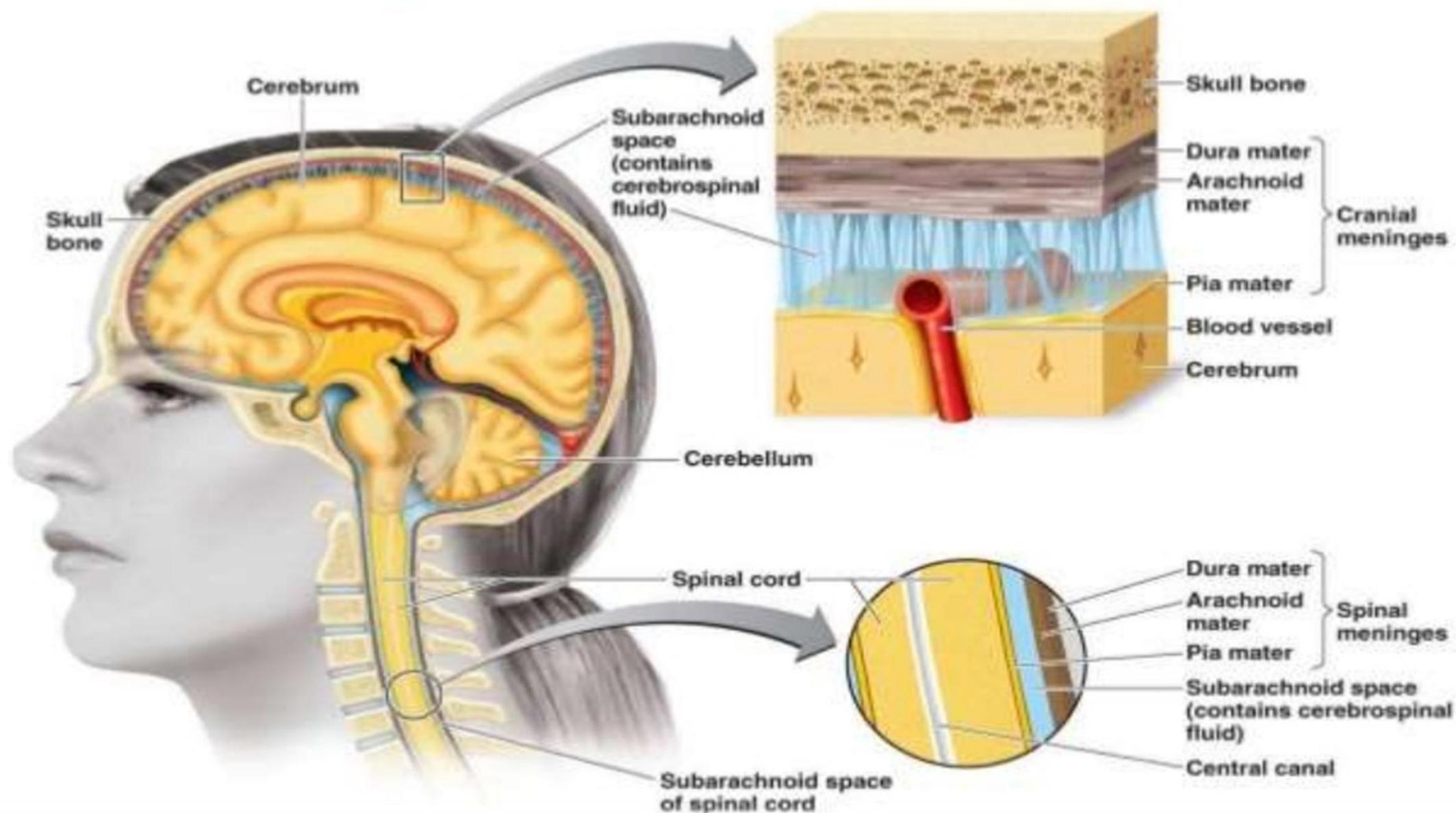
- The entire spinal cord is located within the spinal cavity of the vertebral column, with spinal nerves exiting between the intervertebral spaces throughout almost the entire length of the spinal column.
- Unlike the cranial nerves, which have specific names, the spinal nerves are identified by the region of the vertebral column from which they exit.



# CNS-Meninges

- The brain and spinal cord receive limited protection from three coverings called **meninges** (singular, *meninx*). These coverings include:
- **Dura mater**: is the outermost covering of the brain and spinal cord. It is tough, fibrous, Beneath the dura mater is a cavity called the **subdural space**, which is filled with serous fluid.
- **Arachnoid**: is the middle covering and, as its name suggests, has a spider-web appearance. It fits loosely over the underlying structures.
- A **subarachnoid space** contains **cerebrospinal fluid**, a colorless fluid that contains proteins, glucose, urea, salts, and some white blood cells.
- **Pia mater**: is the innermost meninx. This membrane directly adheres to the brain and spinal cord. As it passes over the brain, it follows the contours of the gyri and sulci. It contains numerous blood vessels and lymphatics that nourish the underlying tissues.

# The Meninges and CSF



# Peripheral nervous system (PNS)

- is composed of all nervous tissue located outside of the spinal column and skull. **Its anatomical** structures consists of 12 pairs of cranial nerves and 31 pairs of spinal nerves.
- **Functionally**, the PNS is subdivided into the somatic nervous system(SNS) and the autonomic nervous system (ANS).
- The **somatic nervous system** consists of **nerve fibers** that transmit sensory information to the brain and spinal cord, and nerve fibers that transmit impulses from the brain and spinal cord to muscles under conscious or voluntary control, such as those required for walking and talking.

# Peripheral nervous system

- The **autonomic nervous system** consists of nerves that control involuntary movement, such as digestion, heart contraction, and vasoconstriction. It also regulates secretion by glands.
- The ANS is subdivided into the **sympathetic and parasympathetic** divisions.
- the **sympathetic** subdivision produces responses evident in “fight-or-flight” situations. It respond when immediate actions are required. Blood flow increases in skeletal muscles to prepare an individual to either fight or retreat from a threatening situation.
- The **parasympathetic** subdivision generally responds when immediate action is not required or a threatening situation subsides. This subdivision is sometimes called the “rest and relax” or “rest and digest” condition

Table 14-2

## Actions Regulated by Sympathetic and Parasympathetic Systems

*This table summarizes some of the responses regulated by the sympathetic and parasympathetic divisions of the peripheral nervous system.*

### Sympathetic Division

Dilates pupils

Inhibits the flow of saliva

Relaxes bronchi

Accelerates heart rate

Slows digestive activities

Constricts visceral blood vessels

### Parasympathetic Division

Constricts pupils

Increases the flow of saliva

Constricts bronchi

Slows heart rate

Accelerates digestive activities

Dilates visceral blood vessels

# PNS- Cranial nerves

- The cranial nerves (CN) originate in the base of the brain and emerge through openings in the base of the skull.
- Cranial nerves may be sensory, motor, or a mixture of both.
- **Sensory nerves** are afferent, and receive impulses from the sense organs, including the eyes, ears, nose, tongue, and skin and transmit them to the CNS. For example olfactory CN I and optic nerves CN II
- **Motor nerves** conduct impulses to muscles and glands for example accessory nerve CN XI, hypoglossal nerve CN XII
- Some cranial nerves are composed of both sensory and motor fibers. They are called ***mixed nerves***. An example of a mixed nerve is the facial nerve CN VII

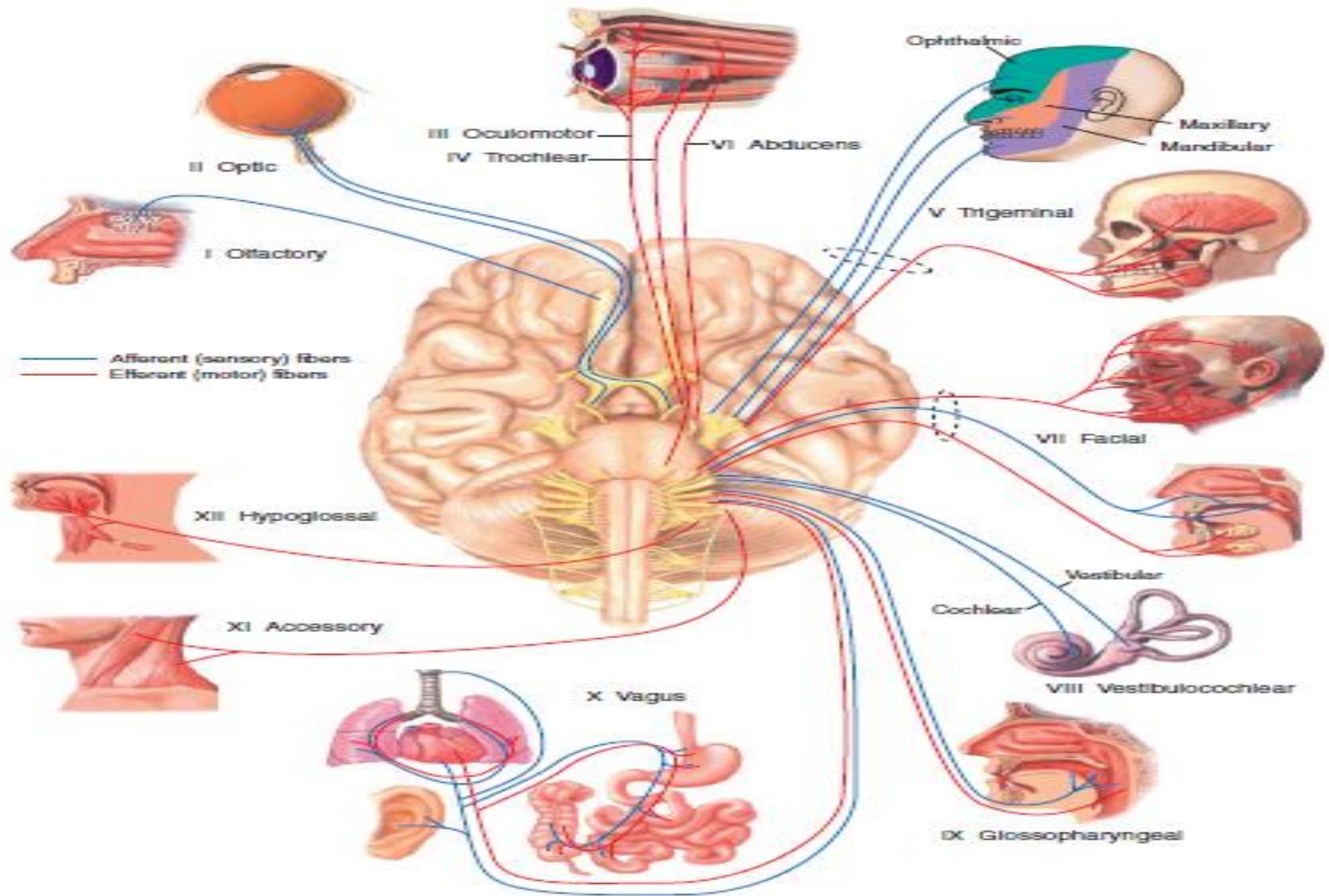
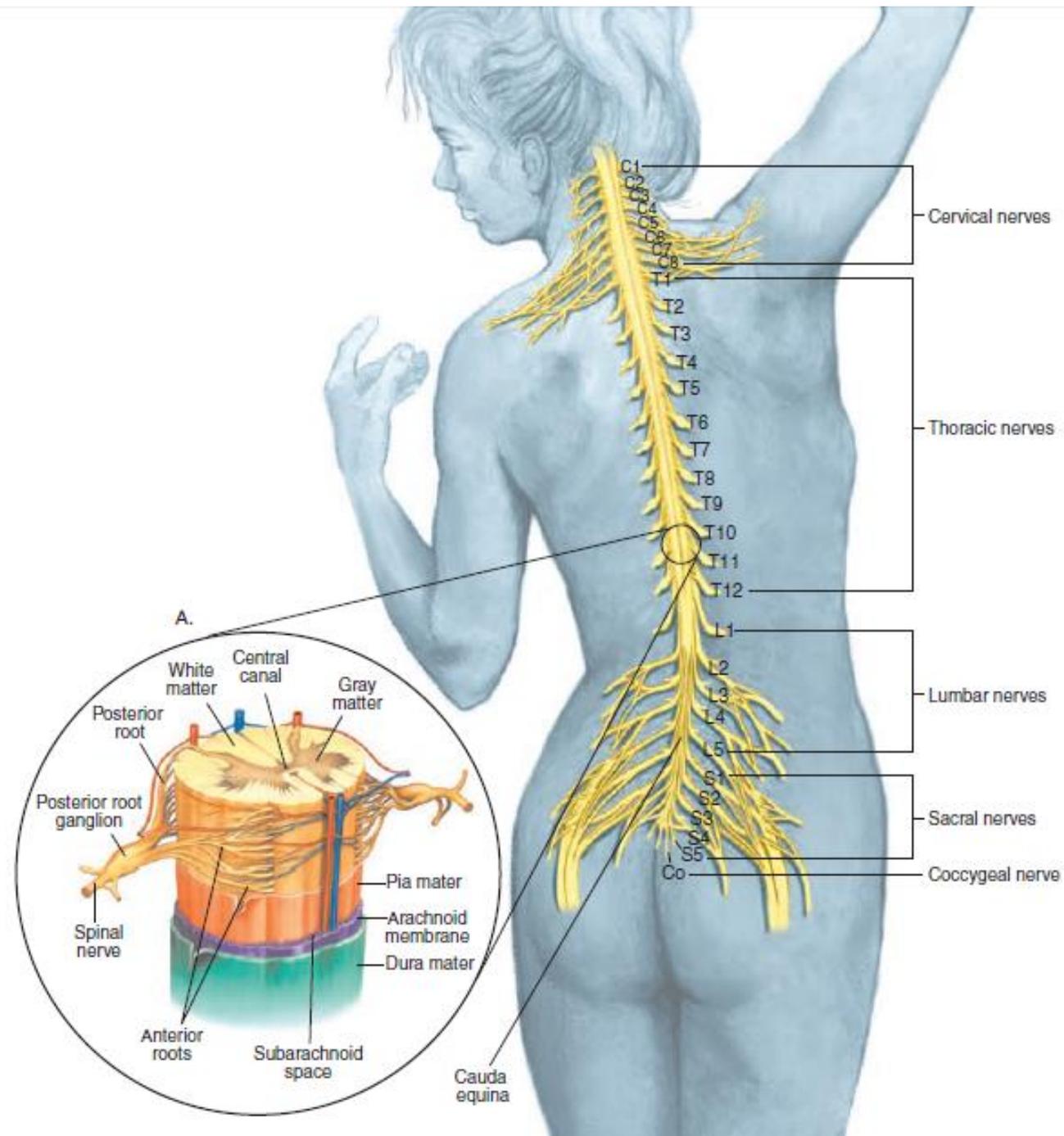


Figure 14-4. Cranial nerve distribution.

# PNS- Spinal nerves

- The spinal nerves emerge from the intervertebral spaces in the spinal column.
- All 31 pairs of spinal nerves are mixed nerves.
- They exit from the spinal canal between the vertebrae and extend to various parts of the body. Each of them is identified according to the vertebra from which they exit.
- Each of them has two points of attachment to the spinal cord: an anterior (ventral) root and a posterior (dorsal) root.
- The **anterior root** contains motor fibers and the **posterior root** contains sensory fibers.
- These two roots unite to form the spinal nerve that has both afferent and efferent qualities.



Term	Definition
afferent ǺF-ĕr-ĕnt	Carry or move inward or toward a central structure <i>The term afferent refers to certain arteries, veins, lymphatic vessels, and nerves.</i>
blood-brain barrier	Protective mechanism that blocks specific substances found in the blood-stream from entering delicate brain tissue
central nervous system (CNS) NĒR-vĕs	Network of nervous tissue found in the brain and spinal cord
efferent ĔF-ĕ-rĕnt	Carry or move away from a central structure <i>The term efferent refers to certain arteries, veins, lymphatic vessels, and nerves.</i>
nerve fiber	Projection of a neuron, especially the axon that transmits impulses
neurilemma nū-rĭ-LĔM-ǻ	Additional sheath external to myelin that is formed by Schwann cells and found only on axons in the peripheral nervous system <i>Because neurilemma does not disintegrate after injury to the axon, its enclosed hollow tube provides an avenue for regeneration of injured axons.</i>
ventricle VĔN-trĭk-l <i>ventr:</i> belly, belly side <i>-ical:</i> pertaining to	Chamber or cavity of an organ that receives or holds a fluid

Element	Meaning	Word Analysis
Combining Forms		
cerebr/o	cerebrum	cerebr/o/tomy (sĕr-ĕ-BRŌT-ō-mĕ): incision of the cerebrum -tomy: incision
crani/o	cranium (skull)	crani/o/malacia (krā-nĕ-ō-mă-LĀ-shĕ-ă): softening of the cranium -malacia: softening
dendr/o	tree	dendr/oid (DĒN-droyd): resembling a (branching) tree -oid: resembling <i>Dendrons, the highly branched portion of the neuron, conduct nerve impulses toward the cell body.</i>
encephal/o	brain	encephal/o/cele (ĕn-SĔF-ă-lō-sĕl): herniation of the brain -cele: hernia, swelling <i>Encephalocele is a condition in which portions of the brain and meninges protrude through a bony midline defect in the skull. It is usually associated with a neural tube defect.</i>
gangli/o	ganglion (knot or knotlike mass)	gangli/ectomy (gāng-glĕ-ĔK-tō-mĕ): excision of a ganglion -ectomy: excision, removal <i>A ganglion is a mass of nerve cell bodies (gray matter) in the peripheral nervous system.</i>

gli/o	glue; neuroglial tissue	<p>gli/oma (glī-Ō-mă): tumor (composed of) neuroglial tissue        -oma: tumor</p> <p><i>A glioma is a tumor composed of neuroglial or supporting tissue of the nervous system.</i></p>
kinesi/o	movement	<p>brady/kines/ia (brăd-ē-kī-NĒ-sē-ă): condition of slow movement        brady-: slow        -ia: condition</p>
lept/o	thin, slender	<p>lept/o/mening/o/pathy (lēp-tō-mĕn-ĭn-GŌP-ă-thē): disease of the meninges        -mening/o: meninges (membranes covering brain and spinal cord)        -pathy: disease</p> <p><i>The leptomeninges include the pia mater and arachnoid, both of which are thin and delicate in structure, as opposed to the dura mater.</i></p>
lex/o	word, phrase	<p>dys/lex/ia (dĭs-LĒK-sē-ă): difficulty using words        dys-: bad; painful; difficult        -ia: condition</p> <p><i>Dyslexia is difficulty or inability with reading, including the tendency to reverse letters or words when reading or writing.</i></p>

Element	Meaning	Word Analysis
mening/o	meninges (membranes covering brain and spinal cord)	mening/o/cele (mĕn-IN-gō-sĕl): herniation of the meninges -cele: hernia, swelling
meningi/o		meningi/oma (mĕn-ĭn-jĕ-Ō-mă): tumor in the meninges -oma: tumor
myel/o	bone marrow; spinal cord	poli/o/myel/itis (pōl-ē-ō-mī-ĕl-Ī-tĭs): inflammation of the gray matter of the spinal cord poli/o: gray; gray matter (of brain or spinal cord) -itis: inflammation
narc/o	stupor; numbness; sleep	narc/o/tic (năr-KŌT-ĭk): relating to sleep -tic: pertaining to <i>Narcotics depress the central nervous system, thus relieving pain and producing sleep.</i>
neur/o	nerve	neur/o/lysis (nū-RŌL-ĭs-ĭs): destruction of a nerve -lysis: separation; destruction; loosening <i>Neurolysis is sometimes performed using cryoablation or radio-frequency techniques to relieve intractable pain as a temporary or permanent measure.</i>
radicul/o	nerve root	radicul/algia (ră-dĭk-ŭ-LĀL-jĕ-ă): pain in the nerve root -algia: pain
sthen/o	strength	hyper/sthen/ia (hī-pĕr-STHĒ-nĕ-ă): condition of excessive strength hyper-: excessive, above normal -ia: condition <i>Hypersthenia is a condition of excessive strength or tonicity of the body or a body part.</i>

thalam/o	thalamus	<p>thalam/o/tomy (thāl-ā-MŌT-ō-mē): incision of the thalamus  <i>-tomy</i>: vincision</p> <p><i>Thalamotomy is performed to treat intractable pain or psychoses.</i></p>
thec/o	sheath (usually refers to meninges)	<p>intra/thec/al (in-trā-THĒ-kāl): pertaining to the space within a sheath  <i>intra-</i>: in, within  <i>-al</i>: pertaining to</p>
ton/o	tension	<p>dys/ton/ia (dīs-TŌ-nē-ā): bad or poor (muscle) tone  <i>dys-</i>: bad; painful; difficult  <i>-ia</i>: condition</p> <p><i>Dystonia usually refers to a movement disorder characterized by sustained muscle contractions resulting in a persistently abnormal posture.</i></p>
ventricul/o	ventricle (of heart or brain)	<p>ventricul/o/metry (vēn-trīk-ū-LŌM-ē-trē): measurement of ventricle (pressure)  <i>-metry</i>: act of measuring</p>

**Suffixes**

-algnesia	pain	<p>an/algnesia (ān-āl-JĒ-zē-ā): absence of (a normal sense of) pain  <i>an-</i>: without, not</p>
-algia		<p>syn/algia (sīn-ĀL-jē-ā): joined (referred) pain  <i>syn-</i>: union, together, joined</p> <p><i>Synalgia is pain experienced in a part of the body other than the place of pathology. For example, right shoulder pain is commonly associated with gallstones.</i></p>

(continued)

Element	Meaning	Word Analysis
-asthenia	weakness, debility	my/asthenia (mī-ās-THĒ-nē-ă): muscle weakness <i>my</i> : muscle
-esthesia	feeling	hyper/esthesia (hī-pēr-ēs-THĒ-zē-ă): increased feeling <i>hyper-</i> : excessive, above normal <i>Hyperesthesia involves a marked sensitivity to touch, pain, or other sensory stimuli.</i>
-kinesia	movement	hyper/kinesia (hī-pēr-kī-NE-zē-ă): excessive movement; also called <i>hyperactivity</i> <i>hyper-</i> : excessive, above normal
-lepsy	seizure	narc/o/lepsy (NĀR-kō-lēp-sē): seizure of sleep <i>narc/o</i> : sleep <i>In narcolepsy, the individual has a sudden and uncontrollable urge to sleep at an inappropriate time, such as when driving.</i>
-paresis	partial paralysis	hemi/paresis (hēm-ē-PĀR-ē-sīs): paralysis of one-half (of the body); also called <i>hemiplegia</i> <i>hemi-</i> : one-half <i>When used alone, the term paresis means partial paralysis or motor weakness.</i>
-phasia	speech	a/phasia (ă-FĀ-zē-ă): without speech <i>a-</i> : without, not
-plegia	paralysis	quadri/plegia (kwōd-rī-PLĒ-jē-ă): paralysis of four (extremities) <i>quadri-</i> : four
-taxia	order, coordination	a/taxia (ă-TĀK-sē-ă): without coordination <i>a-</i> : without, not <i>Ataxia refers to poor muscle coordination, especially when voluntary movements are attempted.</i>

pachy-	thick	<p>pachy/mening/itis (pāk-ē-mēn-ĭn-Jĭ-tīs): inflammation of the dura mater <i>mening</i>: meninges (membranes covering brain and spinal cord) -itis: inflammation</p> <p><i>The dura mater is a thick membrane that provides protection for the brain and spinal cord.</i></p>
para-	near, beside; beyond	<p>para/plegia (pār-ā-PLĒ-jē-ā): paralysis of lower body and limbs -plegia: paralysis</p> <p><i>Paraplegia is the paralysis of the lower limbs of the body.</i></p>
syn-	union, together, joined	<p>syn/algia (sĭn-ĀL-jē-ā): referred pain <i>algia</i>: pain</p> <p><i>Pain in a deteriorated hip commonly causes referred pain in a healthy knee.</i></p>
uni-	one	<p>uni/later/al (ū-nĭ-LĀT-ēr-āl): pertaining to one side <i>later</i>: side, to one side -al: pertaining to</p>

THANK YOU

Questions