

**Organization of the Nervous System**

The nervous system, in coordination with the endocrine system, provides the means by which cell and tissue functions are integrated into a solitary, surviving organism. The nervous system mediates a tremendous range of functions:

- the unconscious control of visceral functions
- sensory perceptions,
- voluntary movement,
- behavior, emotions, dreams,
- intelligence, anticipation, judgment..

**Divisions of the nervous system**

The nervous system has two major divisions:

**I.The central nervous system**, which consists of the:

- brain.
- spinal cord.

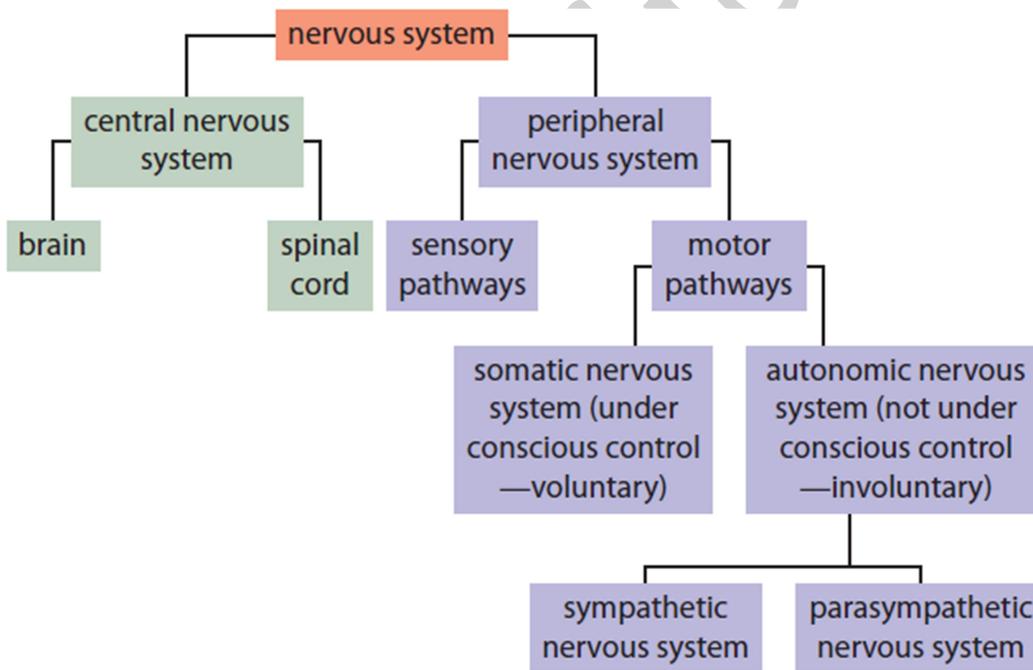


Figure . The organizationof the human nervous system

**II.The peripheral nervous system**, includes nerves that carry sensory messages to the central nervous system and nerves that send information from the CNS to the muscles and glands. It is further divided into :

1.The *somatic system* consists of sensory receptors in the head and extremities, nerves that carry sensory information to the central nervous system, and nerves that carry instructions from the central nervous system to the skeletal muscles.

2.The *autonomic system* controls glandular secretions and the functioning of the smooth and cardiac muscles.

### **Meninges**

Inside the skull and vertebral column, the brain and spinal cord are loosely suspended and protected by several connective tissue sheaths called the meninges:

1. pia mater(delicate mother).
2. Arachnoid.
3. Dura mater (tough mother) .

### **Ventricular System**

The ventricular system is a series of interconnected chambers inside the CNS that are filled with CSF.

- 1.The lateral ventricles of the cerebrum, .
- 2.The slit-like third ventricle, located in the midline and is closely associated with the thalamus.
- 3.The fourth ventricle located in the hind brain and connected to the third ventricle by cerebral aqueduct. The fourth ventricle is continuous inferiorly with the central canal of the spinal cord.

### **Cerebrospinal Fluid**

Watery solution similar in composition to blood plasma (about 80-150 ml), but contains less protein and different ion concentrations than plasma. The CSF is produced by the **choroid plexus**, that project into the ventricles. Reabsorption of CSF into the vascular (blood) system occurs by the **arachnoid villi**.

### **Function of CSF**

- Forms a liquid cushion that gives buoyancy to the CNS organs.
- Prevents the brain from crushing under its own weight.
- Protects the CNS from blows and other trauma.
- Nourishes the brain and carries chemical signals throughout it.

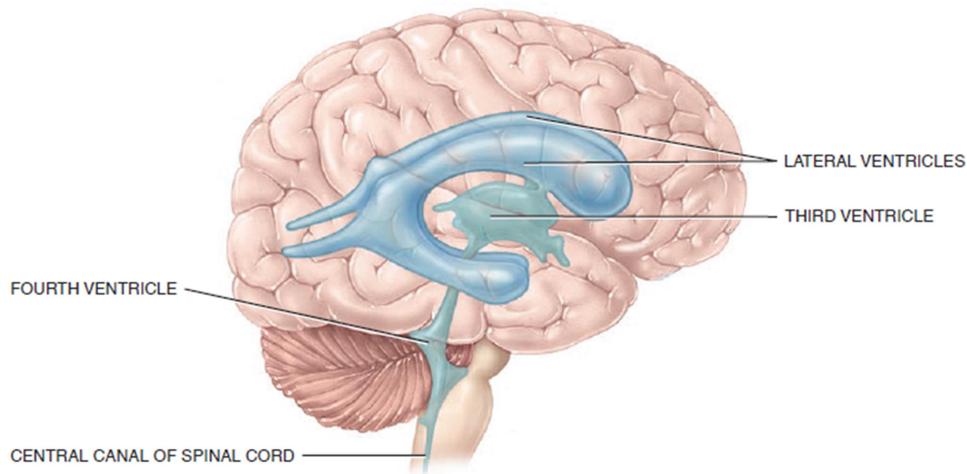


Figure : The ventricular system of the brain.

### The Cerebral Circulation

The blood flow to the brain is supplied by:

- The anterior cerebral arteries (branch of internal carotid artery) .
- The middle cerebral artery(branch of internal carotid artery)
- The posterior cerebral arteries (branch of vertebral artery)

The distal branches of the cerebral arteries communicate at the base of the brain through the circle of Willis.

The cerebral circulation is drained by two sets of veins that empty into the dural venous sinuses. This system of sinuses returns blood to the heart primarily through the internal jugular veins.

### Blood-Brain Barrier.

The cerebral capillaries allow only a few substances to diffuse into cerebral tissues (like O<sub>2</sub>, CO<sub>2</sub>, Glucose) and prevent the passage of toxic substances to protect delicate neurons. This characteristic is called the blood-brain barrier. Its function depends on

- the tight junctions between endothelial cells of brain capillaries
- most brain capillaries are completely surrounded by a basement membrane
- the processes of supporting astrocyte cells of the brain

### The Spinal Cord

The spinal cord lies in the vertebral canal. It is about 42 to 45 cm in length, it extends from the foramen magnum at the base of the skull to a cone-shaped termination, the conus medullaris, usually at the level of the first or second lumbar vertebra (L1 or L2). Below this level, the terminal end of the spinal cord is called the *cauda equina* ("horse's tail"). The pia mater of the spinal

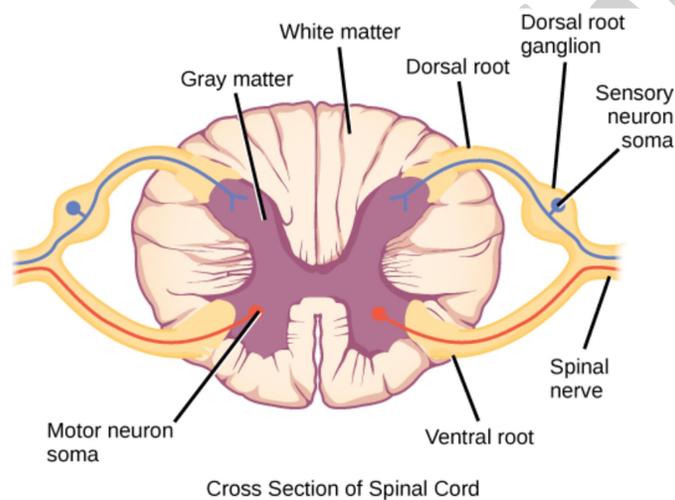
cord, continues caudally and attaches to the second sacral vertebra (S2) this portion called the filum terminale.

### Cross-Sectional Anatomy

Like the brain, the spinal cord is covered by meninges and bathed in CSF within bony vertebral canal.. The spinal cord is somewhat oval on transverse section and consist of

**I. gray matter**, the spinal cord has a central core of gray matter that looks somewhat butterfly- or H-shaped in cross sections, with the central canal in the midline, the central canal filled with CSF.

**II.The white matter**, contains bundles of myelinated nerve fibers ascending and descending through the spinal cord.



#### 1. Ascending tracts

- Dorsal column, it carry sensory signals of vibration, visceral pain, touch, and proprioception from different part of body to brain.
- The spinothalamic tract, carries signals for pain, temperature, from different part of body to brain.
- The spinocerebellar tracts carry proprioceptive signals from the limbs and trunk to the cerebellum. the tracts provide the cerebellum with feedback needed to coordinate muscle action.

#### 2.Descending Tracts

Descending tracts carry motor signals down the brainstem and spinal cord to different muscle of the body , like corticospinal tracts.

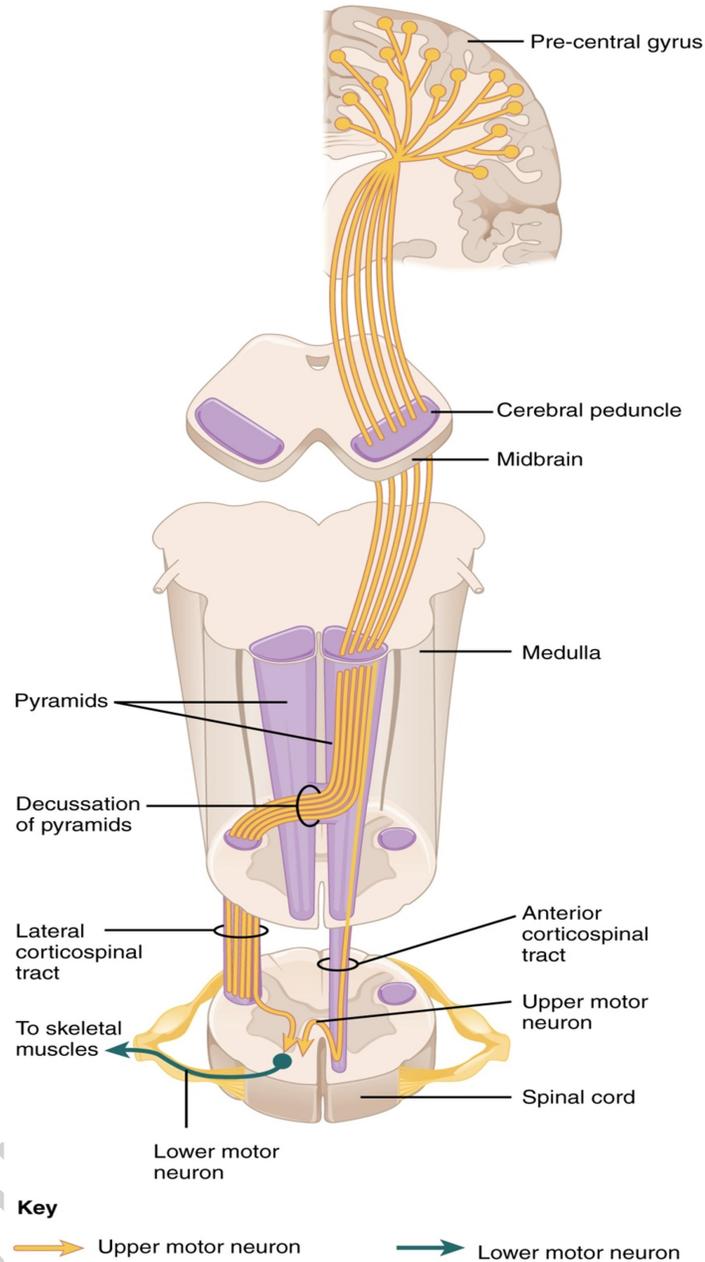


Figure:descending tracts

**Spinal Nerves**

The peripheral nerves that carry information to and from the spinal cord are called spinal nerves. There are 32 or more pairs of spinal nerves (i.e., 8 cervical, 12 thoracic, 5 lumbar, 5 sacral, and 2 or more coccygeal). Each spinal cord had two roots:

- dorsal root, carrying the axons of afferent neurons into the CNS.

- ventral root, carrying the axons of efferent neurons into the periphery.

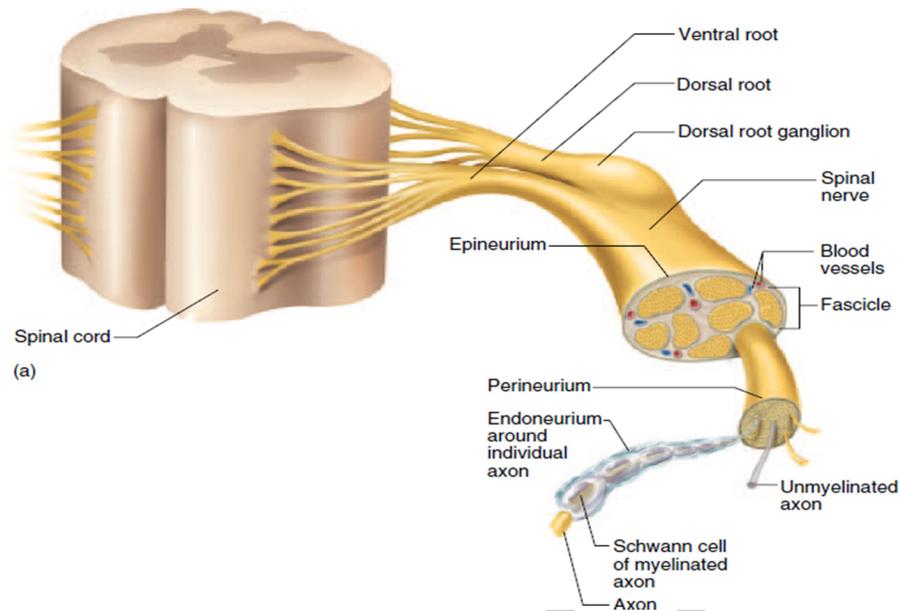


Figure: spinal nerve

### Functions

The spinal cord serves three principal functions:

1. conduct information up and down between the brain and periphery.
2. Locomotion, motor neurons in the brain initiate walking and determine its speed, distance, and direction, but the simple repetitive muscle contractions that put one foot in front of another, over and over, are coordinated by groups of neurons called central pattern generators in the cord.
3. Reflexes. Reflexes are involuntary stereotyped responses to stimuli.

### Reflex

Reflexes are sudden, , subconscious response to changes within or outside the body. Spinal reflexes concerned with unlearned skeletal muscle reflexes. They result in the involuntary contraction of a muscle—for example, the quick withdrawal of your hand from a hot stove .the spinal reflex arc, in which signals travel along the following pathway:

1. somatic receptors in the skin, a muscle, or a tendon.
2. afferent nerve fibers, which carry information from these receptors into the spinal cord.
3. interneurons in spinal cord.

4. efferent nerve fibers, which carry motor impulses from spinal cord to the skeletal muscles.
5. effector, like skeletal muscles, that carry out the response..

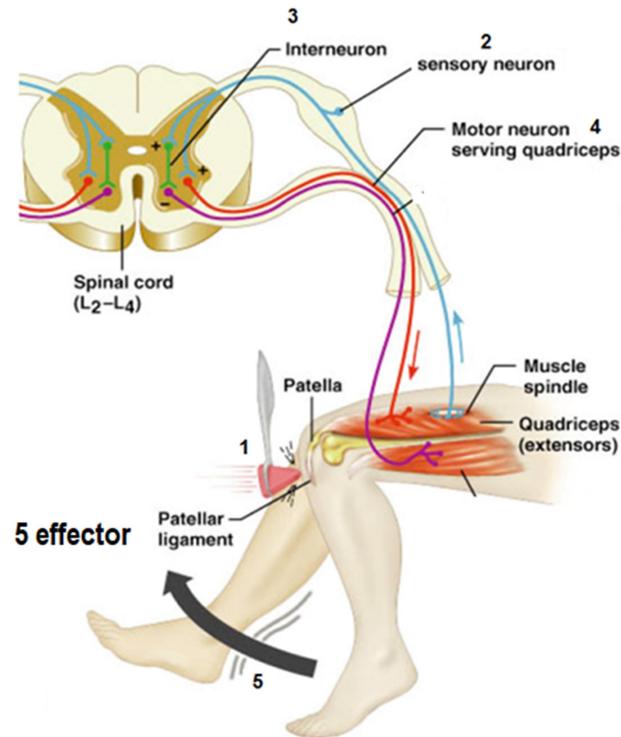


Figure: knee-jerk (patellar) reflex.

### Types of spinal motor reflexes

#### 1.The (flexor ) withdrawal reflex

A flexor reflex is the quick contraction of flexor muscles resulting in the withdrawal of a limb from an injurious stimulus

#### 2.stretch reflexes

Stretch (tendon) reflex, defined as the reflexive contraction of a muscle when its tendon is tapped like:

- **knee-jerk (patellar) reflex**, When you tap the patellar tendon with a rubber hammer, the quadriceps muscles contract and leg extended , this is called the patellar reflex.

### Dermatome

The area of body supply by each spinal cord nerve called dermatome.

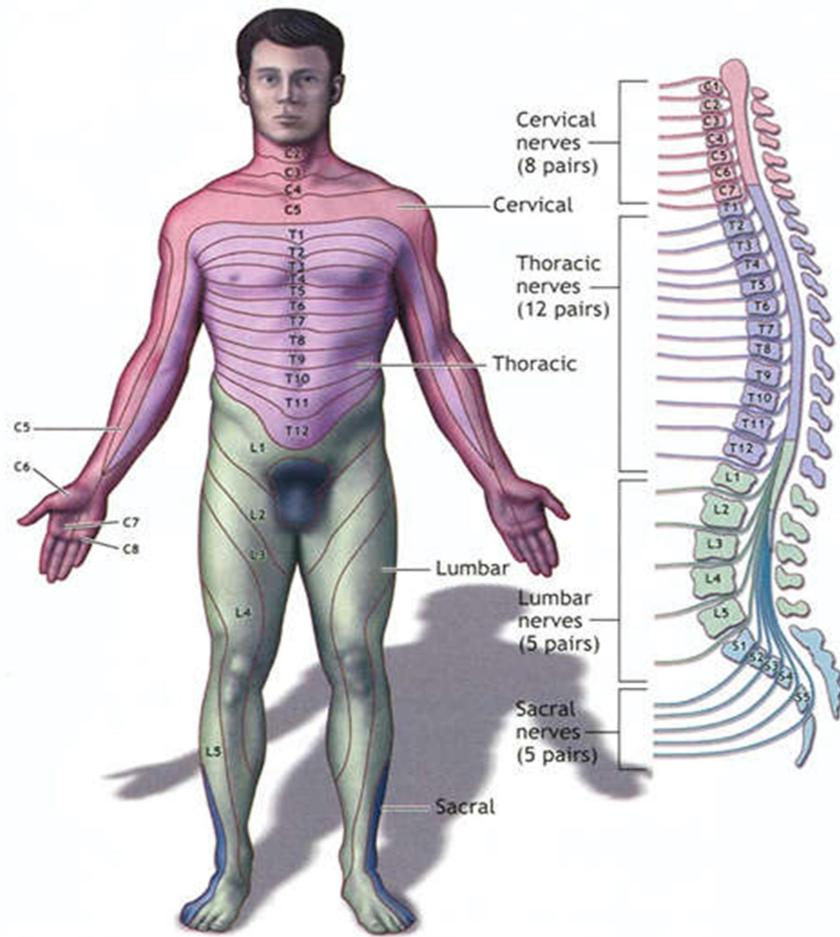


Figure: A dermatome map

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