11.1A: Overview of the Spinal Cord

The spinal cord runs along the inside of the vertebral column and serves as the signaling conduit between the brain and the periphery.

Learning Objectives

• Describe the features of the spinal cord

Key Points

• The spinal cord extends from the occipital bone of the skull until it terminates near the second lumbar vertebra.
• The spinal cord is protected by three layers of meninges: the dura mater, the arachnoid mater, and the pia mater.
• The central nervous system (CNS) is made up of the brain and spinal cord. The area between the arachnoid space and the pia mater contains cerebral spinal fluid (CSF).
• The spinal cord is divided into 31 segments that send nerve rootlets out into the body through intervertebral foramen.
• Each segment of the spinal cord is associated with a pair of ganglia called dorsal root ganglia, which are situated just outside of the spinal cord and contain cell bodies of sensory neurons. These neurons travel into the spinal cord via the dorsal roots.
• Ventral roots consist of axons from motor neurons, which bring information to the periphery from cell bodies within the CNS. Dorsal roots and ventral roots come together and exit the intervertebral foramina as they become spinal nerves.
Key Terms

- **peripheral nervous system**: The part of the nervous system that consists of the nerves and ganglia on the outside of the brain and spinal cord.
- **efferent**: The conduction of impulses outward from the brain or spinal cord.
- **afferent**: The conduction of impulses inwards to the brain or spinal cord.
- **cauda equina**: A bundle of nerve roots at the base of the spinal column.
- **spinal cord**: A thick, whitish cord of nerve tissue which is a major part of the vertebrate central nervous system. It extends from the brain stem down through the spine, with nerves branching off to various parts of the body.

**EXAMPLES**

- A lumbar puncture (spinal tap) is an example of a medical procedure that directly targets the spinal cord.
- The birth defect spina bifida is a failure of the vertebral arch to close, exposing the spinal cord.

The spinal cord is a long, thin, tubular bundle of nervous tissue and support cells that extends from the medulla oblongata of the brain to the level of the lumbar region. The brain and spinal cord together make up the central nervous system (CNS). The spinal cord, protected by the vertebral column, begins at the occipital bone and extends down to the space between the first and second lumbar vertebrae. The spinal cord has a varying width, ranging from 0.5 inch thick in the cervical and lumbar regions to 0.25 inch thick in the thoracic area. The length of the spinal cord is approximately 45 cm (18 in) in men and about 43 cm (17 in) long in women.
Spinal Cord and Vertebrae.png: Relationship between the spinal cord and vertebral column, delineating the cervical, thoracic, and lumbar sections.

Layers and Regions of the Spinal Cord

The spinal cord is protected by three layers of tissue called meninges and divided into three regions.

Spinal Cord Tissue Layers

The dura mater is the outermost layer of spinal cord tissue, forming a tough protective coating. The space between the dura mater and the surrounding bone of the vertebrae is called the epidural space. The epidural space is filled with adipose tissue and contains a network of blood vessels. The middle layer is called the arachnoid mater. The pia mater is the innermost protective layer and is tightly associated with the surface of the spinal cord. The space between the arachnoid and pia mater is called the subarachnoid space and is where the CSF is located. It is from this location at the level of the lumbar region that CSF fluid is obtained in a spinal tap.

Spinal Cord Regions

In cross-section, the peripheral region of the cord displays neuronal white matter tracts containing sensory and motor
neurons. Internal to this peripheral region is the gray, butterfly-shaped central region made up of nerve cell bodies. This central region surrounds the central canal, which is an anatomic extension of the spaces in the brain known as the ventricles and like the ventricles, contains cerebrospinal fluid.

Spinal Cord Regions: Cross-sectional perspective of the spinal cord regions

The spinal cord is divided into cervical, thoracic, and lumbar regions. The cervical region is divided into eight levels that are related to different motor and sensory functions in the neck and the arms. The spinal nerves of the thoracic region supply the thorax and abdomen. The nerves of the lumbosacral spinal cord supply the pelvic region, legs, and feet.

Spinal Cord Nerve Branches

Thirty-one pairs of spinal nerves (sensory and motor) branch from the human spinal cord. Each spinal nerve is formed from the combination of nerve fibers from its posterior and anterior roots. The posterior root is the sensory (afferent) root that carries sensory information to the brain from other areas of the body. The anterior root is the motor (efferent) root that carries motor information to the body from the brain.

The spinal nerve emerges from the spinal column through the opening (intervertebral foramen) between adjacent vertebrae. An exception is the first spinal nerve pair (C1), which emerges between the occipital bone and the atlas (the first vertebra). The swelling found in the posterior root is the posterior (dorsal) root ganglion, which contains the cell bodies of sensory neurons. The anterior (ventral) root contains axons of motor neurons that conduct nerve impulses from the CNS to other parts of the body such as the muscles.

The cauda equina ("horse’s tail") is the name for the collection of nerves in the vertebral column that extends beyond the cord. The nerves that compose the cauda equina supply the pelvic organs and lower limbs, including motor innervation for the hips, knees, ankles, feet, and internal and external anal sphincters. In addition, the cauda equina extends to sensory innervation of the perineum.

Primary Spinal Cord Function

The spinal cord functions primarily in the transmission of neural signals between the brain and the rest of the body, but it also contains neural circuits that can independently control numerous reflexes and central pattern generators. The three major functions of the spinal cord are the conduction of motor information traveling down the spinal cord, the conduction of sensory information in the reverse direction, and acting as the center for conducting certain reflexes. The spinal cord is the main pathway for information connecting the brain and peripheral nervous system.