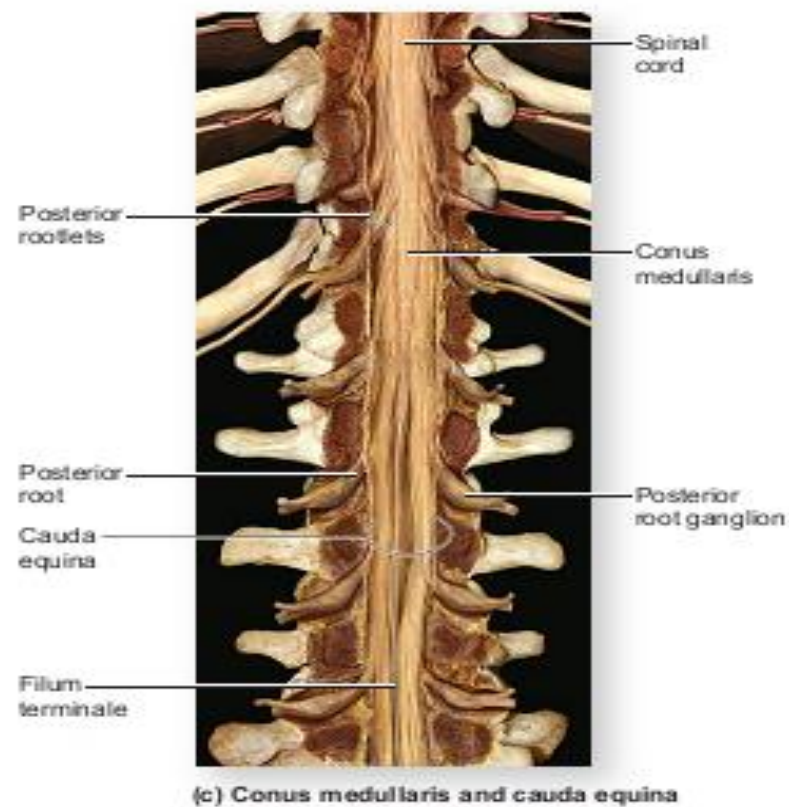
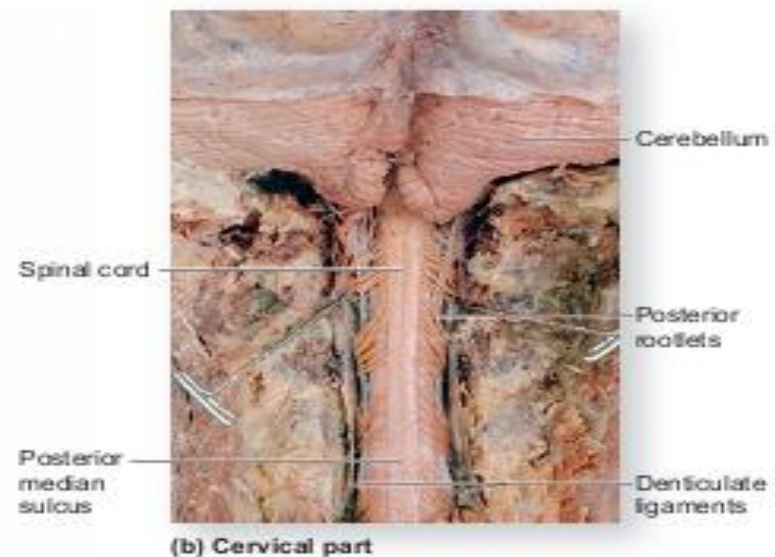
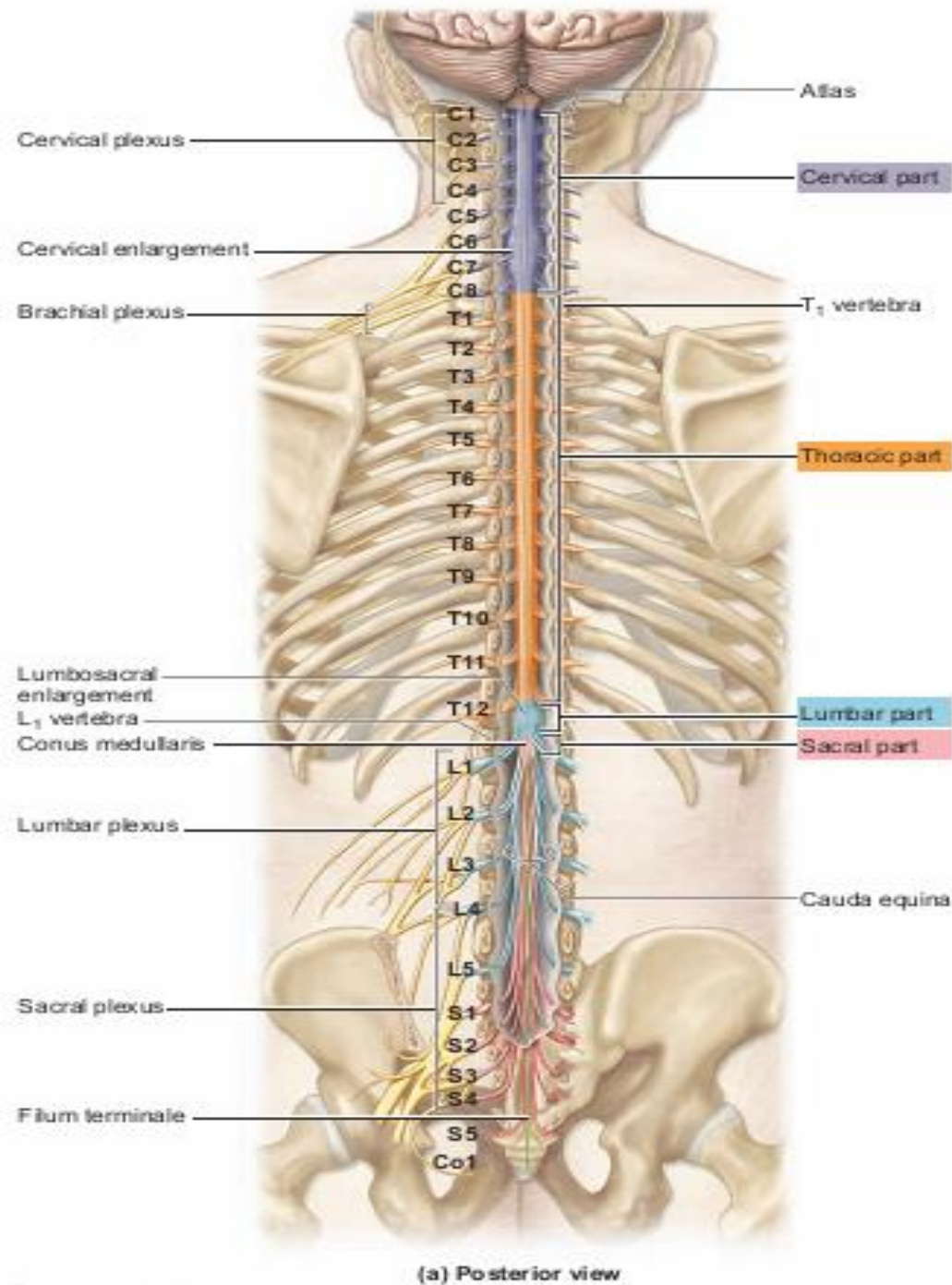


# Spinal cord

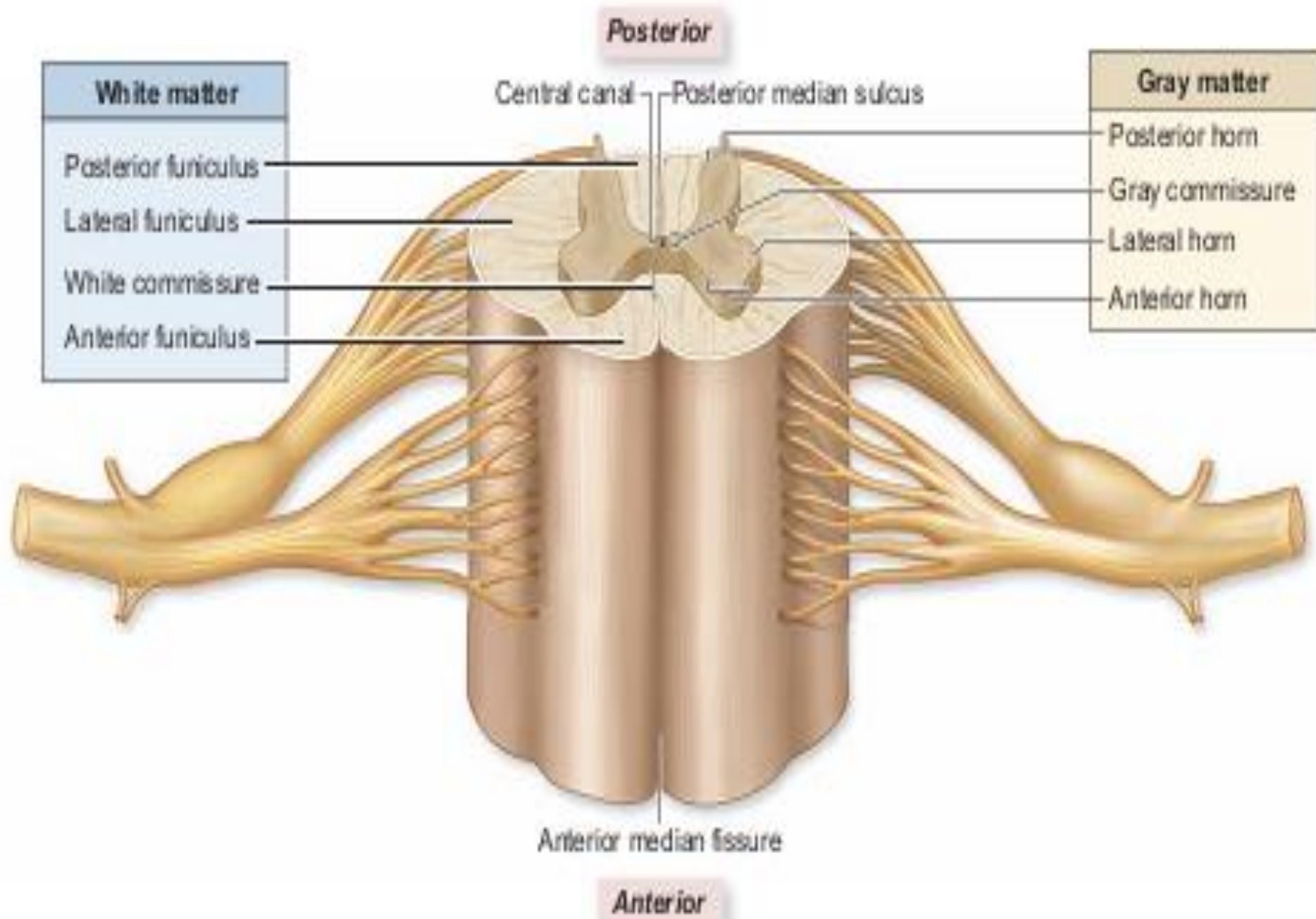
- The second organ of the CNS is spinal cord which serve as communication link between the brain and the PNS
- In adult spinal cord ranges between 42 and 45 cm in length and extends inferiorly from the brain through the foramen magnum and then through the vertebral canal and ends at the level of the L1 vertebra.
- It is considerably shorter than the vertebral column because it does not grow as rapidly as the vertebral column during development.
- The spinal cord gives rise to 31 pairs of spinal nerves, which exit the vertebral column through intervertebral and sacral foramina
- The spinal cord is divided into four regions
  - ❑ **The cervical part-** superiormost region of the spinal cord, continuous with the medulla oblongata
  - ❑ **The thoracic part** lies inferior to the cervical part
  - ❑ **The lumbar part** is a shorter segment of the spinal cord
  - ❑ **The sacral part**
  - ❑ **The coccygeal part** is the most inferior “tip” of the spinal cord

- Two prominent enlargements can be seen in an external view. The **cervical enlargement** is located between the **third cervical and the second thoracic** vertebrae. Nerves emerging from this region serve the upper extremities.
- The **lumbar enlargement** lies between the **ninth and twelfth thoracic** vertebrae. Nerves from the lumbar enlargement supply the lower extremities.
- Immediately inferior to the lumbosacral enlargement, the spinal cord tapers to form a conelike region called the conus medullaris which makes the inferior end of spinal cord.
- Inferior to conus medullaris there is groups of axons collectively called the cauda equina
- Arising from the conus medullaris is the filum terminale which is an extension of the pia mater that extends inferiorly and fuses with the arachnoid mater and dura mater and anchors the spinal cord to the coccyx
- Two grooves, an **anterior median fissure** and a **posterior median sulcus**, extend the length of the spinal cord and partially divide it into right and left portions.
- Like the brain, the spinal cord is protected by three distinct meninges and is cushioned by cerebrospinal fluid.



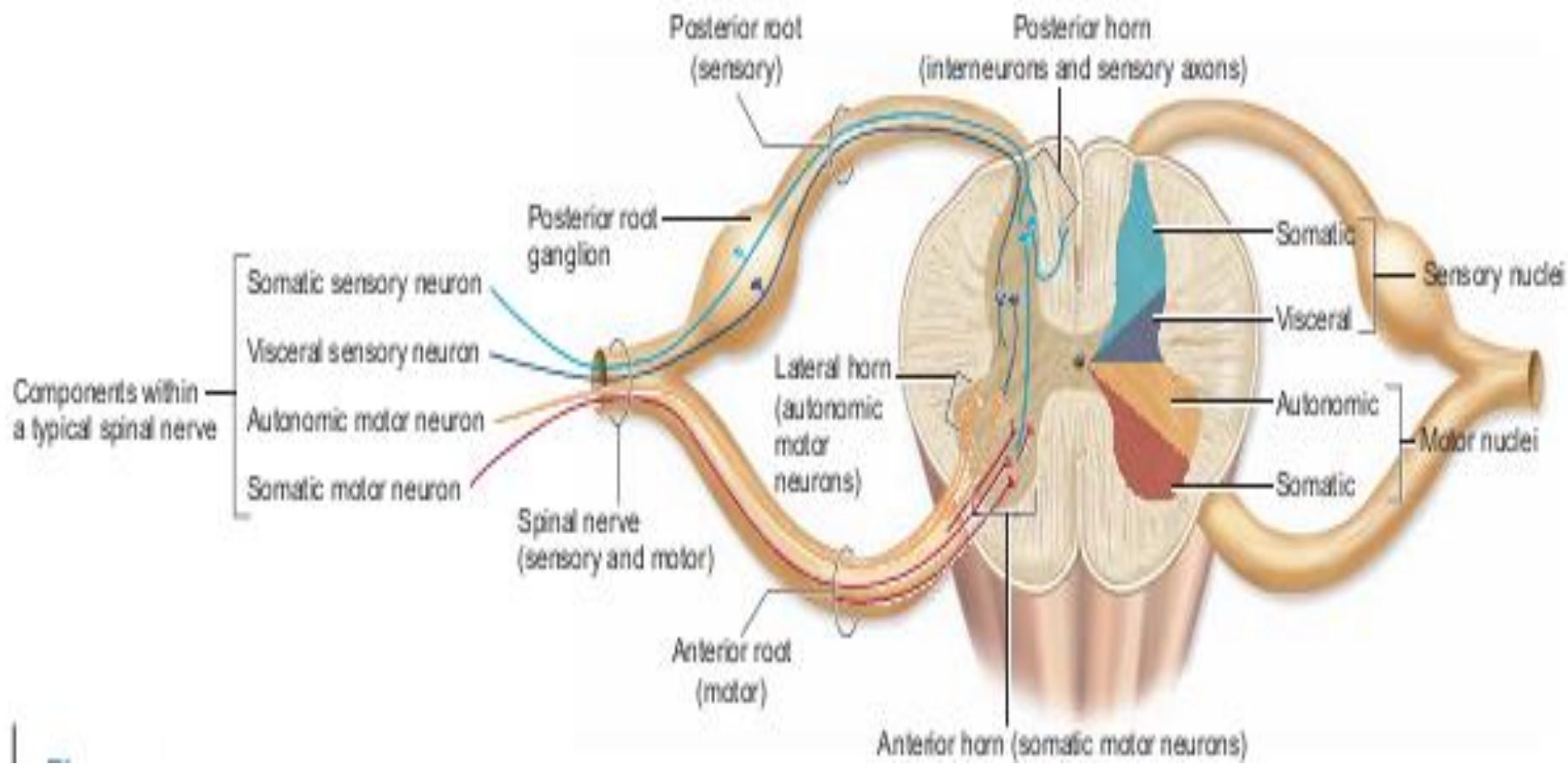
- A transverse section of the spinal cord reveals regions of white matter that surround an inner core of gray matter.
- The gray matter of the spinal cord is shaped like the letter H or a butterfly; it consists of dendrites and cell bodies of neurons, unmyelinated axons, and neuroglia.
- Projections of the gray matter within the spinal cord are called ***horns***, and are *named according to the direction* in which they project.
  - ❑ The paired **posterior horns** extend posteriorly. Contain cell bodies and axons of interneurons as well as axons of incoming sensory neurons
  - ❑ The paired **anterior horns** project anteriorly. Contain somatic motor nuclei, which are clusters of cell bodies of somatic motor neurons that provide nerve impulses for contraction of skeletal muscles
  - ❑ Paired **Lateral horns extend to the sides** between the posterior and anterior horns. Contain autonomic motor nuclei, which are clusters of cell bodies of autonomic motor neurons that regulate the activity of cardiac muscle, smooth muscle, and glands.
- The **gray commissure** forms the crossbar of the H. In the center of the gray commissure is a small space called the central canal; it extends the entire length of the spinal cord and is filled with cerebrospinal fluid. At its superior end, the central canal is continuous with the fourth ventricle

- The spinal cord has **six columns of white matter called funiculi** *which are named according to their relative position* within the spinal cord.
  - ❑ The two **anterior funiculi** are located between the two anterior horns of gray matter, to either side of the anterior median fissure.
  - ❑ The two **posterior funiculi** are located between the two posterior horns of gray matter, to either side of the posterior median sulcus.
  - ❑ Two **lateral funiculi** are located between the anterior and posterior horns of gray matter.



(a) Gray and white matter





# Spinal nerves

- Spinal nerves are the paths of communication between the spinal cord and specific regions of the body.
- There are 31 pair of spinal nerves.
  - ☐ 8 pairs of cervical nerves (C1–C8),
  - ☐ 12 pairs of thoracic nerves (T1–T12),
  - ☐ 5 pairs of lumbar nerves (L1–L5),
  - ☐ 5 pairs of sacral nerves (S1–S5),
  - ☐ 1 pair of coccygeal nerves (Co1).
- A spinal nerve is a mixed nerve attached to the spinal cord by a posterior (dorsal) root, composed of sensory fibers, and an anterior (ventral) root, composed of motor fibers
- The posterior root is formed from merger of posterior rootlets which arise from **posterior root ganglion** which itself is attached to spinal cord. Posterior root axons bring sensory information. The posterior root ganglion is made up of cell bodies of sensory neurons.
- The anterior root is formed from merger of multiple anterior rootlets which arise from spinal cord. The anterior root consists of axons of motor neurons, which convey motor impulses away from the CNS.



- A spinal nerve is formed as the fibers from the posterior and anterior roots converge and emerge through an intervertebral foramen
- After leaving the intervertebral foramen spinal nerve splits into branches, termed rami.
- There are three types of rami:
  - ❑ **Anterior ramus:** splits into multiple other branches, which innervate the anterior and lateral portions of the trunk, the upper limbs, and the lower limbs.

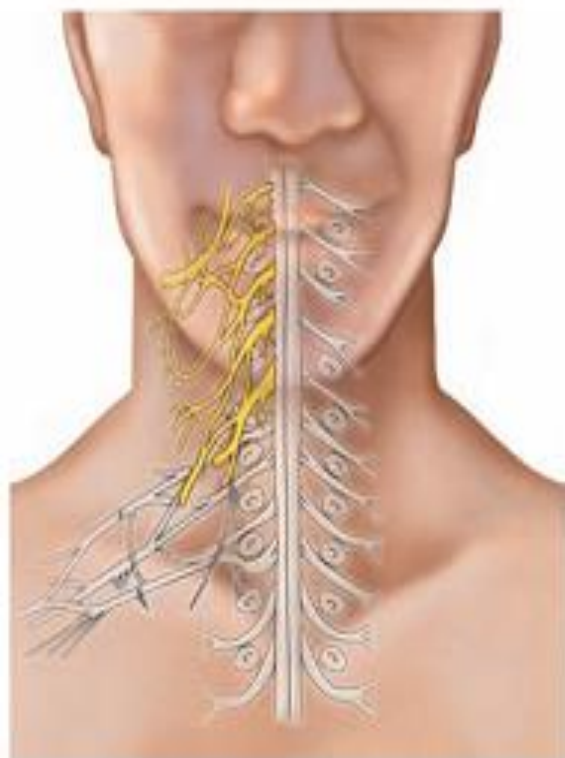
The anterior/ventral rami are distributed in two ways. In the thoracic region, the ventral rami form intercostal (between ribs) nerves which extend along the inferior margin of each rib and innervate the intercostal muscles and the skin over the thorax.

The ventral rami of the cervical, lumbar, sacral, and coccygeal spinal nerves form plexuses
  - ❑ **Posterior ramus:** innervates the deep muscles and the skin of the back
  - ❑ **Rami communicantes:** These rami contain axons associated with the autonomic nervous system. Each set of rami communicantes extends between the spinal nerve and the sympathetic trunk ganglion

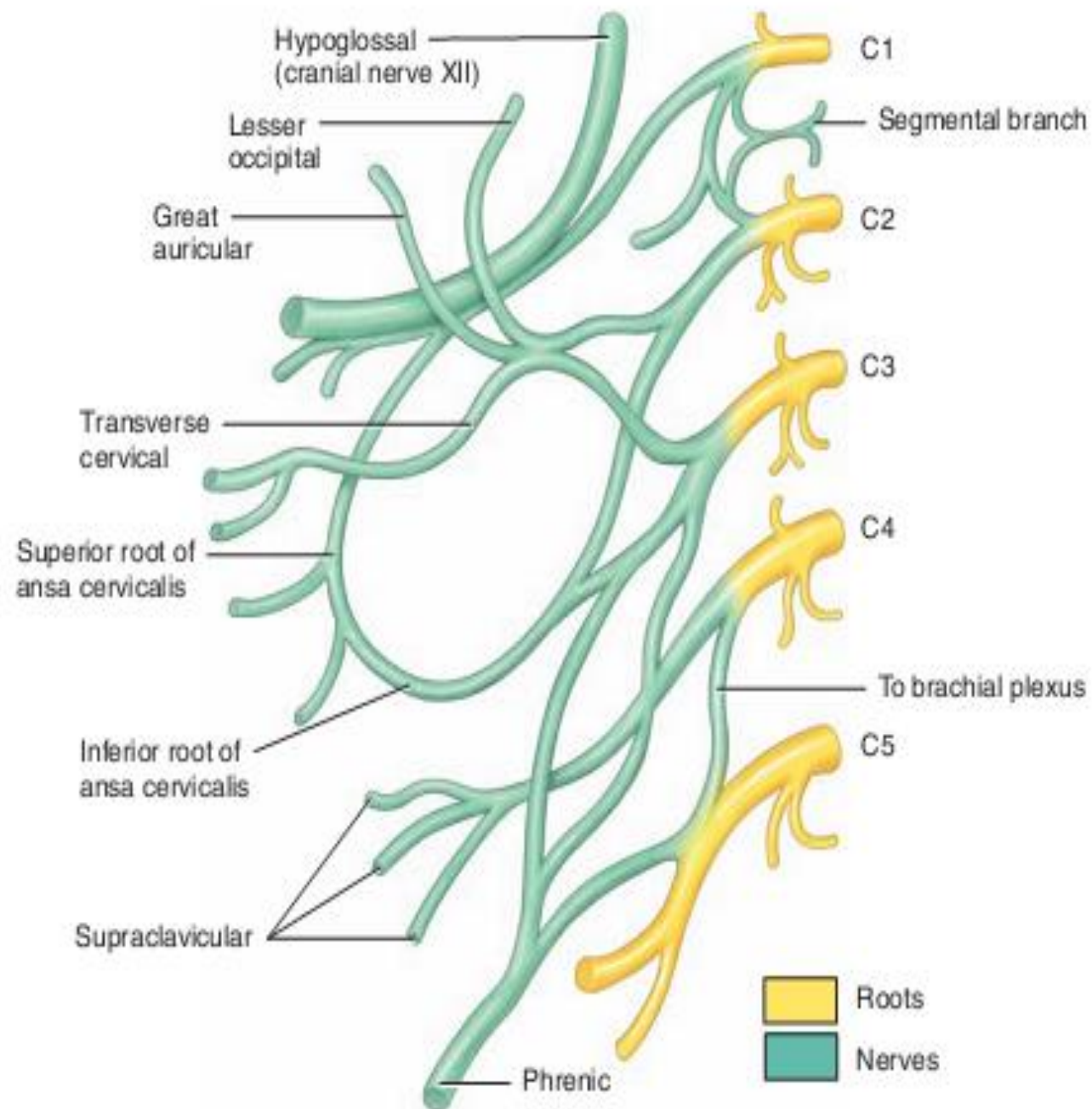
# Spinal Plexus

- Except in thoracic nerves, T2 through T12, the *anterior rami* of the spinal nerves combine and then split again as networks of nerve fibers referred to as nerve plexuses
- The principal plexuses are the cervical plexus, brachial plexus, lumbar plexus, and sacral plexus
- Nerves emerging from the plexuses are named according to the structures they innervate
- The anterior rami of spinal nerves T2–T12 do not enter into the formation of plexuses and are known as intercostal or thoracic nerves. These nerves directly connect to the structures they supply in the intercostal spaces. They supply the intercostal muscles, rib cage, abdominal muscles and skin of these areas

- The cervical plexus *is positioned deep on the side of the neck*, lateral to the first four cervical vertebrae.
- It is formed by the anterior rami of the first four cervical nerves (C1–C4) and a portion of C5.
- Branches of the cervical plexus innervate the skin and muscles of the neck and portions of the head and shoulders.
- Some fibers of the cervical plexus also combine with the accessory and hypoglossal cranial nerves to supply dual innervation to some specific neck and pharyngeal muscles.
- An important nerve that originate from cervical plexus with contribution from brachial plexus is phrenic nerve. It descend along each side of the neck to enter the thorax, after passing through mediastinum reaches the diaphragm



Cervical plexus projected to surface



Origin of cervical plexus

# Brachial plexus

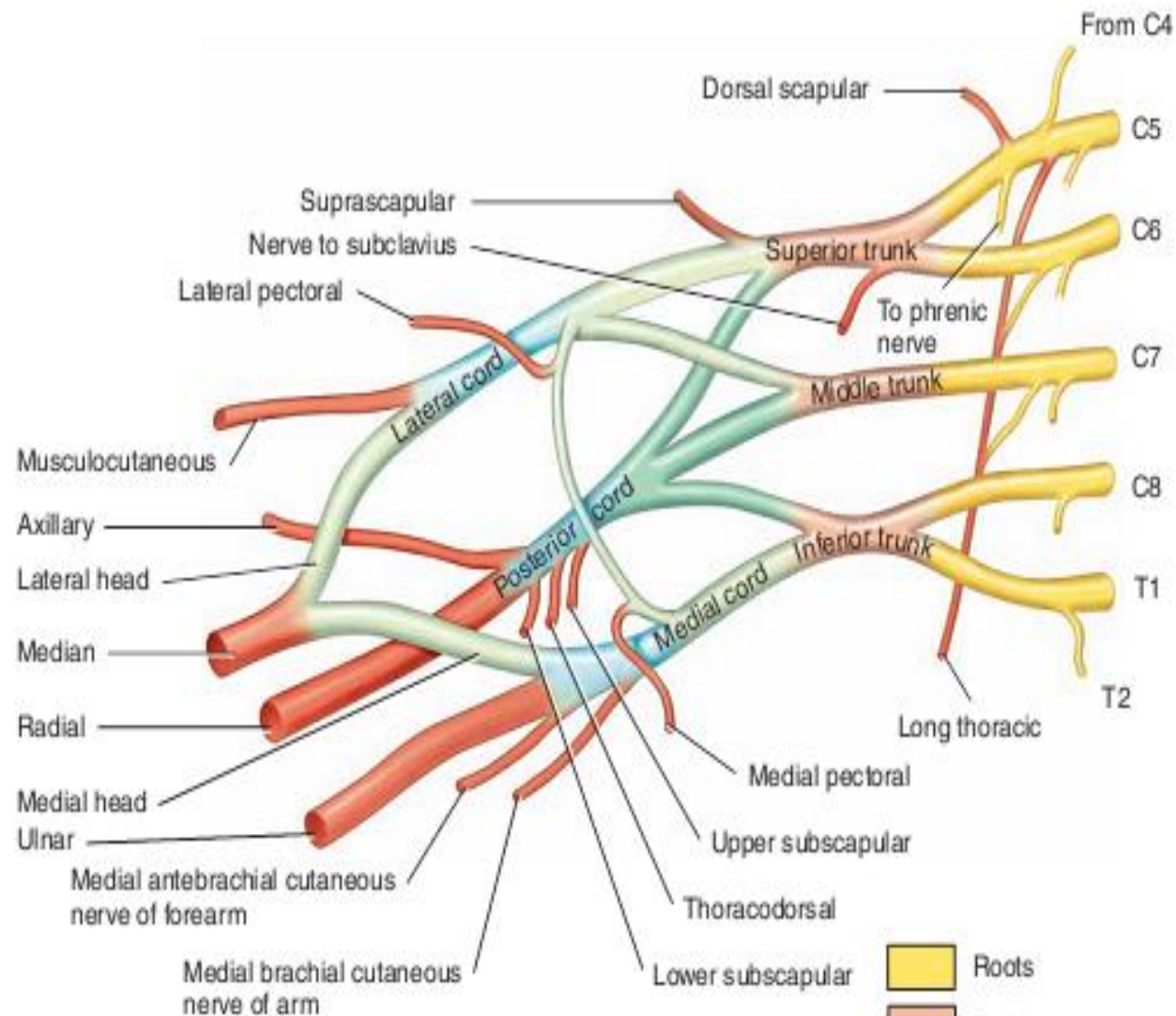
- The brachial plexus is positioned to the side of the last four cervical vertebrae and the first thoracic vertebra.
- It is formed by the anterior rami of C5 through T1, with occasional contributions from C4 and T2.
- From its emergence, the brachial plexus extends downward and laterally, passes over the first rib behind the clavicle, and enters the axilla.
- Each brachial plexus innervates the entire upper extremity of one side, as well as a number of shoulder and neck muscles.
- Structurally, the brachial plexus is divided into roots, trunks, divisions, and cords.

- The roots of several spinal nerves unite to form trunks in the inferior part of the neck. These are the superior, middle, and inferior trunks. Posterior to the clavicles, the trunks divide into divisions, called the anterior and posterior divisions. In the axillae, the divisions unite to form cords called the lateral, medial, and posterior cords. The cords are named for their relationship to the axillary artery, a large artery that supplies blood to the upper limb. The principal nerves of the brachial plexus branch from the cords.
- The important nerves that arise from the brachial plexus are axillary nerve, musculocutaneous nerve, radial nerve, ulnar and medial nerve





Brachial plexus projected to surface



(a) Origin of brachial plexus



MNEMONIC for subunits of the brachial plexus:

**R**isk Takers **D**on't **C**autiously **B**ehave.

**R**oots, **T**runks, **D**ivisions, **C**ords, **B**ranches

# Lumbar plexus

- The lumbar plexus is positioned to the side of the first four lumbar vertebrae.
- It is formed by the anterior rami of spinal nerves L1 through L4 and some fibers from T12.
- The nerves that arise from the lumbar plexus innervate structures of the lower abdomen and anterior and medial portions of the lower extremity.

# Sacral Plexus

- The **sacral plexus** lies immediately inferior to the lumbar plexus.
- It is formed by the anterior rami of spinal nerves L4, L5, and S1 through S4.
- The nerves arising from the sacral plexus innervate the lower back, pelvis, perineum, posterior surface of the thigh and leg, and dorsal and plantar surfaces of the foot.
- **Because some of the nerves** of the sacral plexus also contain fibers from the nerves of the lumbar plexus through the **lumbosacral trunk**, these two plexuses are frequently described collectively as the **lumbosacral plexus**.

- The **sciatic nerve** *is the largest nerve arising from* the sacral plexus and is the largest nerve in the body.
- The sciatic nerve passes from the pelvis through the greater sciatic notch of the os coxae and extends down the posterior aspect of the thigh.
- It is actually composed of two nerves—the tibial and common fibular nerves—wrapped in a connective tissue sheath.
- The **tibial nerve** arises from the anterior division of the sacral plexus, extends through the posterior regions of the thigh and leg, and branches in the foot to form the **medial and lateral plantar nerves**.
- The **common fibular nerve (peroneal nerve)** arises from the posterior division of the sacral plexus, extends through the posterior region of the thigh, and branches in the upper portion of the leg into the **deep and superficial fibular nerves**