



- Where does the spinal cord end?
 - **In adults:** at the lower border of L1 vertebra.
 - **In newborns:** at the level of L3 vertebra.
- The spinal cord is surrounded by the dura which is ending at the level of S2 vertebra. After the dura ends, there will be extension of pia mater known as filum terminale.
- The spinal cord has 2 swellings:
 - **In the cervical/upper thoracic region.**
 - **And in the lumbosacral region.**

Note: these swelling are due to the formation of two important plexuses which are supplying the limbs of the body from these two areas.
- Cervical vertebrae (C2 & C7):
 - They have **massive white mater** because all ascending and descending fibers are present at this point/region.

Note: the closer the injury to the brain, the worse it is.
- As you descend reaching (L4 & S4):
 - The **white mater will be smaller** because some fibers have left.
- In a cross-section of the spinal cord, you will notice that it has:
 - **A ventral median fissure.**
 - **And a posterior median sulcus.**
- Dura matter: it is the outermost covering of the spinal cord. Internally, it is lined by arachenoid. Notice that when the dura is stretched this will result in its inflammation and a subsequent sensation of pain.
- Pia matter: it is anchored directly to the surface of spinal cord. Note that there are some extensions from the pia mater (denticulate ligaments) which will pass through the dura to attach to vertebral column (aim: support).
- The spinal nerve:
 - It is formed when ventral and dorsal roots merge together.
 - The spinal nerve and dura are directly attached to each other forming what is known as dura sleeve.
- Spinal cord and vertebral relationships:
 - The spinal cord is divided into imaginary segments which can be specified by counting the vertebral spines.
 - A spinal nerve exits above its corresponding vertebra in the cervical region. After the cervical region (after C8), spinal nerves will exit below their corresponding vertebrae.
 - **As you descend, you will notice that the vertebral column is longer than the spinal cord** → thus the nerve roots sacral region will descend further down as bundles of nerve roots known as cauda equina.
 - **Note** that the dorsal root ganglion is present at the level of intervertebral foramen.
- Neurologic deficits at segmental levels suggest a spinal cord disorder.
- Level and pattern of spinal cord dysfunction help determine presence and location of a spinal cord lesion but not always type of lesion.
- Vertebrae and corresponding spinal cord segments:

Cervical vertebrae (from C3 downwards)	+1 (example: if cervical vertebra is C4 → C4 + 1 = C5 spinal segment)
Thoracic vertebrae (T1-T6)	+2



Thoracic vertebrae (T7-T9)	+3
T10	Is corresponding to L1 & L2 spinal segments
T11	Is corresponding to L3 & L4 spinal segments
T12	Is corresponding to L5 spinal segment
L1	Is corresponding to sacral segments

- The spinal cord is a central structure which is sending and receiving signals through descending and ascending fibers respectively (motor and sensory functions).
- **The ascending pathways of the spinal cord are classified to:**
 - **Proprioceptive:** which is providing us with sensory information about the position and state of our different body parts. Proprioception can be conscious if the fibers are reaching the cerebral cortex (through the dorsal column pathway) or unconscious if the fibers are reaching the cerebellum (through the spino-cerebellar pathway).
 - **Exteroceptive:** which is transmitting sensory information coming from the body wall (modalities of sensation). These sensations include: fine touch, pressure, pain, temperature and crude touch.
- **Details about sensory (ascending) pathways:**
 - **Dorsal column-medial lemniscus pathway:**
 - ✓ It is transmitting: conscious proprioception, fine touch, vibration and two-points discrimination.
 - ✓ 1st order neurons: sensory fibers entering the spinal cord through the dorsal horn and going to the dorsal column (without synapsing) and ascend directly as:
 - ❖ *F.gracilis*: which is transmitting sensory information from lower limbs and is occupying the medial part of the dorsal column.
 - ❖ *F.cuneatus*: which is transmitting information from upper limbs and is occupying the lateral part of the dorsal column.These fibers will ascend until they terminate in n.gracilis and n.cuneatus at the level of medulla.
 - ✓ 2nd order neurons: starting from n.gracilis and n.cuneatus in the medulla → crossing → and then ascending to end in VPL nucleus of the thalamus.
 - ✓ 3rd order neurons: from the thalamus to post-central gyrus in cerebral cortex.
 - ✓ What are the criteria required to classify fibers as lemnisci?
 - ❖ Sensory fibers.
 - ❖ Crossed.
 - ❖ Located in the brain-stem.
 - ❖ Terminating in the thalamus.
 - **Spino-thalamic pathway:**
 - ✓ Anterior spino-thalamic tract: transmitting crude touch. Sensory fiber enter the spinal cord through the dorsal horn and cross in the anterior spinal commissure 3-4 segments above the level of entry. After which 2nd order neurons will ascend to terminate in the VPL nucleus of the thalamus. 3rd order neurons are from the thalamus to the post-central gyrus of cerebral cortex.
 - ✓ Lateral spino-thalamic tract: transmitting pain and temperature. Sensory fibers enter the spinal cord through the dorsal horn and cross the midline of the spinal cord 1-2 segments above the level of entry. After which 2nd order



neurons will ascend to terminate in the VPL nucleus of the thalamus. 3rd order neurons are from the thalamus to post-central gyrus of cerebral cortex.

- ✓ Note: lesion in anterolateral spinothalamic tract → loss of pain, temperature and crude touch from contralateral side of the body 2-3 segments below the level of the lesion.

- Proprioception:

- **Conscious**: transmitted by the dorsal column-ML pathway.
- **Unconscious**: transmitted by the spino-cerebellar tract which is further subdivided into:
 - ✓ Dorsal spino-cerebellar tract: transmitting information from lower limbs to ipsilateral cerebellum (through inferior cerebellar peduncle).
 - ✓ Ventral spino-cerebellar tract: fibers entering the spinal cord through the dorsal horn and crossing at the level of entry → then they ascend and re-cross again and then terminate in the ipsilateral cerebellum (through superior cerebellar peduncle).

- Why are there crossed fibers in the nervous system (what are the benefits of crossing)?

- Increasing the number of synapses and thus increasing the resolution → resulting in more opportunities for interpretation and analysis of different types of information.
- Engaging both sides of the spinal cord (with each side having an opposite activity to the other).
- Both sides of the cerebral cortex are receiving information from both sides of the spinal cord (this will aid in more control and coordination).

- Details about motor (descending) pathways: they are classified to:

- **Direct (pyramidal: because they are passing in medullary pyramids) tracts** → corticospinal pathway which is originating from the cerebral cortex and descending to control lower motor neurons that will terminate in the neuromuscular junction and causing movement of body muscles. 80% of corticospinal fibers will cross at the level of the medulla (the rest will continue without crossing).
 - ✓ Note: corticonuclear pathway is the one which is supplying musculature of the face.
- **Indirect (extrapyramidal) tracts** → including: tectospinal, reticulospinal, vestibulospinal, rubrospinal and olivospinal tracts.

- Blood supply of the spinal cord: from 3 small arteries:

- **Anterior spinal artery**: formed by branches from vertebral artery.
- **2 posterior spinal arteries**: formed by branches from the posterior inferior cerebellar arteries (PICA) or from vertebral arteries.

Note: radicular (feeder) arteries enter via intervertebral foramina and reinforce anterior and posterior spinal arteries and supply the dorsal root ganglia.

- Anterior spinal artery syndrome:

- Anterior spinal artery is supplying the anterior 2/3 of the spinal cord.
- At the level of lesion, there will be lower motor neuron type of problems.
- Below the level of lesion, there will be upper motor neuron type of problems.
- There will be bilateral loss of pain and temperature below level of lesion.
- Bilateral loss of crude touch below level of lesion.
- Bilateral dystaxia.
- **Note**: dorsal column and dorsal horns are spared.