Spinal Cord
Gross morphology & internal structure

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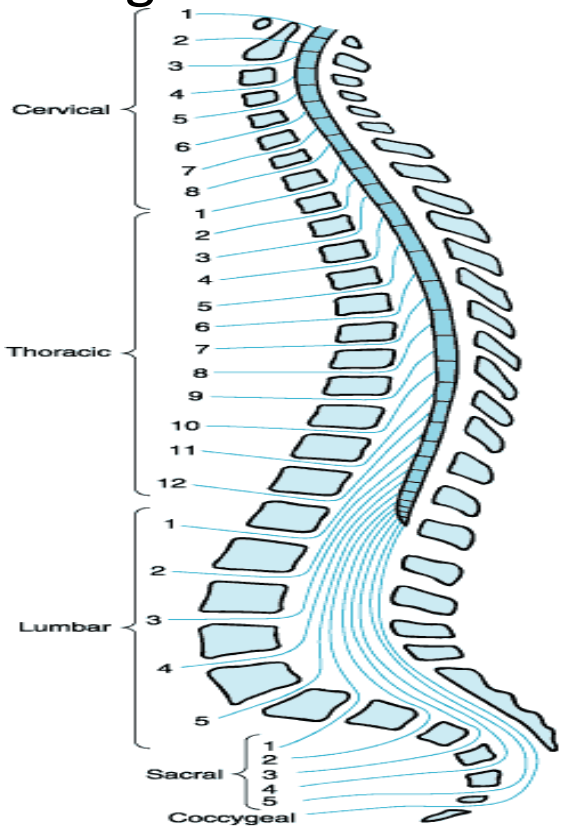
Spinal cord segments& levels

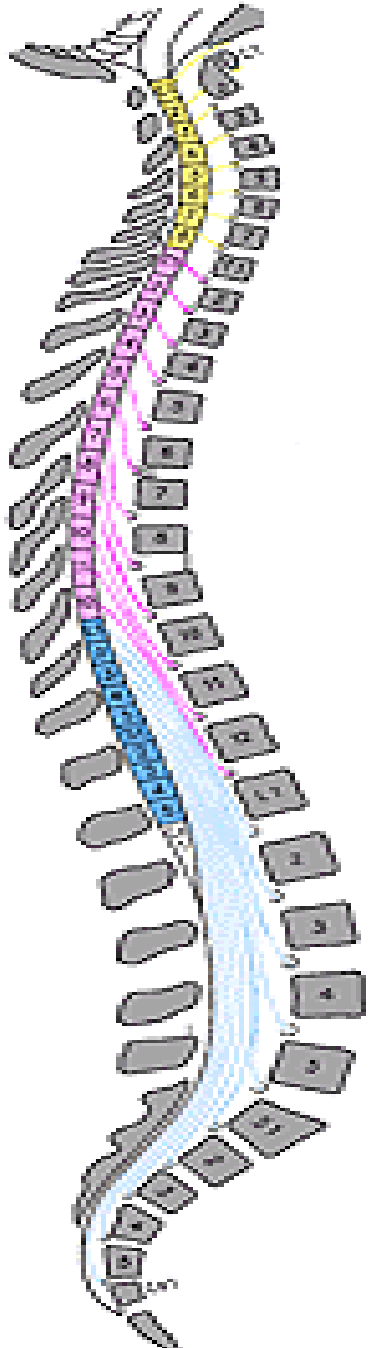
Spinal cord segments don't lie opposite the corresponding vertebra as the spinal cord is shorter than the vertebral column

- **Cervical region**: subtract one from spinal cord segment to get number of vertebra
- **In upper 6 thoracic**: subtract 2
- **In lower 6 thoracic**: subtract 3
- **In lumber** : subtract 4
- **All sacral& coccygeal:** lie opposite L1 &L2



Exit of Spinal nerve

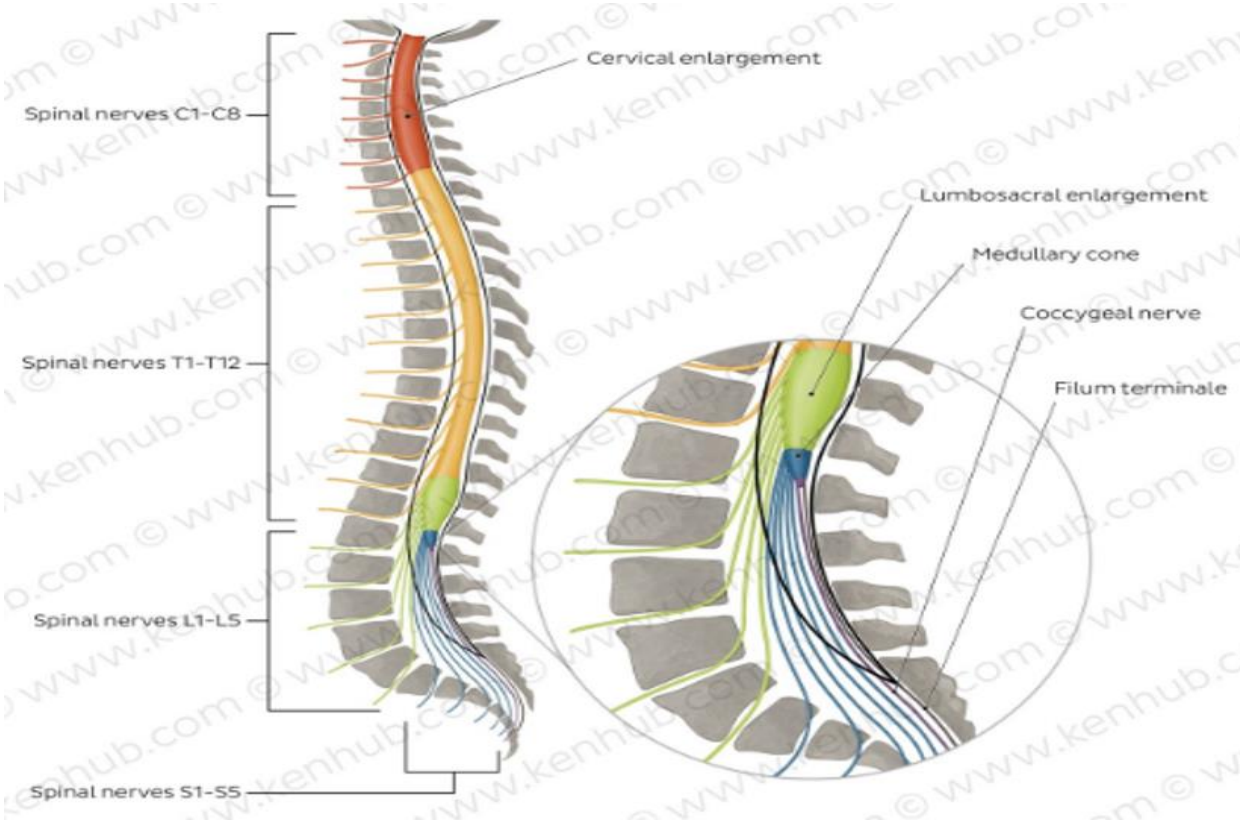
- C1 to C7 exit above the corresponding vert.
- C8 Passes below C 7 vertebra
- T1 –L5 passes below corresponding vertebra
- S1- S4 passes in sacral canal
- S5 passes in sacral hiatus

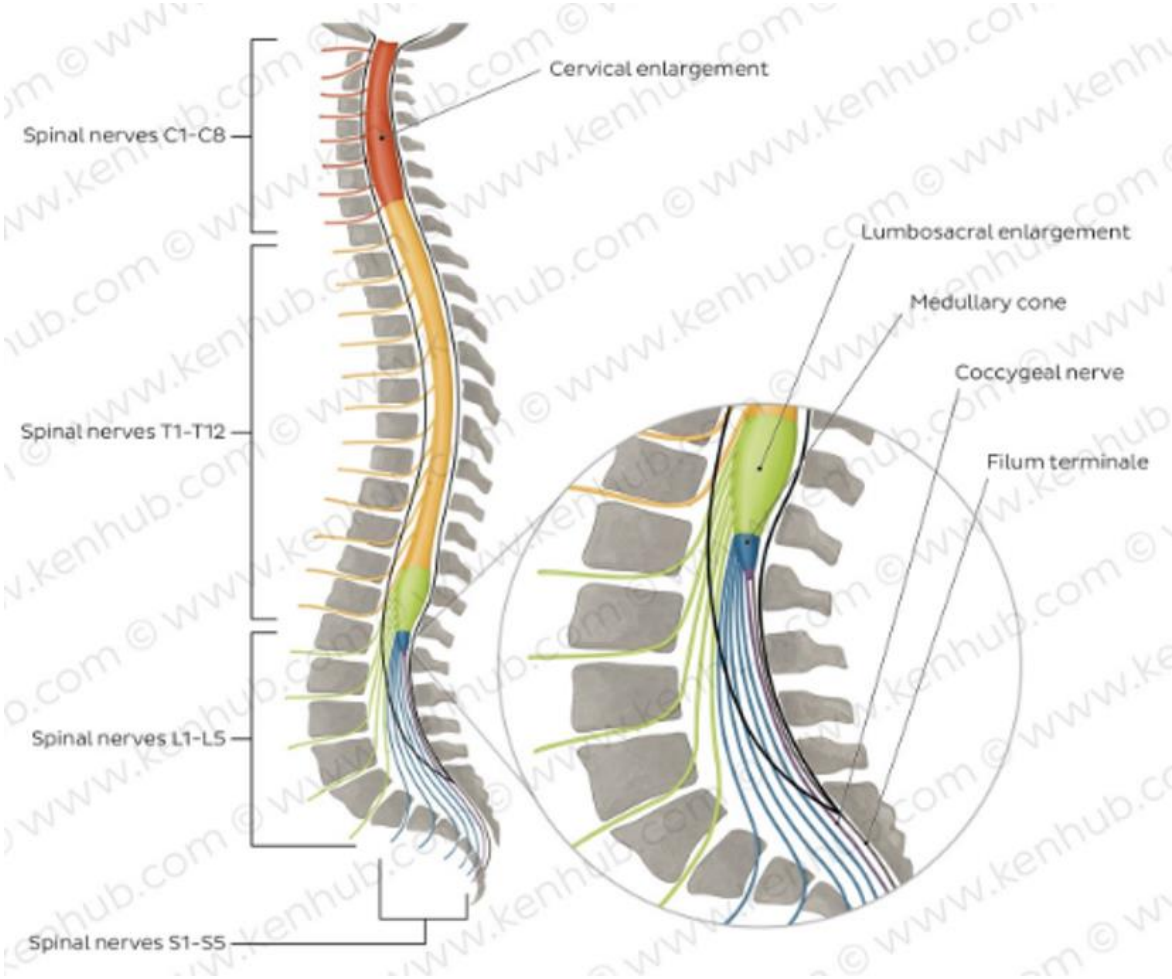


Direction of Roots

- **C1 and C2** : pass horizontal
- **C3 to T12**: pass oblique
- **Lumber, sacral, coccygeal**

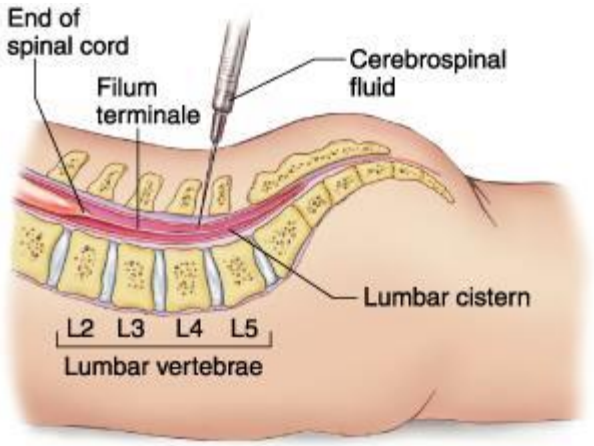
pass vertical in subarachnoid space to form **cauda equina**




Cervical enlargement
Spinal nerves C1-C8
Lumbosacral enlargement
Medullary cone
Coccygeal nerve
Filum terminale
Spinal nerves T1-T12
Spinal nerves L1-L5
Spinal nerves S1-S5

Lumbar Puncture

- In subarachnoid space
- Just above or below tip of 4 lumber spine
- Opposite an imaginary line connecting the highest points of iliac crest
- Either diagnostic or therapeutic



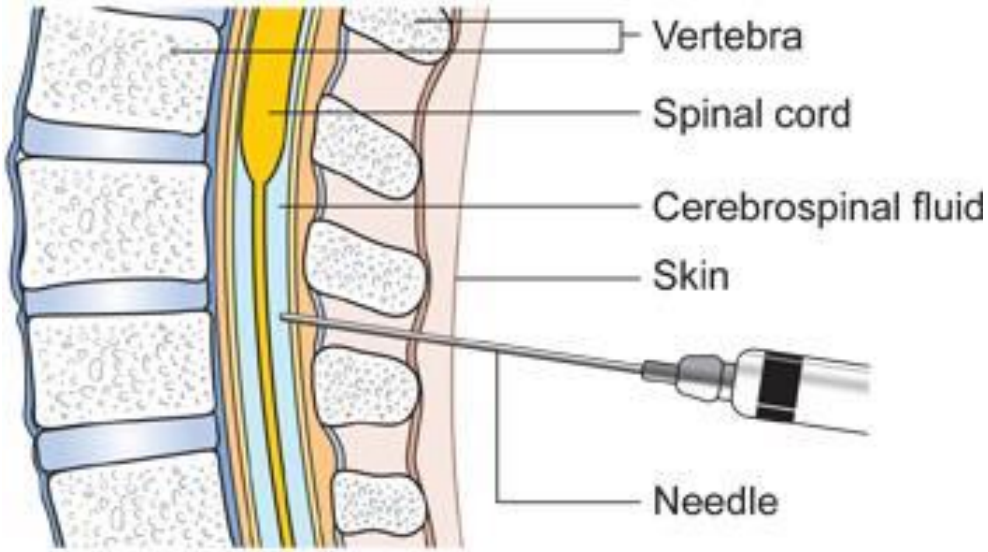


Diagram showing how you have a lumbar puncture


L4
L5
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Nuclei of Grey matter of Spinal Cord

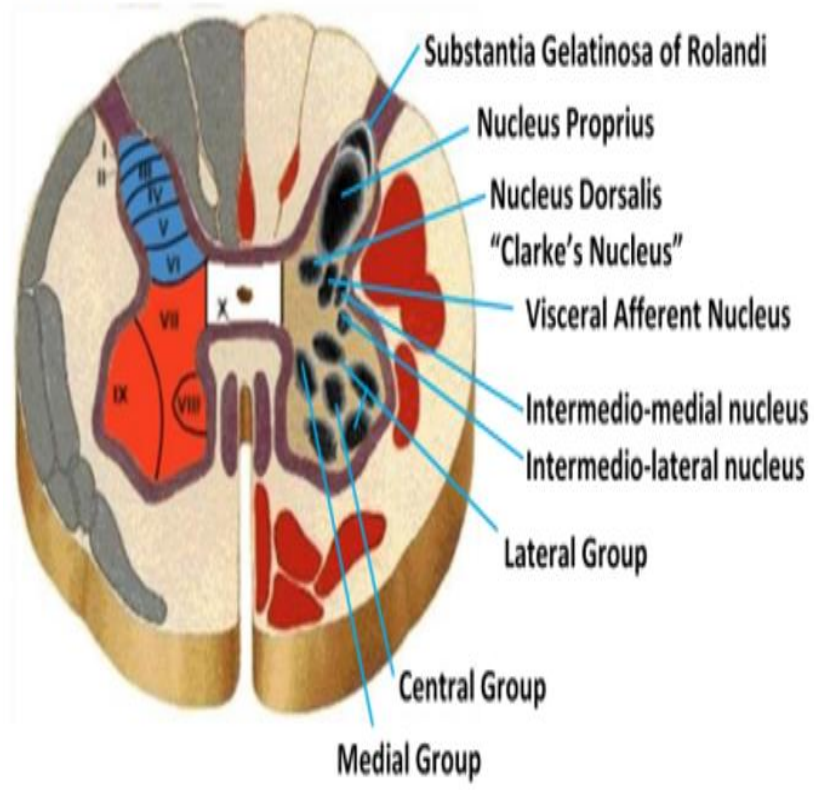
In Dorsal Horn: - Nuclei are mainly sensory

1. **Substantia Gelatinosa of Rolandi:** Present at tip of dorsal horn in all segments of spinal cord.
   Function: pain modulation.

2- Nucleus Proprius: Present anterior to Substantia Gelatinosa in all segments of spinal cord.
Function: relays exteroception.

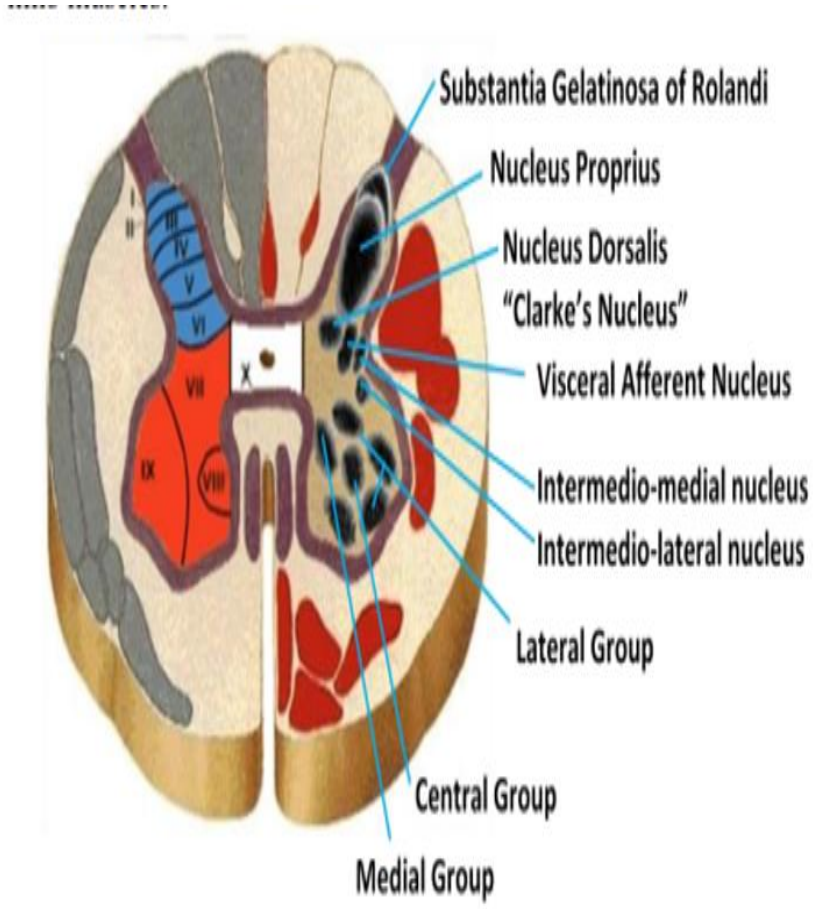
3-Nucleus Dorsalis "Clarke‟s Nucleus": Present at the base of dorsal horn in C8 to L3 segments of the spinal cord. Function: relays unconscious proprioception.

4- Visceral Afferent Nucleus: Present in C8 to L3 segments of the spinal cord lies lateral to Clarke‟s Nucleus.
Function: relays visceral sensations.



In Lateral Horn:

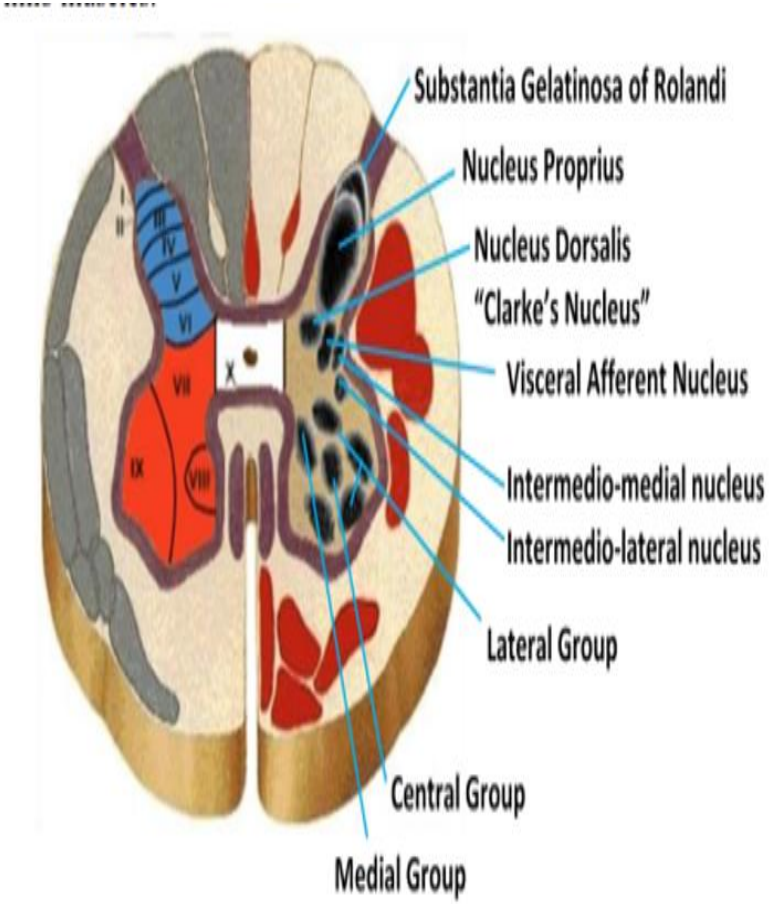
- Contains the intermediate nucleus present in thoracic & upper 3 lumbar segments.
- It is further divided into Intermedio-medial & intermedio-lateral nuclei.
- These are sympathetic neurons whose axons pass in the ventral root of the corresponding spinal nerves to reach the ganglia of the sympathetic trunk.
- A similar group of autonomic neurons “Sacral Parasympathetic” is present in S2, 3, 4 segments of the spinal cord but these do not form a lateral horn.



In Ventral Horn

- Nuclei are mainly motor neurons which are either
- 1. Alpha-motor neurons (anterior horn cells- AHC): Large, their axons pass in ventral root to supply extrafusal muscle fibers.
- 2. Gamma- motor neurons: Small, their axons also pass in ventral root to supply intrafusal muscle fibers (muscle spindles) –

- **The nuclei in the ventral horn are arranged in three groups:**
- 1. Medial Group: present throughout the whole length of the spinal cord and supply trunk muscles
- 2. Central Group: present only in some cervical segments e.g. Phrenic Nucleus C3,4,5 & spinal accessory nucleus (C1-5).
- 3. Lateral Group: present in cervical & lumbosacral segments and supply limb muscles



Grey matter Laminae „of Rexed" Rexed (1964)

described 10 laminae in the grey matter of the spinal cord depending on neurons size, density, shape & cytological features.

Laminae I -VI: are sensory & occupy the posterior horn.

L I = marginal layer of Waldeyer

L II + part of LIII = Substantia gelatinosa of Rolandi.

The rest of LIII + L IV = Main sensory nucleus. Lamina VII occupies the lateral horn & extends into the middle part of the anterior horn.

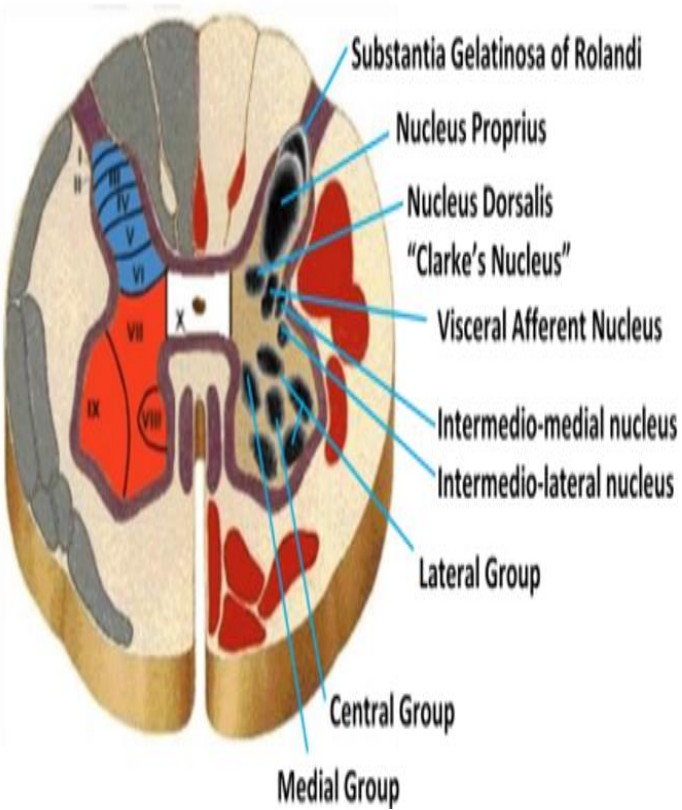
It contains: - Clarke's nucleus. - Lateral horn nuclei (intermediolateral & internediomedial). –

Middle part of anterior horn (between L VIII & IX), contains Renshaw cells.

Laminae VIII- IX occupy the anterior horn.

L IX is lateral. It contains the motor neurons. LVIII is medial. It controls the muscle tone.

Lamina X surrounds the central canal.



Tracts OF WHITE MATTER:

I. Ascending tracts (sensory):includes3 main groups:

A. Lemniscal system: lie in the dorsal column - carries conscious proprioception (from deep structures such as muscles & joints) to the cerebral cortex:

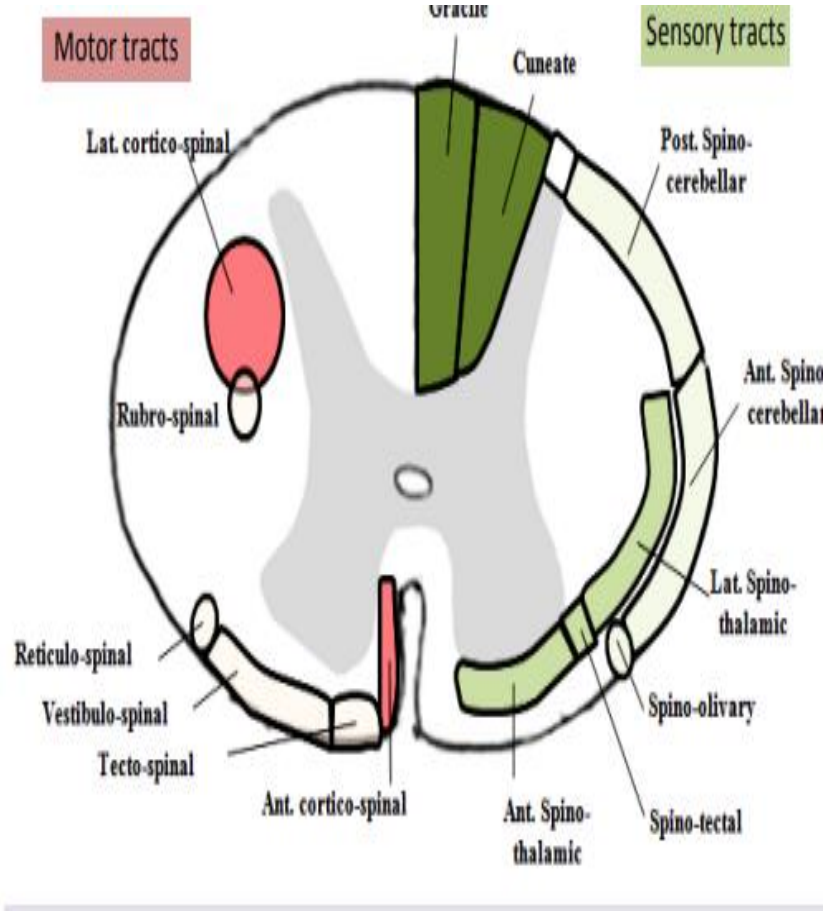
1. Gracile tract [lower body proprioception]
2. Cuneate tract [upper body proprioception]

B. Unconcious proprioceptive tracts(to cerebellum): lie superficially in the lat. column

1. Two spino-cerebellar tracts (Post. & Ant.)
2. Spino-olivary tract

C. Anterolateral system: lie in the ant. and lat. columns - carries exteroception

1. Lat. Spinothalamic tract [pain & temp]
2. Ant. spinothalamic tract [crude touch]
3. Spino-reticular tract
4. Spino-tectal trac



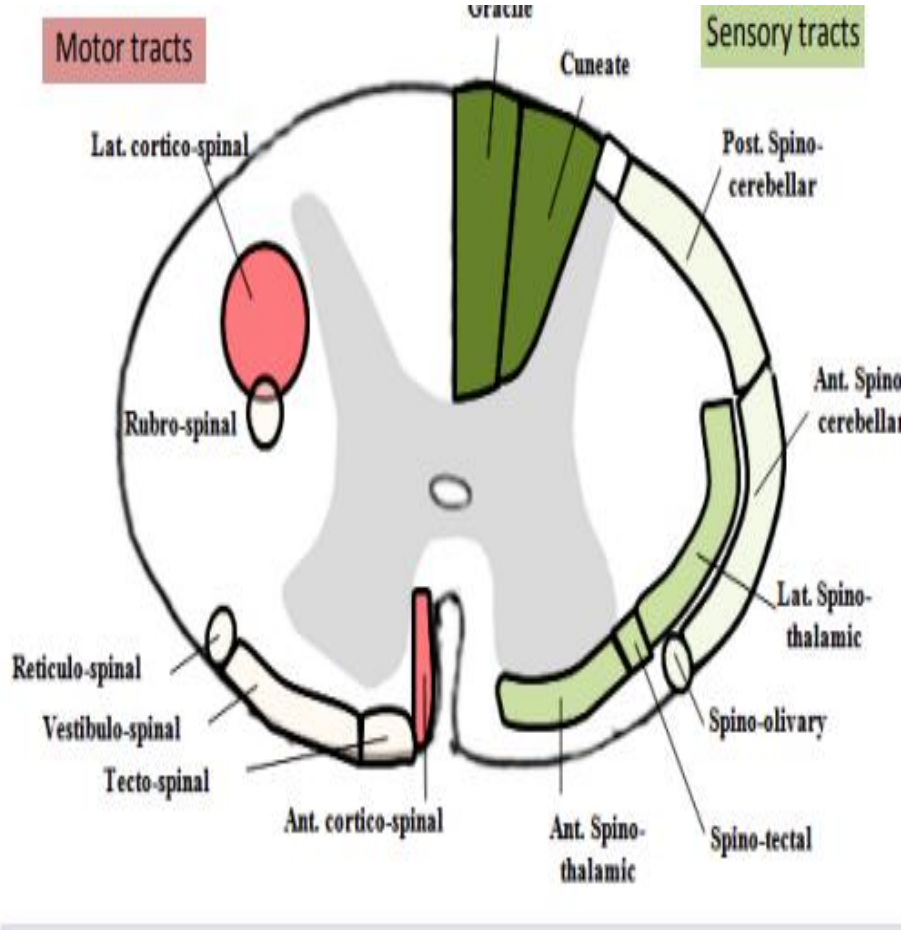
II. Descending tracts (motor):

A. Pyramidal:
lateral & anterior corticospinal tracts.

B. Extrapyramidal: -
2 from the midbrain: rubro-spinal tract & tecto-spinal tract
2 reticulo-spinal tracts: medial & lateral
2 Vestibulo-spinal tracts: medial & lateral
Olivo-spinal tract.

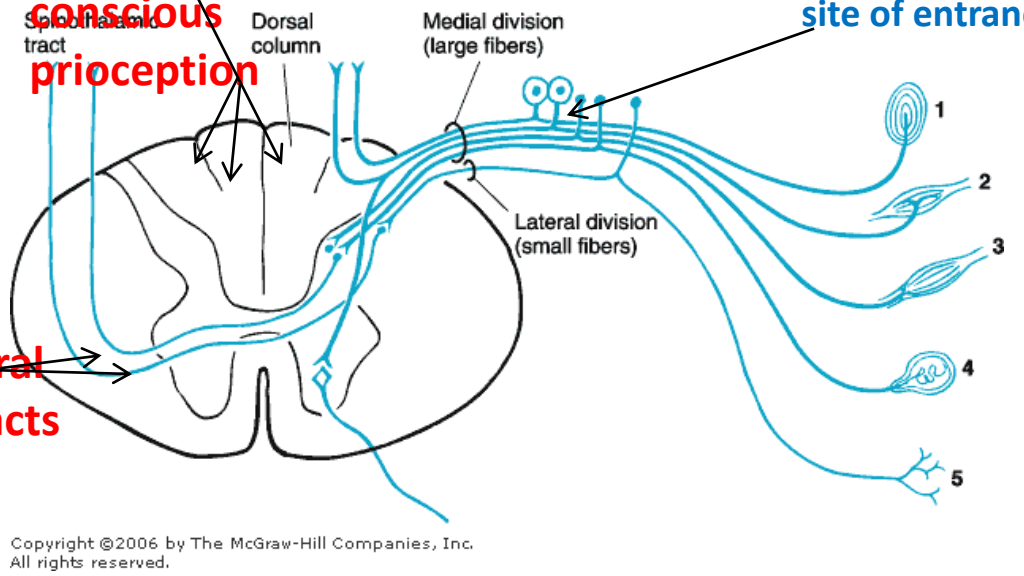
III. Intersegmental tracts

(propriospinal): Surround the grey matter forming the fasciculus proprius anterior, lateralis & posterior. Contains ascending and descending short axons of interneurons between adjacent segments of spinal cords



Ascending tracts

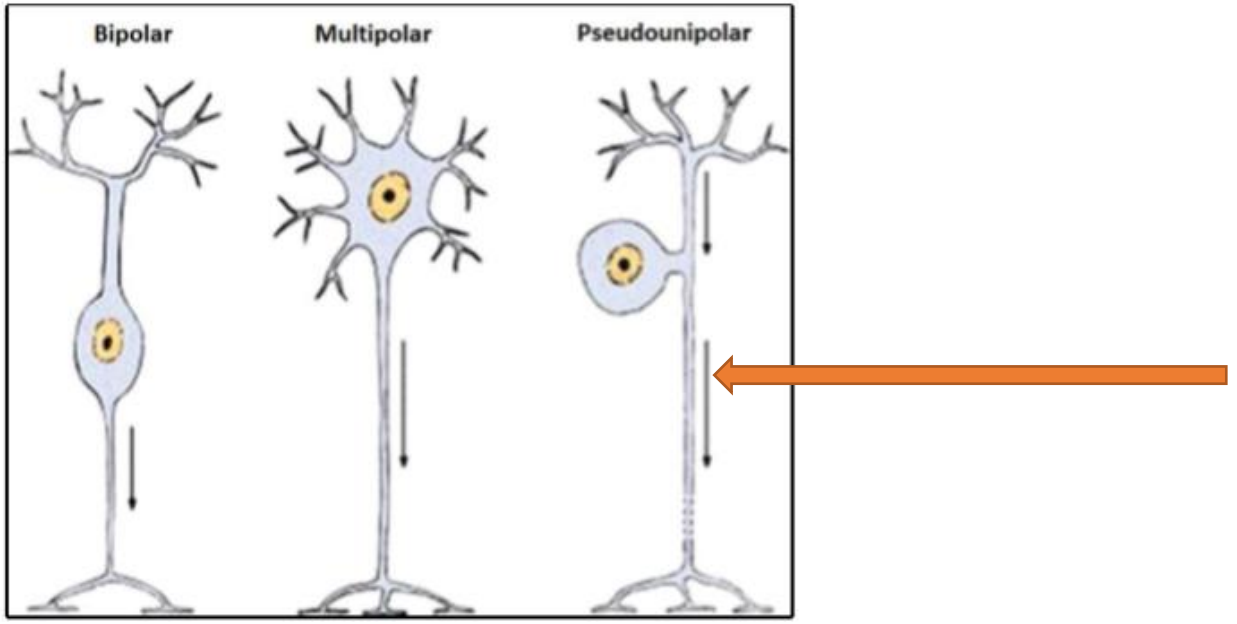
gracile and cunate conscious prioception



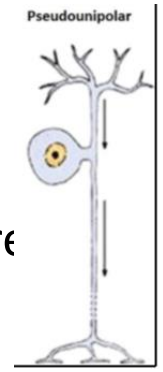
site of entrance

ventral and lateral spinothalmic tracts

What is the type of dorsal root ganglion neuron cell?



Ascending tracts

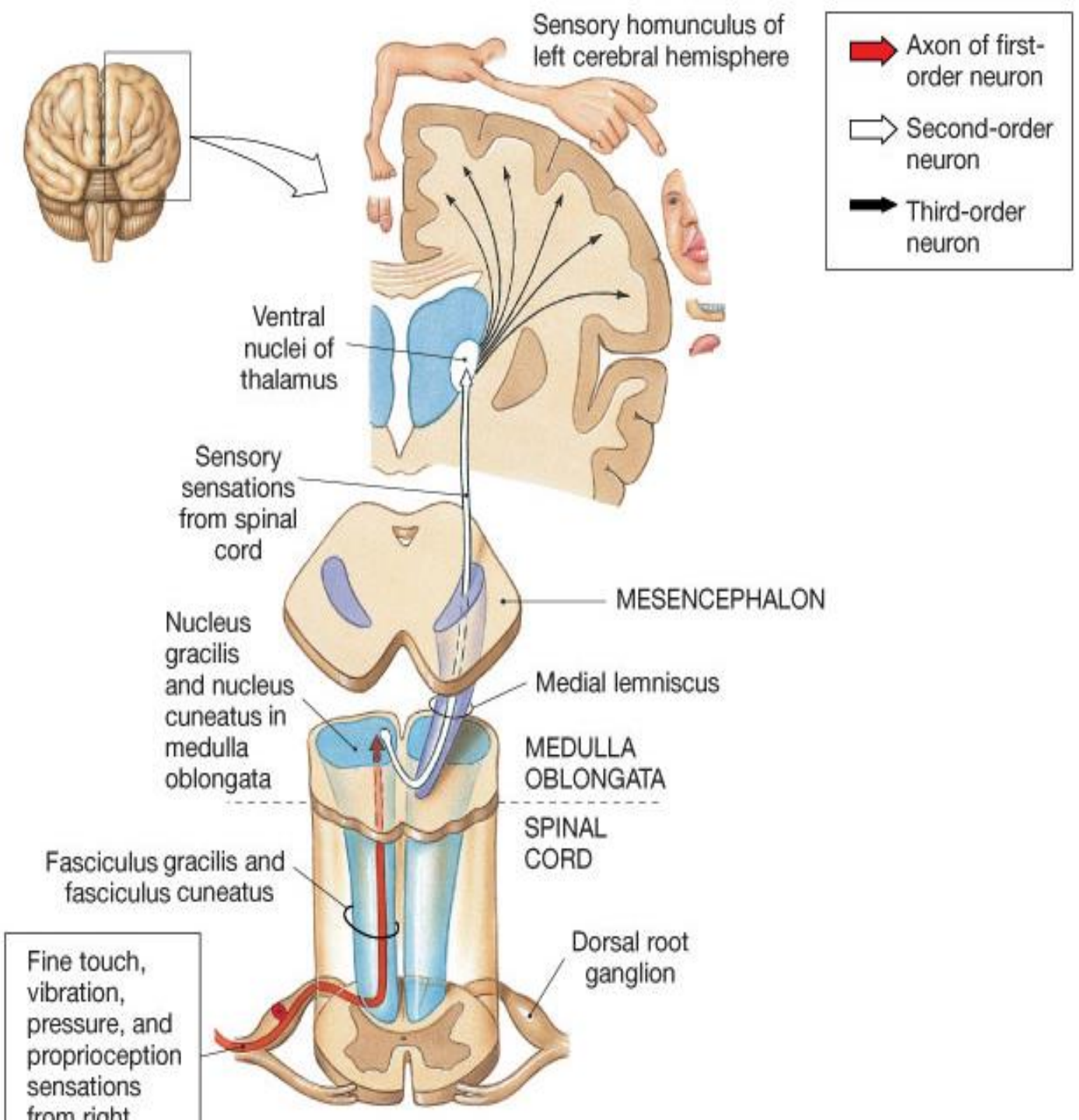


Form parts of the sensory pathways. A sensory pathway is formed of thre neurons.

1. First-order Neuron is always a pseudounipolar cell of the Dorsal Root Ganglion. It carries sensation by its peripheral process from receptors & conveys this sensation by its central processes to the dorsal root to the spinal cord.

2. Second-order neuron is always a cell in the CNS (spinal cord or medulla oblongata). Its axon always decussates to the opposite side and ascends in the brainstem as lemniscus to end in the thalamus.

3. Third-order Neuron is always cells of the Ventral Postero-Lateral Nucleus of Thalamus (VPLN). Their axons pass through posterior limb of internal capsule, then through corona radiata to reach sensory area of cerebral cortex.


Sensory homunculus of left cerebral hemisphere
Axon of first-order neuron
Second-order neuron
Third-order neuron
Ventral nuclei of thalamus
Sensory sensations from spinal cord
MESENCEPHALON
Nucleus gracilis and nucleus cuneatus in medulla oblongata
Medial lemniscus
MEDULLA OBLONGATA
SPINAL CORD
Fasciculus gracilis and fasciculus cuneatus
Dorsal root ganglion
Fine touch, vibration, pressure, and proprioception sensations from right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