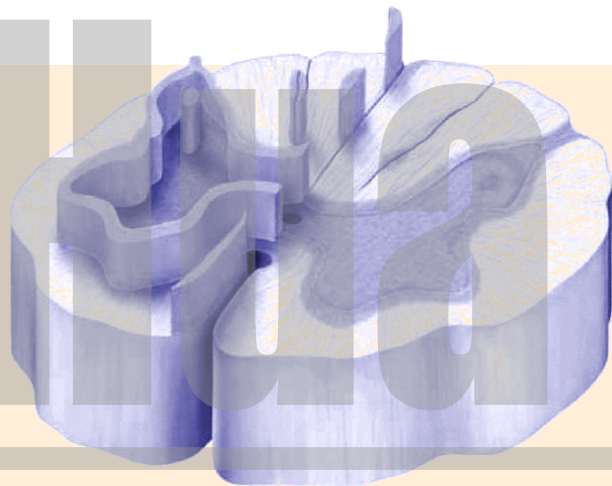


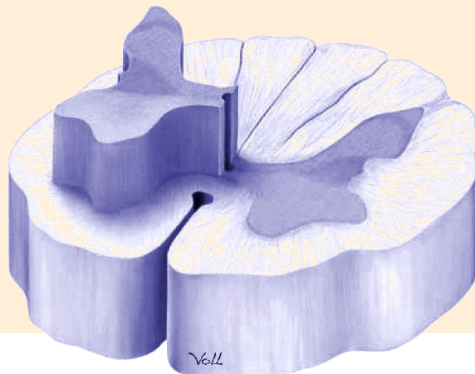
## The Internal Structure of Spinal Cord



*Feng Shi*

*Dept. of Human Anatomy*

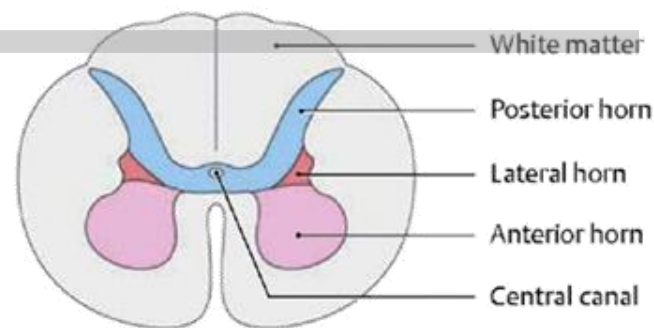
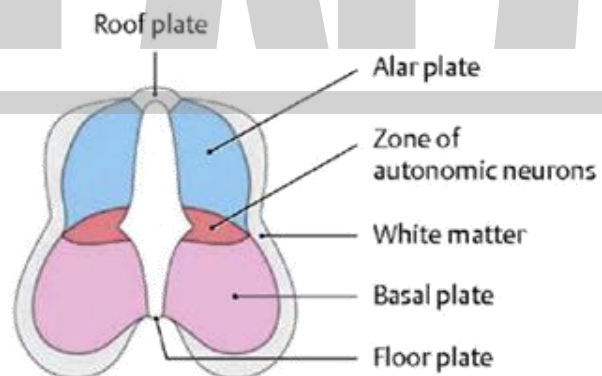
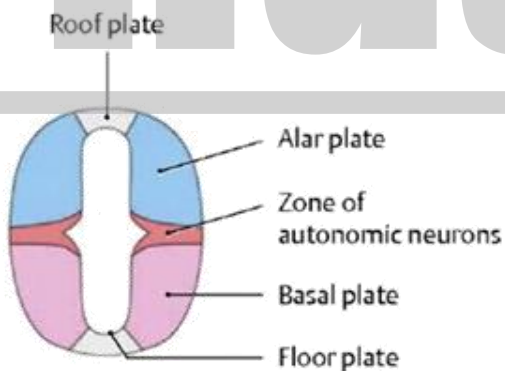
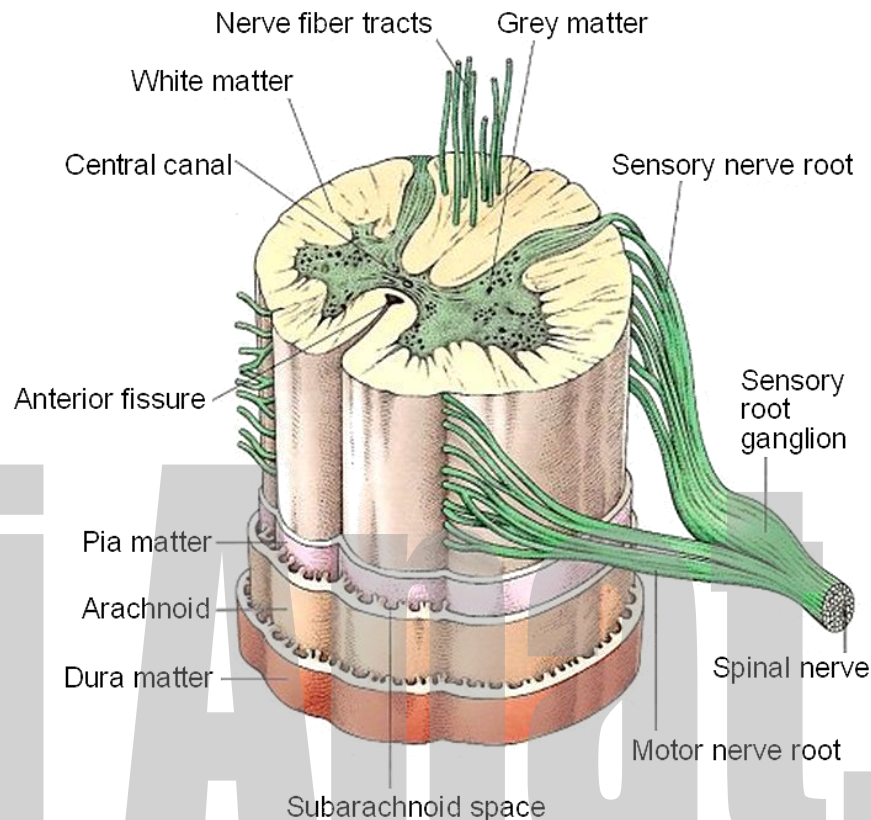
*Sichuan University*





## OUTLINE

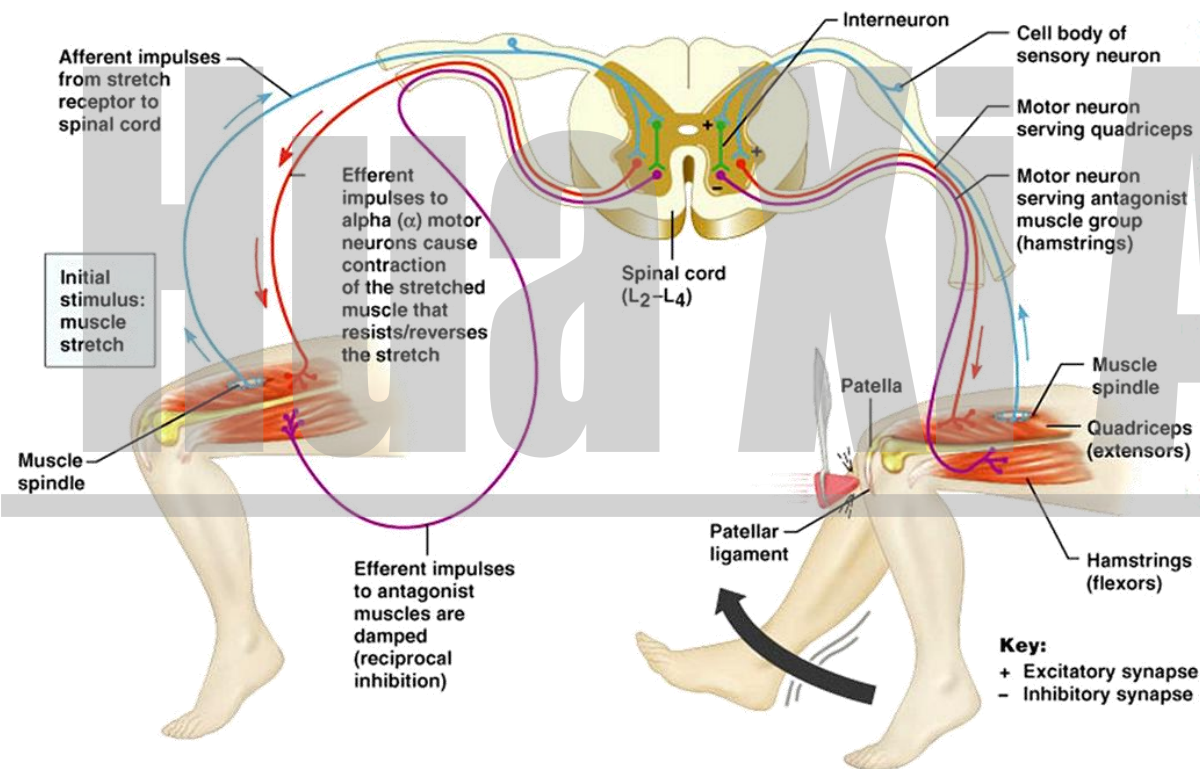
- Gray Matter
- White Matter
- Conscious Sensory & Motor Tracts





## Functions of Spinal Cord

- transmitting
- spinal



**Key:**  
 + Excitatory synapse  
 - Inhibitory synapse

The nervous system sorts and interprets incoming information before directing a response.

**A** Receptors in the skin sense a tap or other stimulus.



**B** Sensory neurons transmit the touch message.



**C** The message is interpreted. A response is sent to the motor neurons.



**D** Motor neurons transmit a response message to the shoulder muscles.



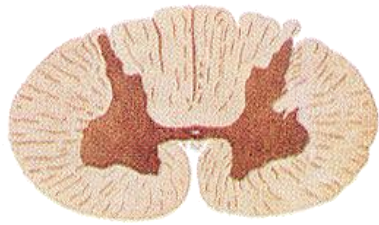
**E** The neck muscles are activated, causing the head to turn.







## Internal Structure of Spinal Cord



C<sub>5</sub>



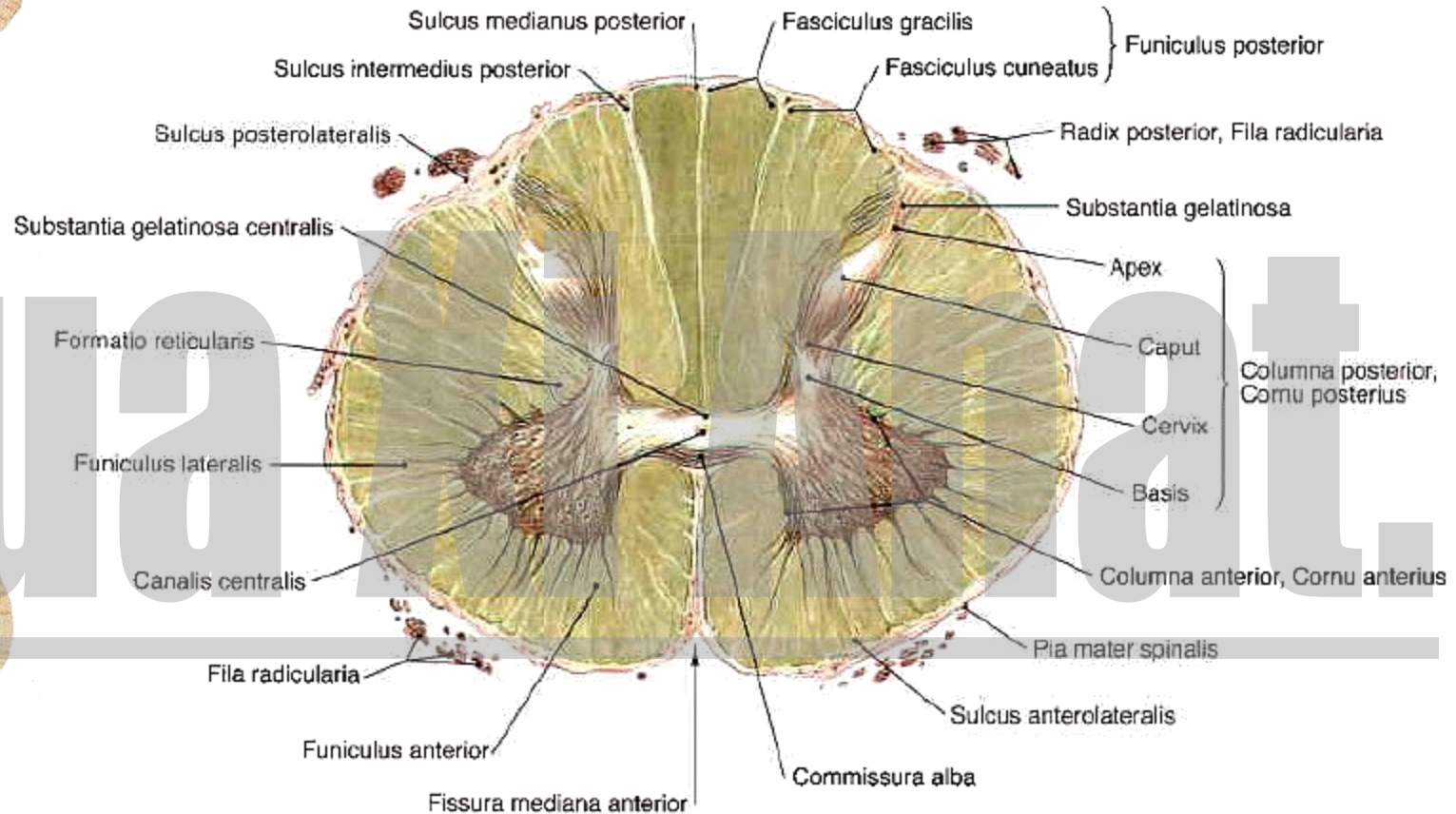
T<sub>8</sub>



L<sub>3</sub>



S<sub>3</sub>



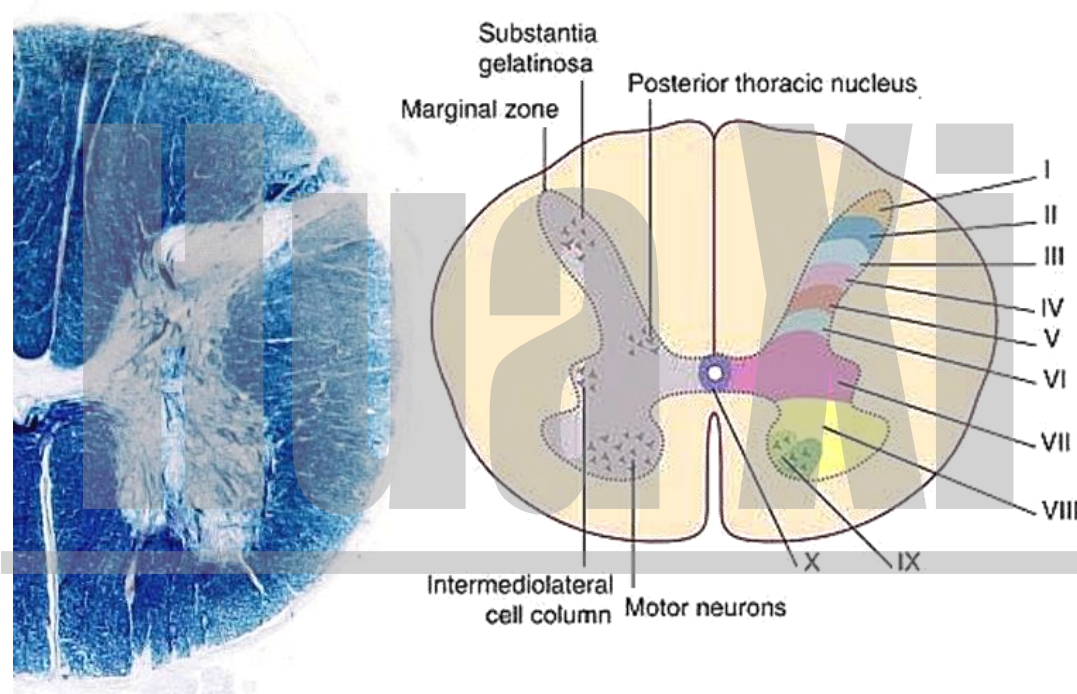
- white matter
- grey matter
- central canal



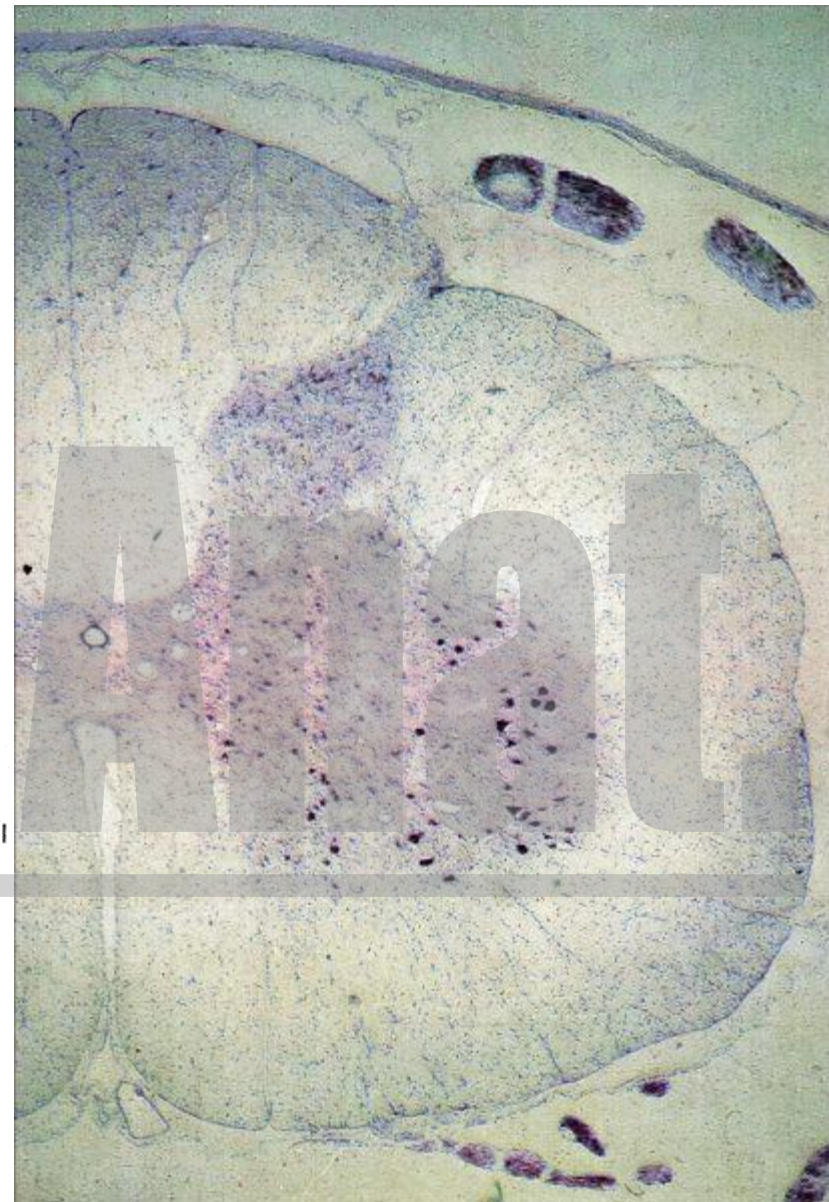


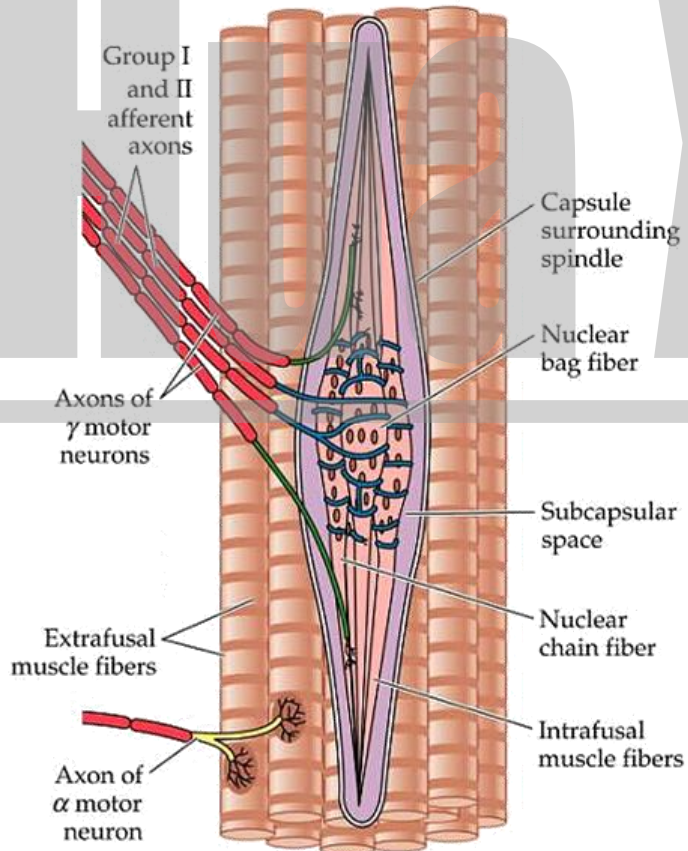
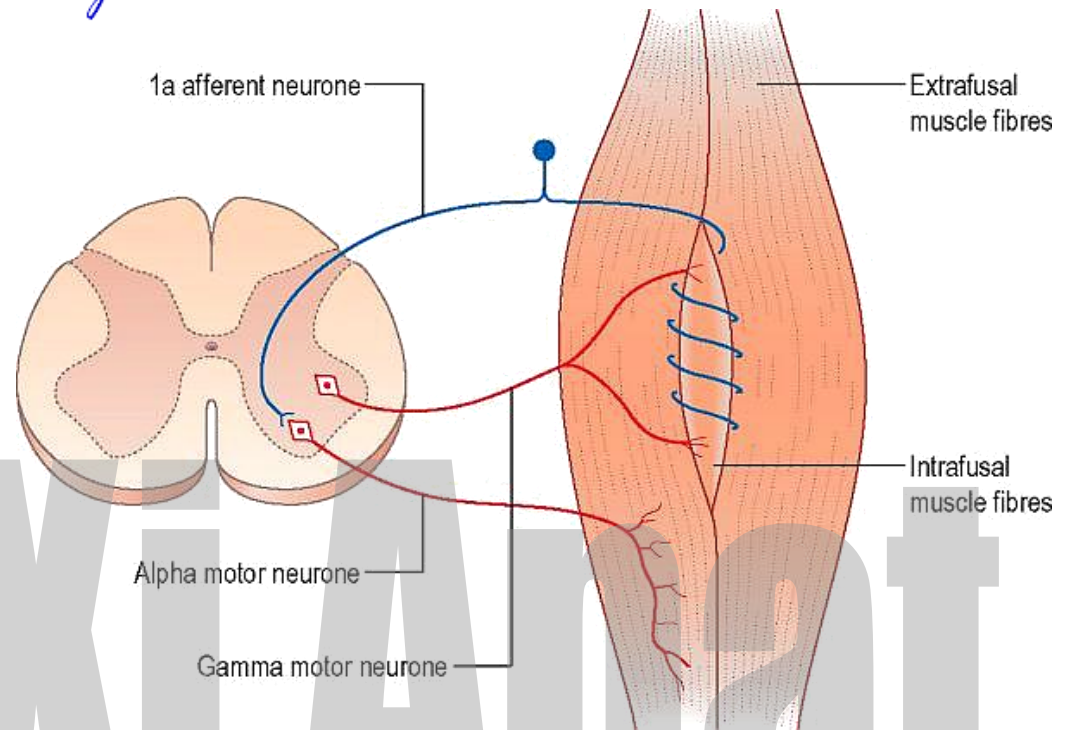
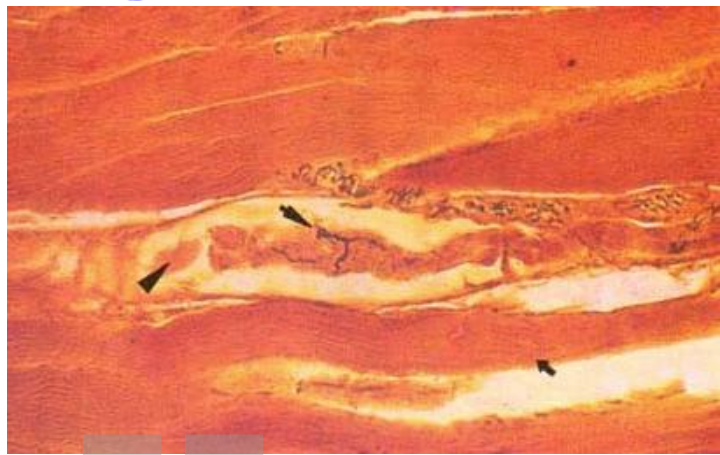


# The Gray Matter of Spinal Cord



The Cytoarchitectural Lamination  
(Rexed's Laminae)



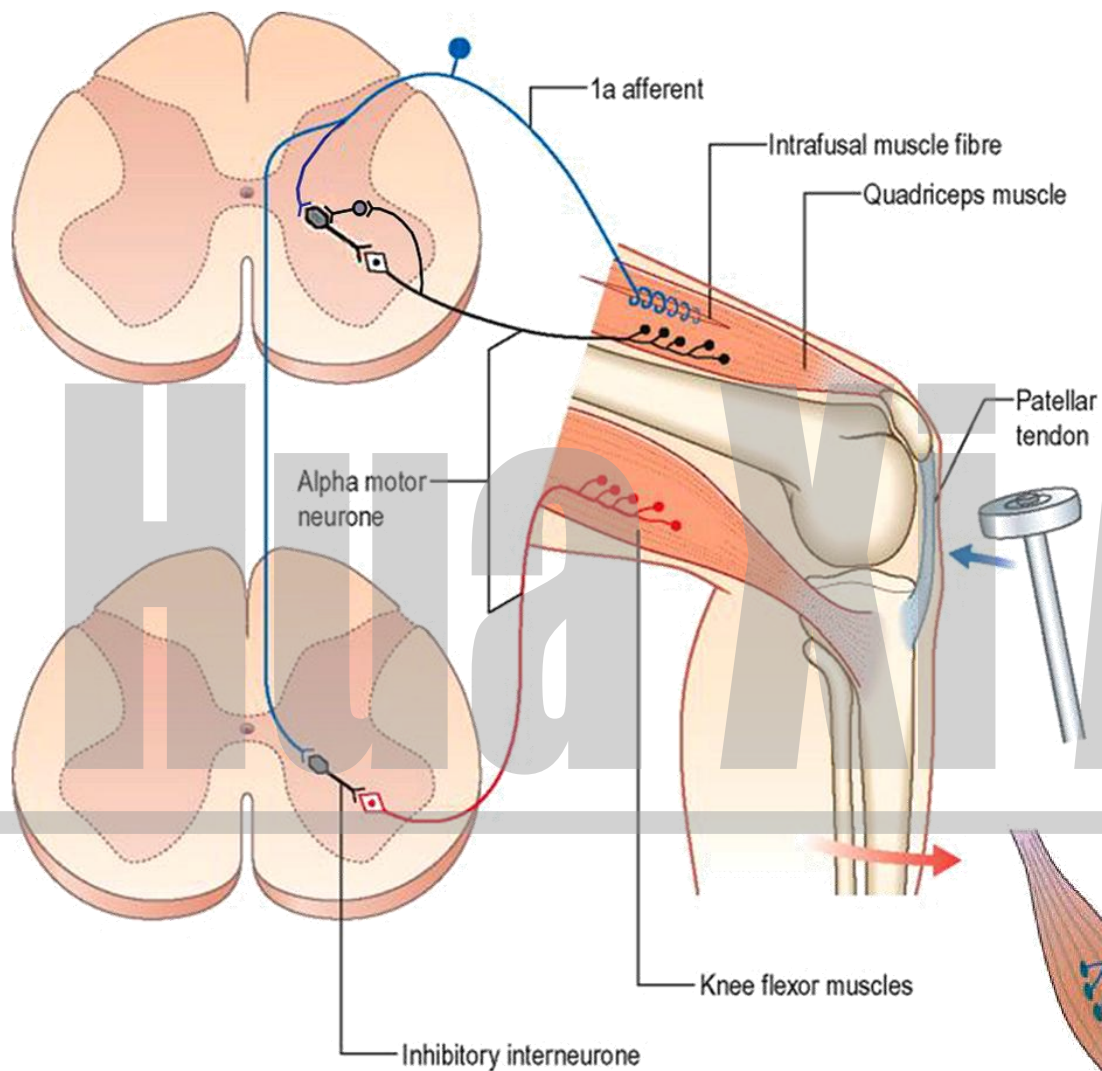


## The Anterior Horn

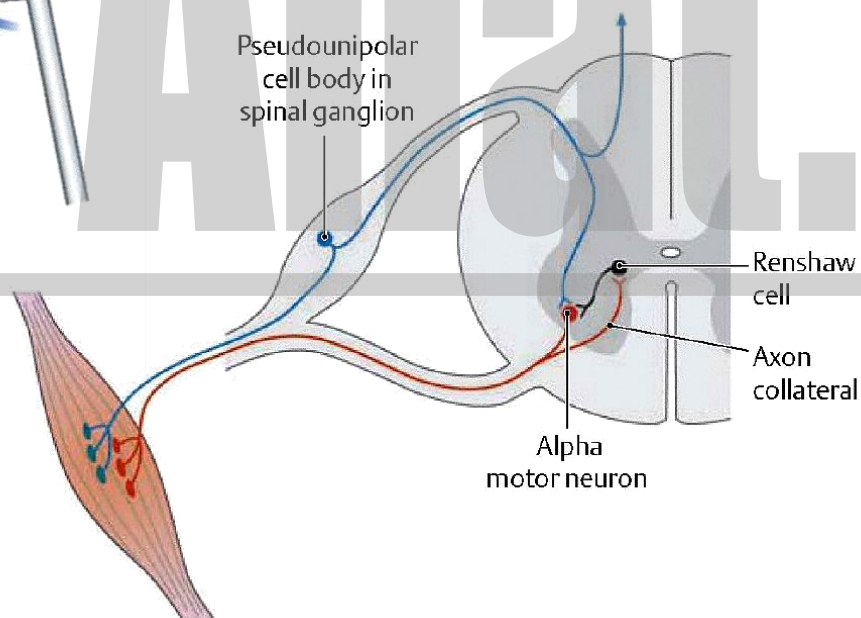
- $\alpha$  motor neuron – extrafusal muscle fibres (voluntary movement)
- $\gamma$  motor neuron – intrafusal muscle fibers (muscle tonus)







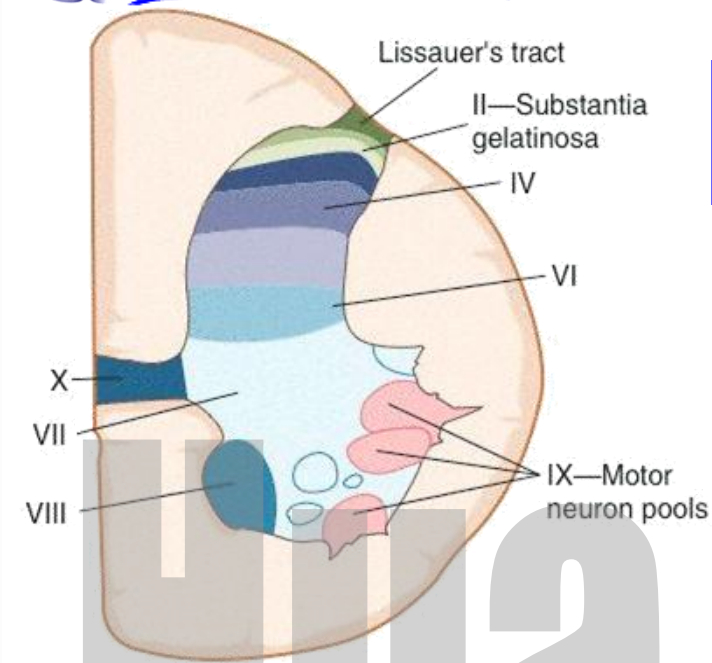
- Renshaw cell:  
α motor neuron (axon collaterals)  
↓  
Renshaw cell  
↓  
α motor neuron  
(negative feedback mechanism)



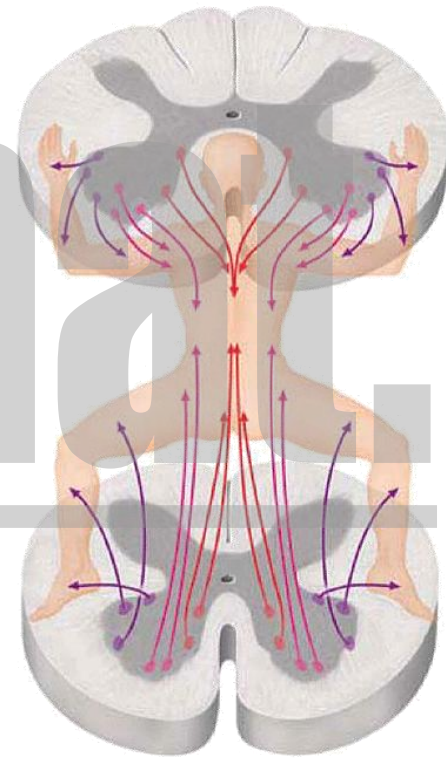
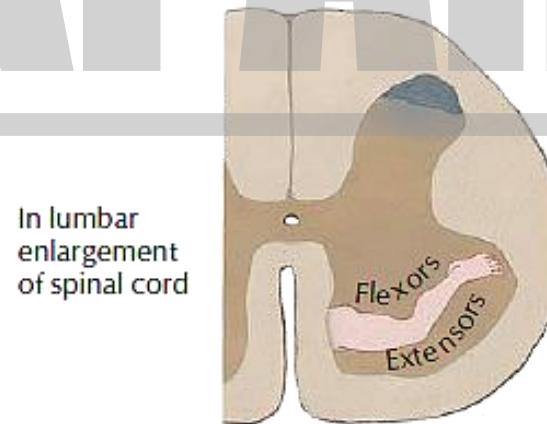
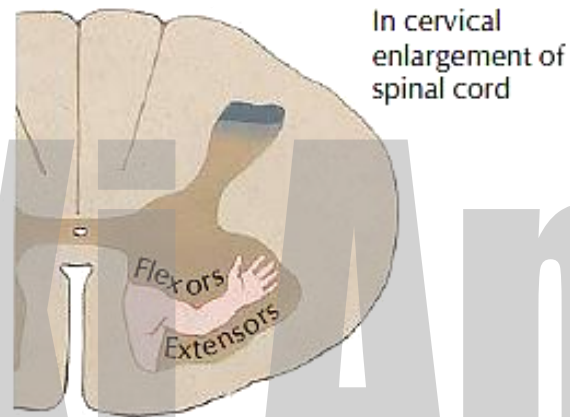
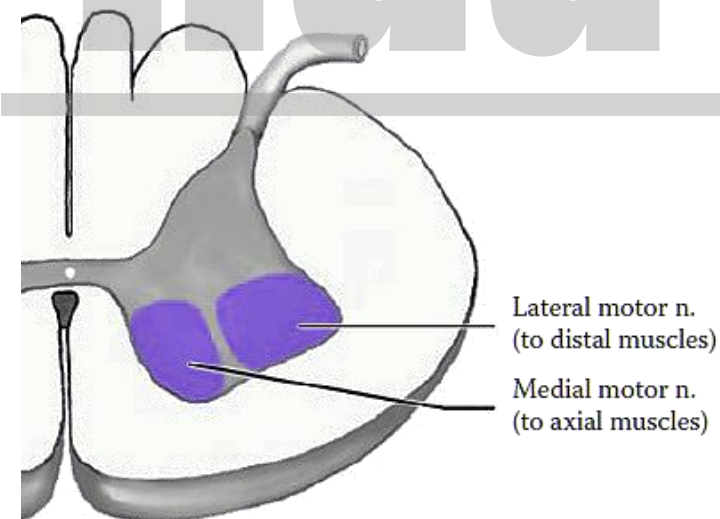




- medial nuclear group (lamina VIII) – axial muscles

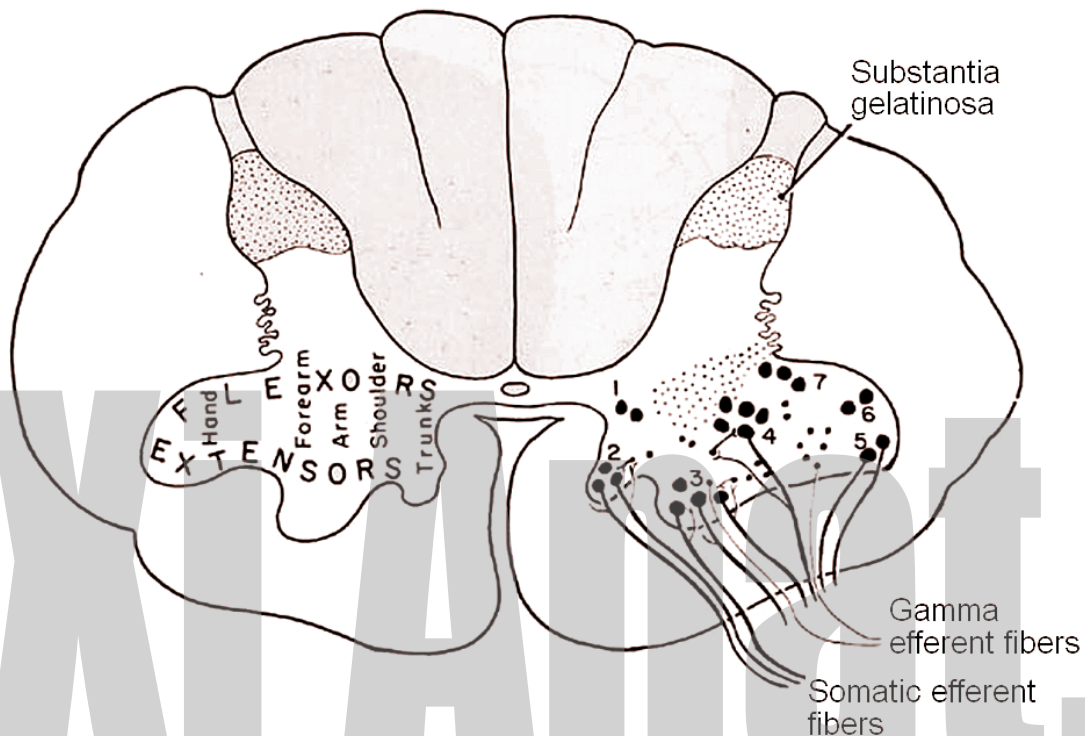
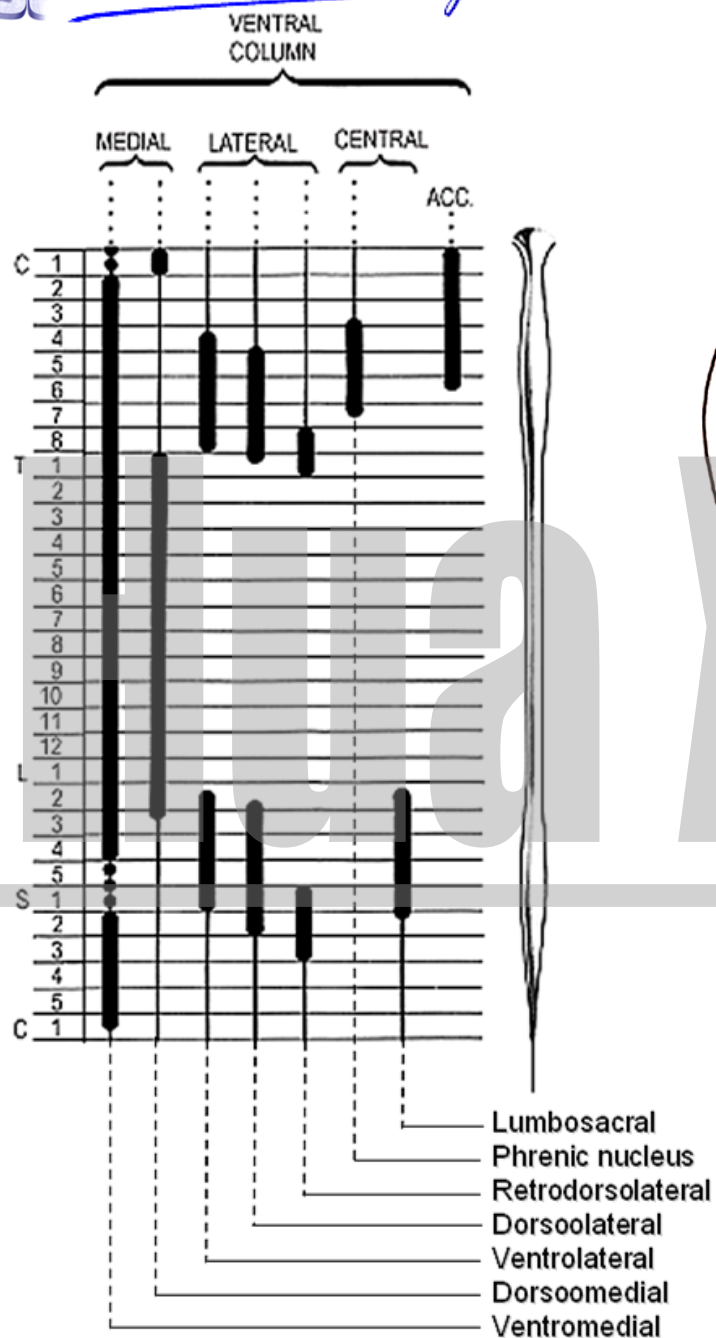


## Nuclei in the Anterior Horn





# Human Anatomy: Neuroanatomy

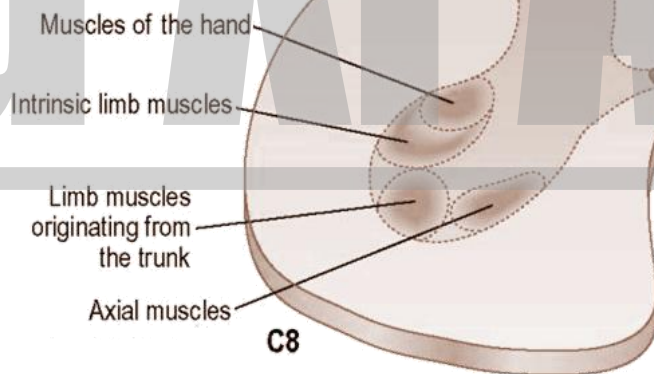
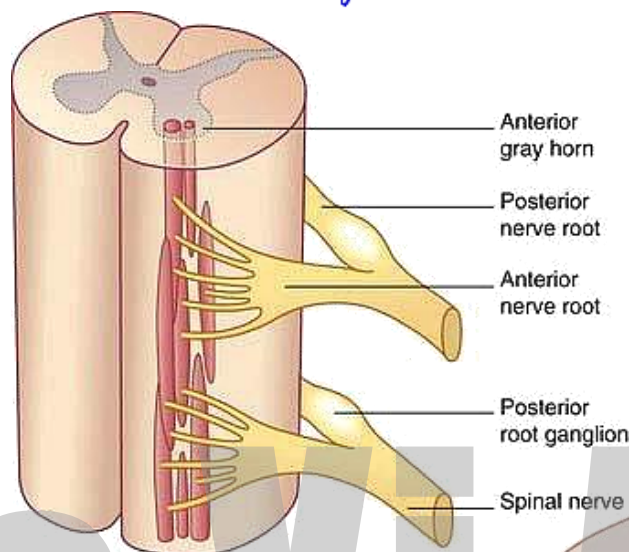
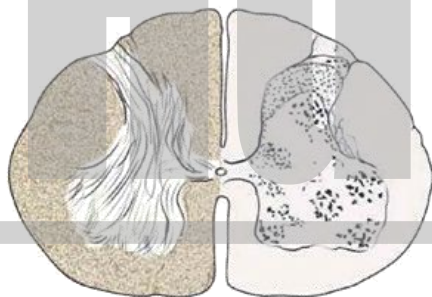
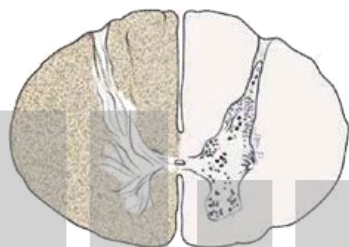
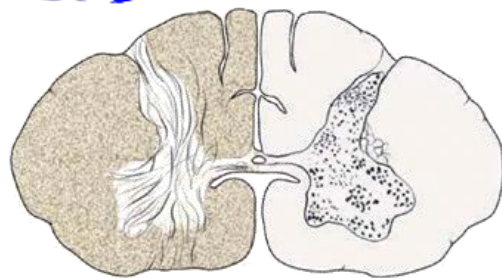


- **Medial Group:** extends throughout the whole length of spinal cord, supplies axial muscles
- **Lateral Group:** exists in the 2 enlargements, supplies distal muscles

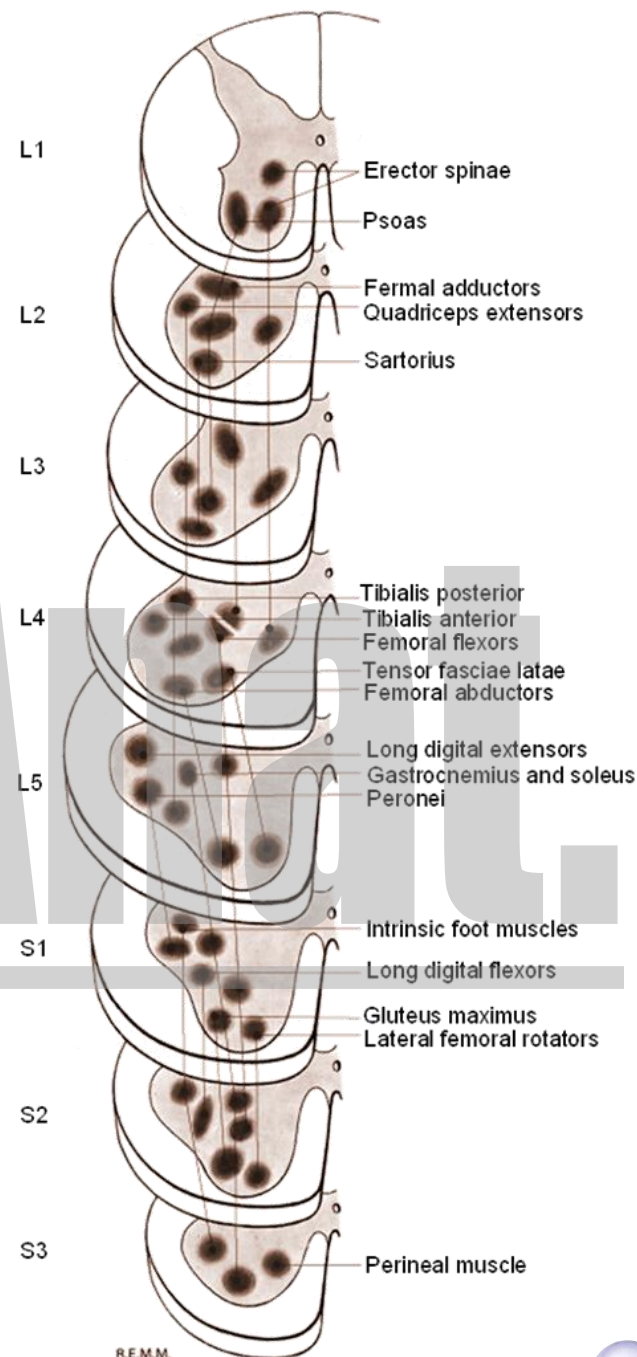




# Human Anatomy: Neuroanatomy



Nuclei in Cervical, Lumbar Enlargements



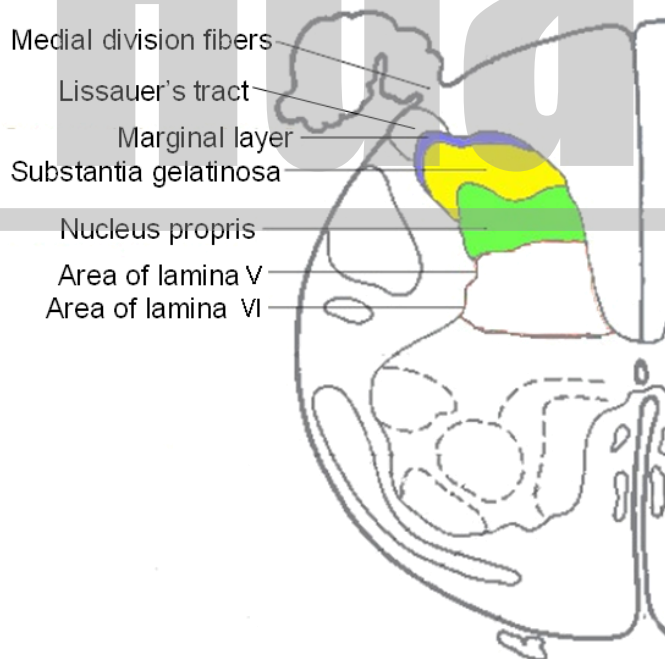
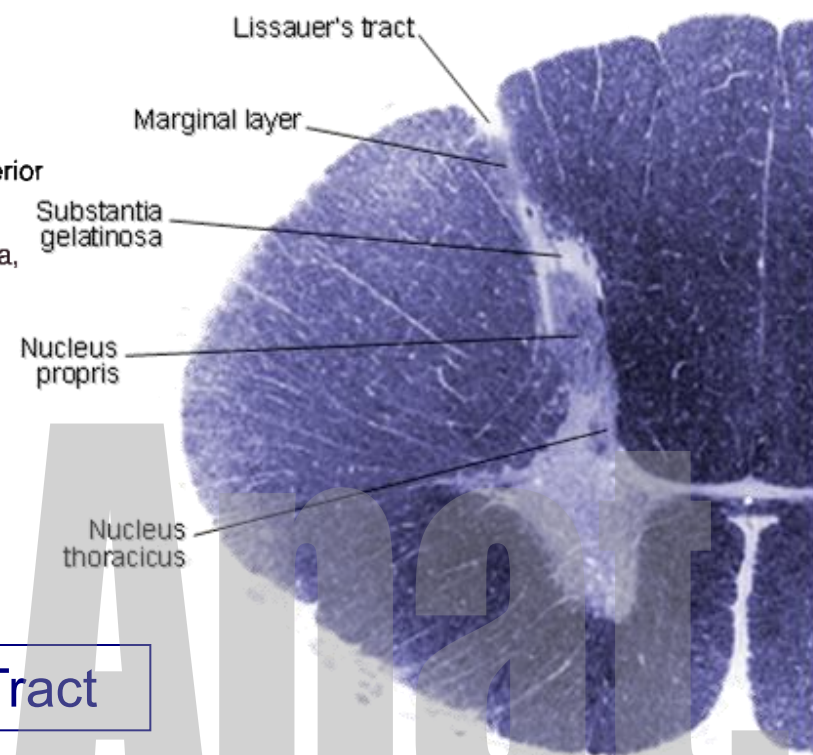
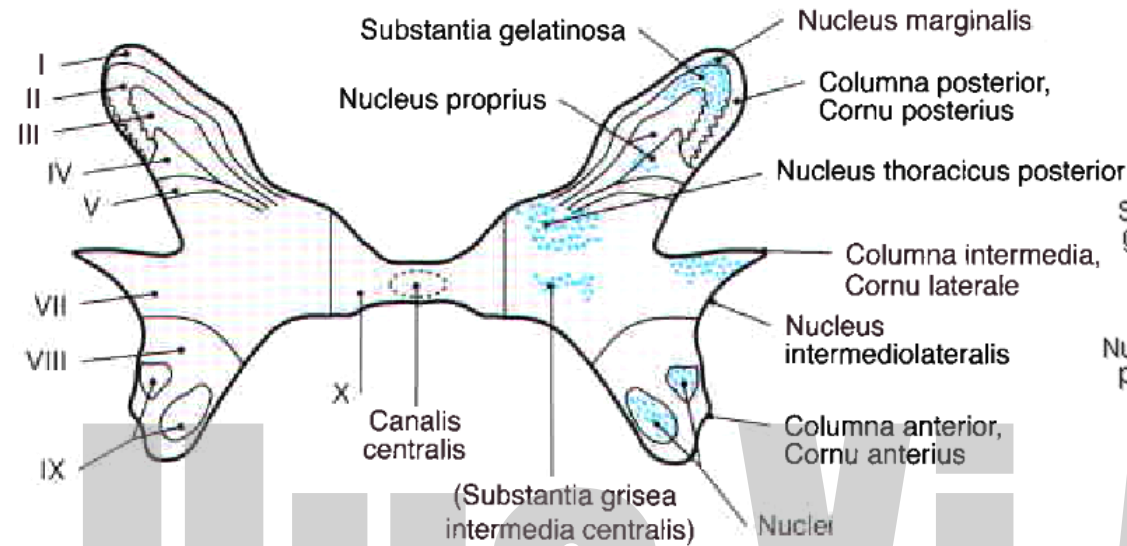
R.E.M.M.







# Human Anatomy: Neuroanatomy

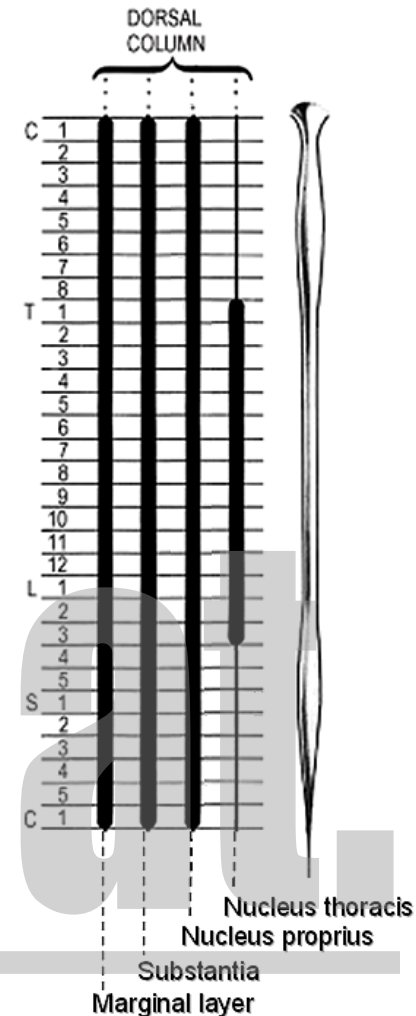
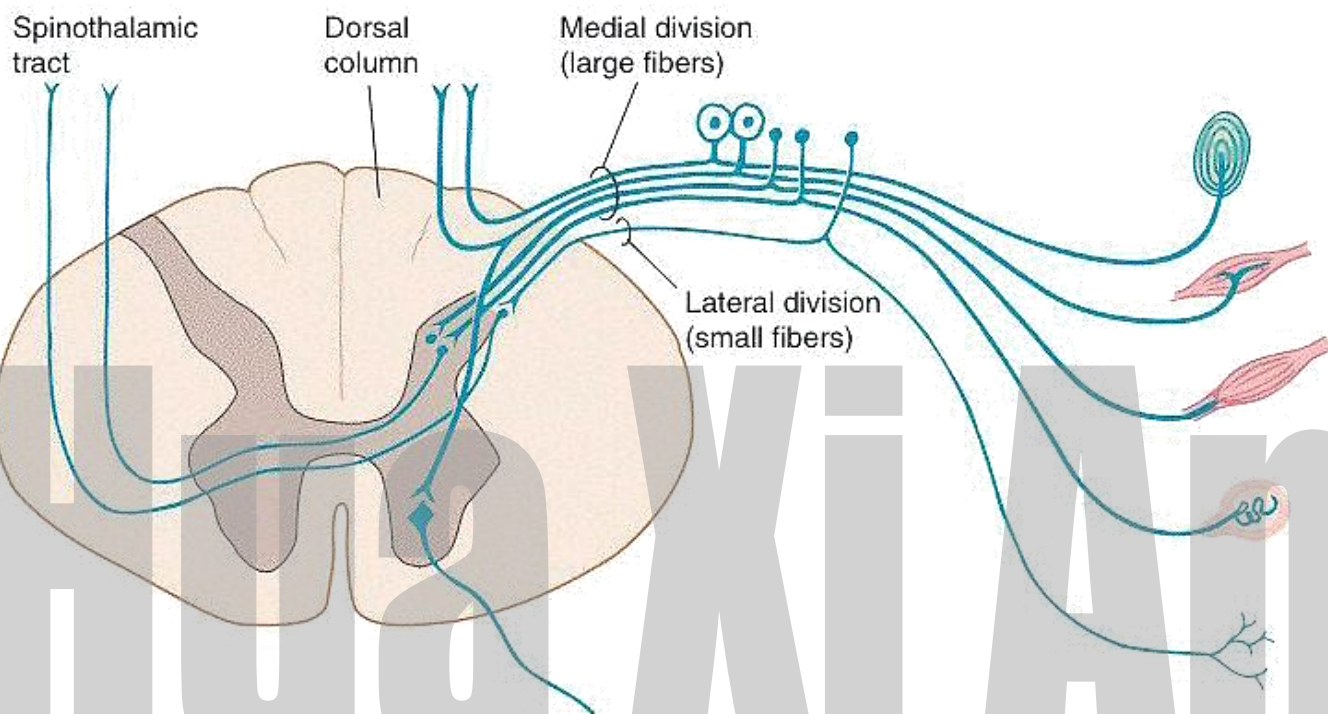


## Lissauer's Tract

## The Nuclei in Posterior Horn

- marginal layer (lamina I)
  - substantia gelatinosa (lamina II)
  - nucleus proprius (laminae III & IV)
  - nucleus thoracicus (lamina VII)
- throughout the whole length of spinal cord  
thoracic region





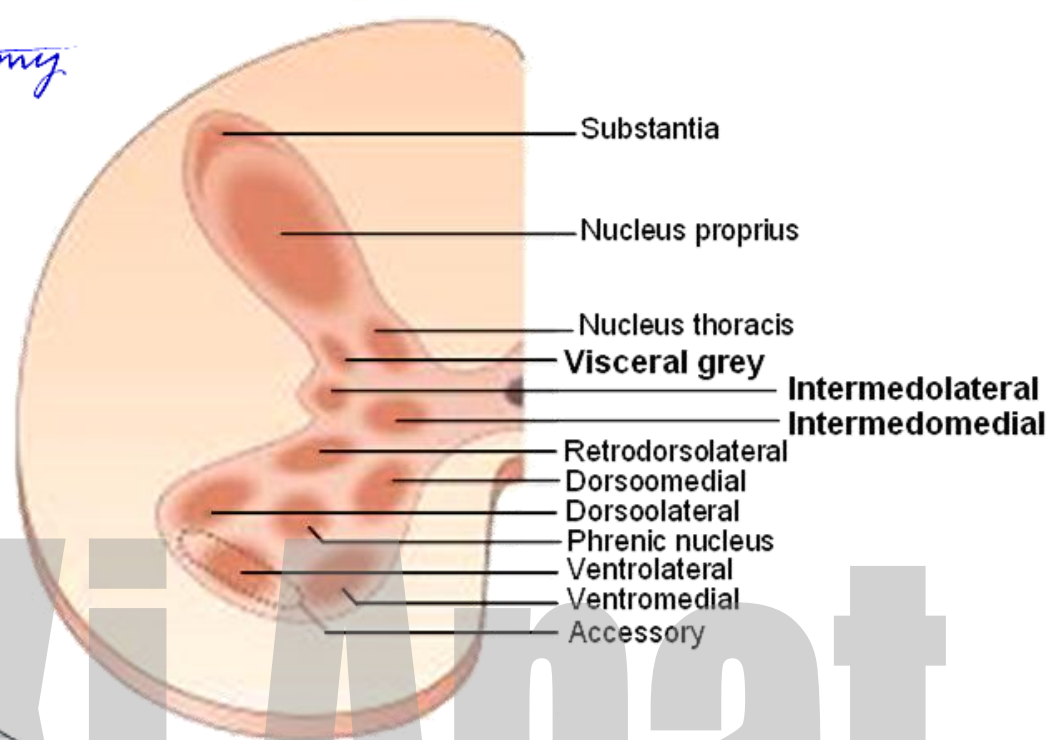
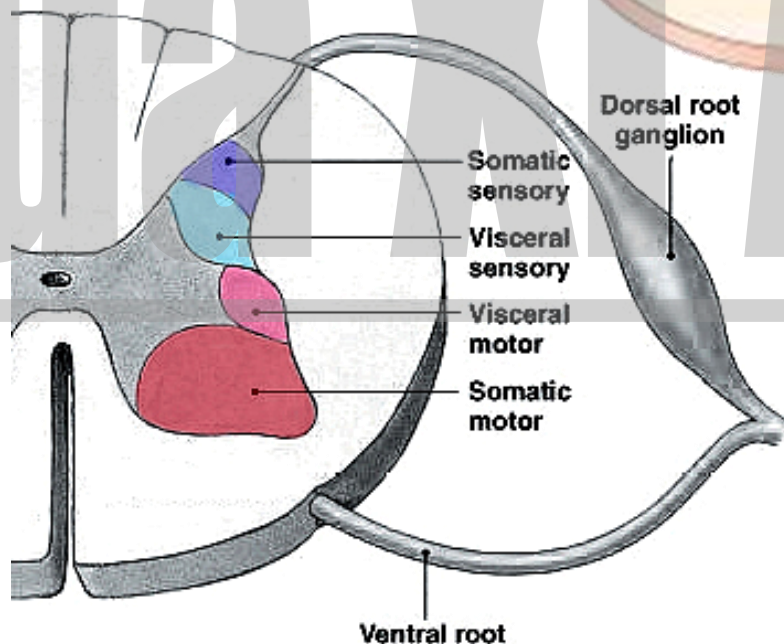
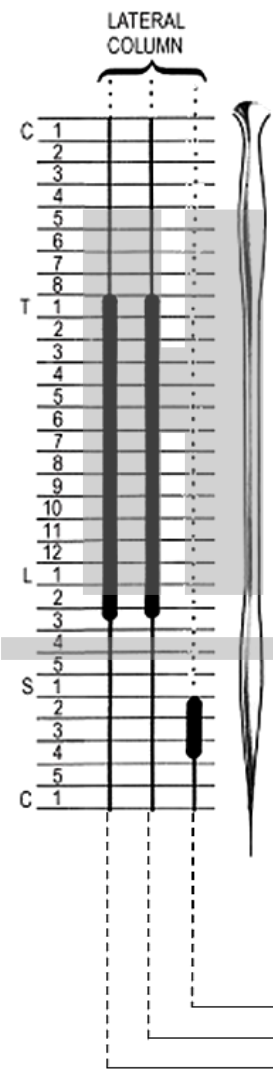
## Functions of Nuclei in Posterior Horn

- **marginal layer & substantia gelatinosa:** pain, temperature, crude touch & pressure
- spinothalamic tract
- **nucleus proprius:** discriminative touch, vibratory sense & conscious muscle joint sense
- fasciculi gracilis & cuneatus
- **nucleus thoracicus:** proprioceptive information to cerebellum
- spinocerebellar tract





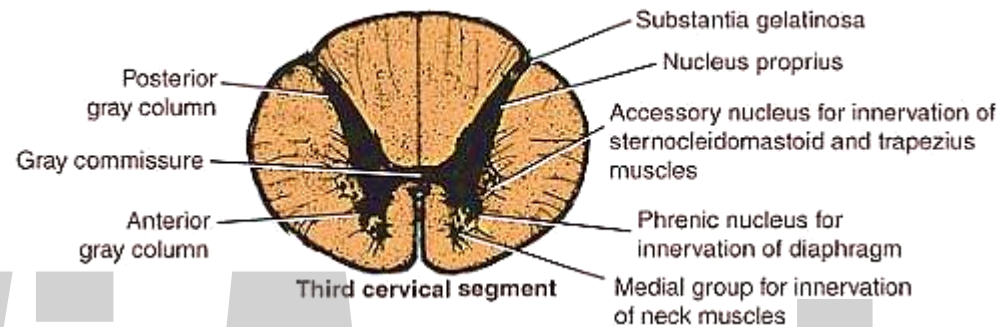
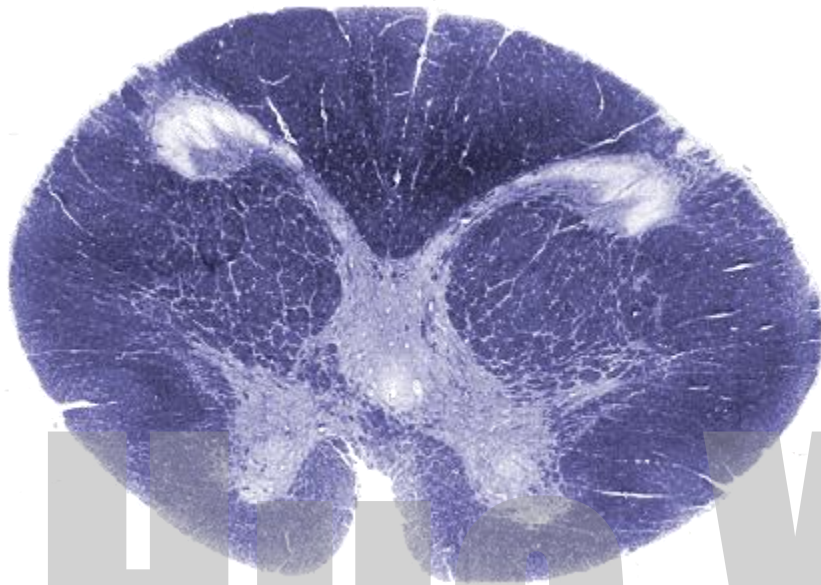
# The Nuclei in Lateral (Intermediolateral) Horn



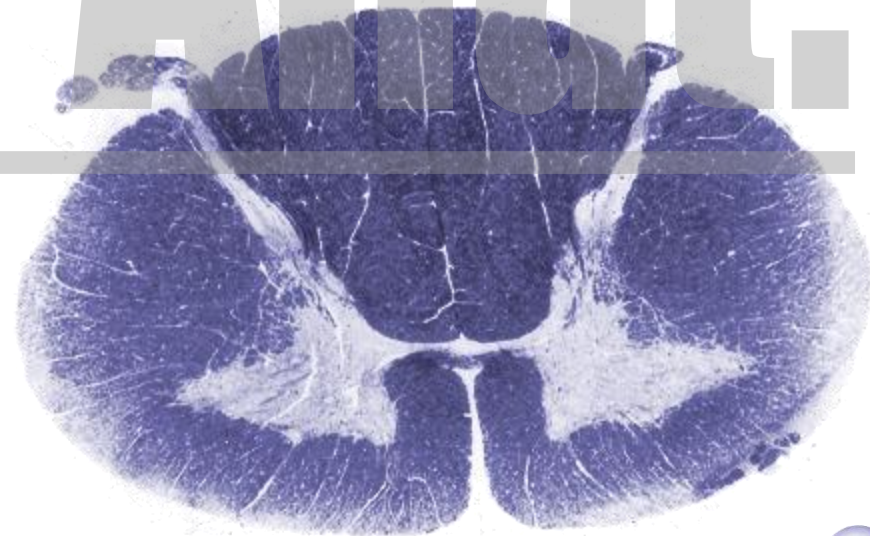
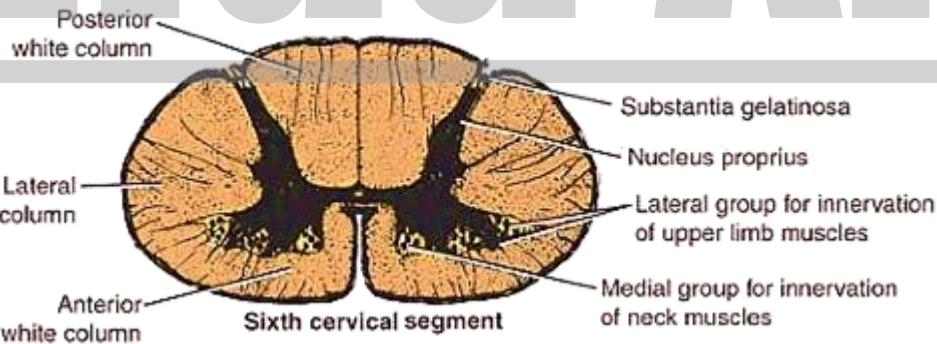
- intermediolateral nucleus
  - visceral motor
- intermediomedial nucleus
  - fibers constitute spinocerebellar tract
- visceral grey
  - visceral sensory
- sacral parasympathetic nucleus

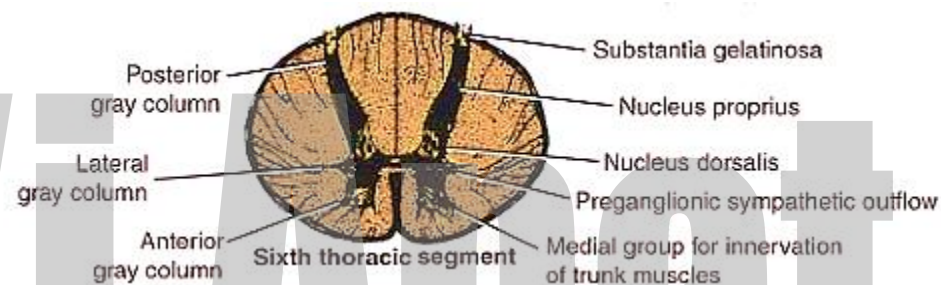
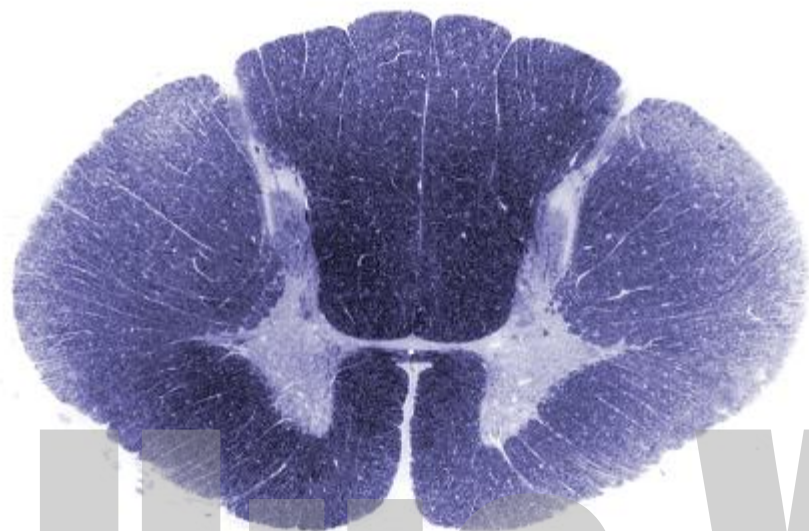
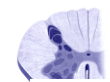




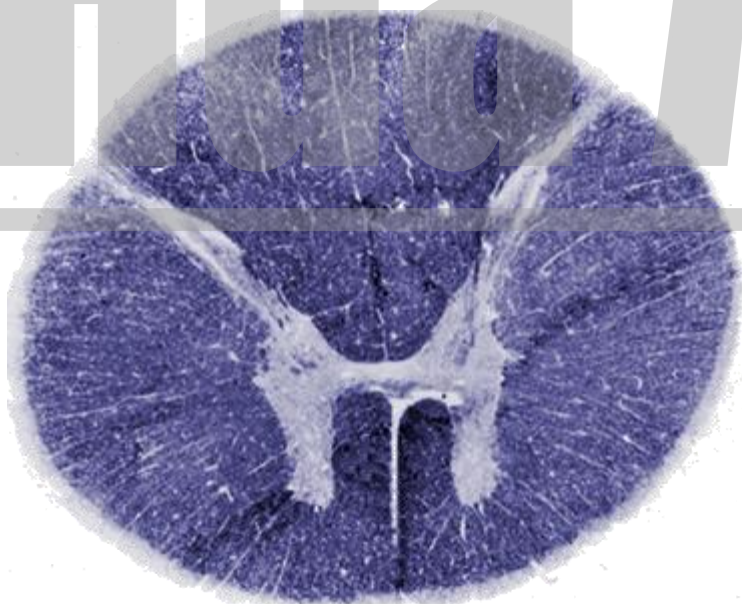


## Coronal Section of the Spinal Cord at the Upper & Lower Cervical Levels

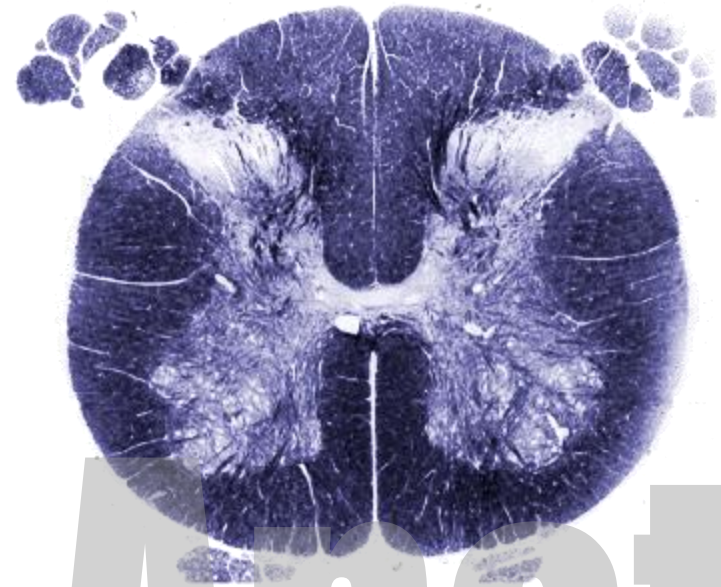
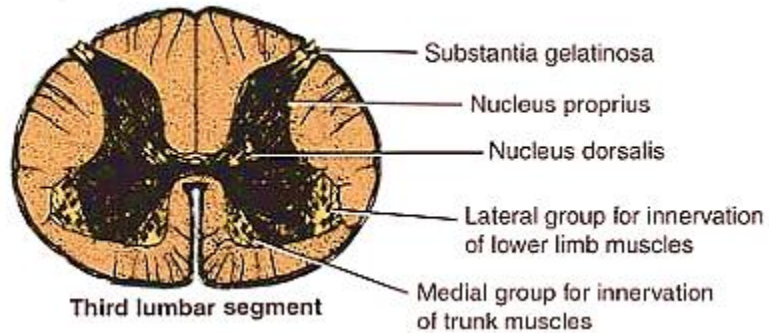




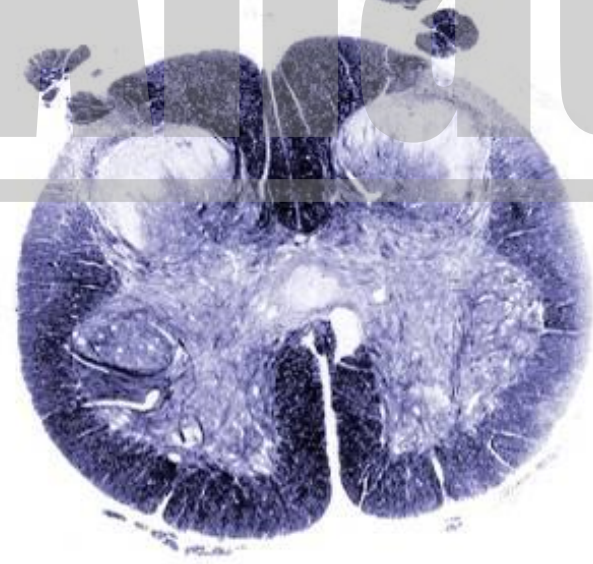
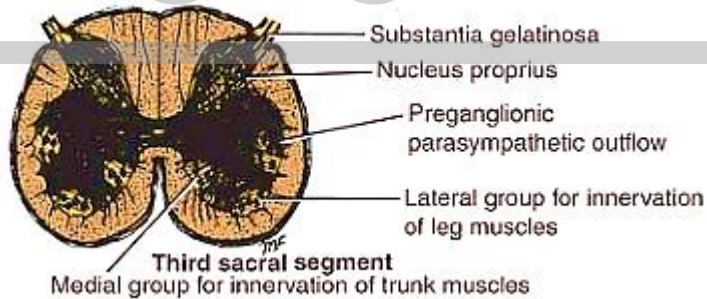
Coronal Section of the Spinal Cord at the Thoracic Levels







## Coronal Section of the Spinal Cord at the Lumbar & Sacral Levels

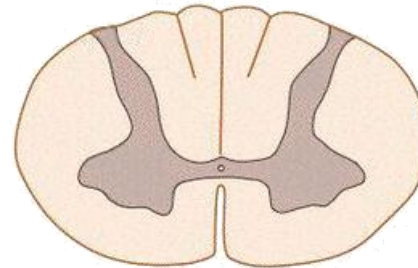
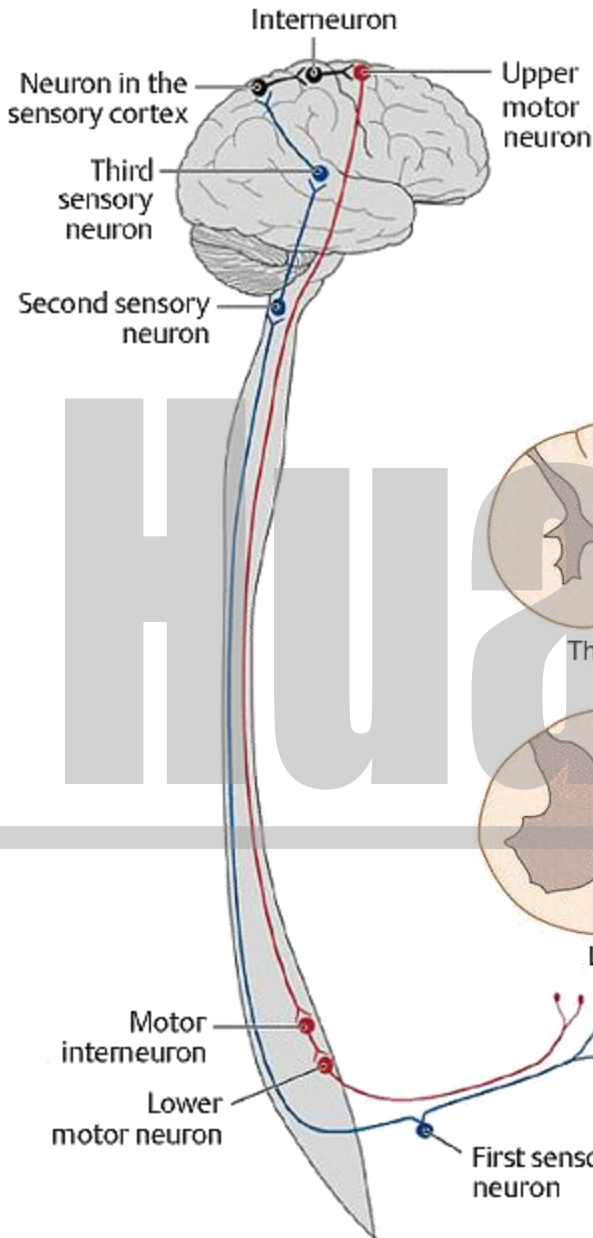






## The White Matter of Spinal Cord

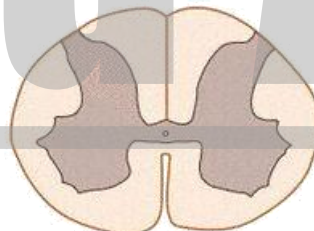
- 3 funiculi (columns):  
anterior (ventral), lateral  
& posterior (dorsal)



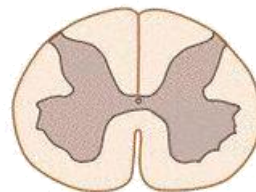
Cervical



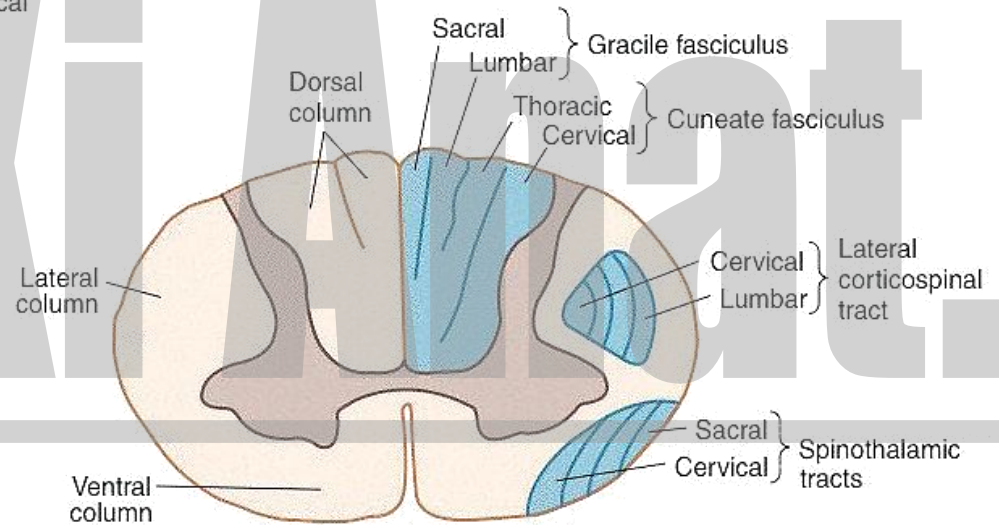
Thoracic



Lumbar



Sacral

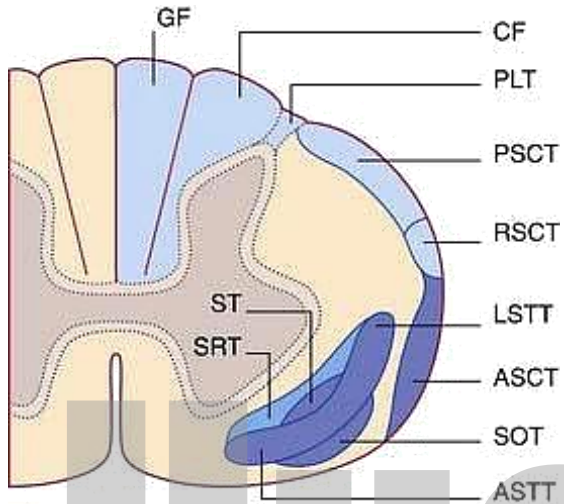


- 2 commissures: anterior &

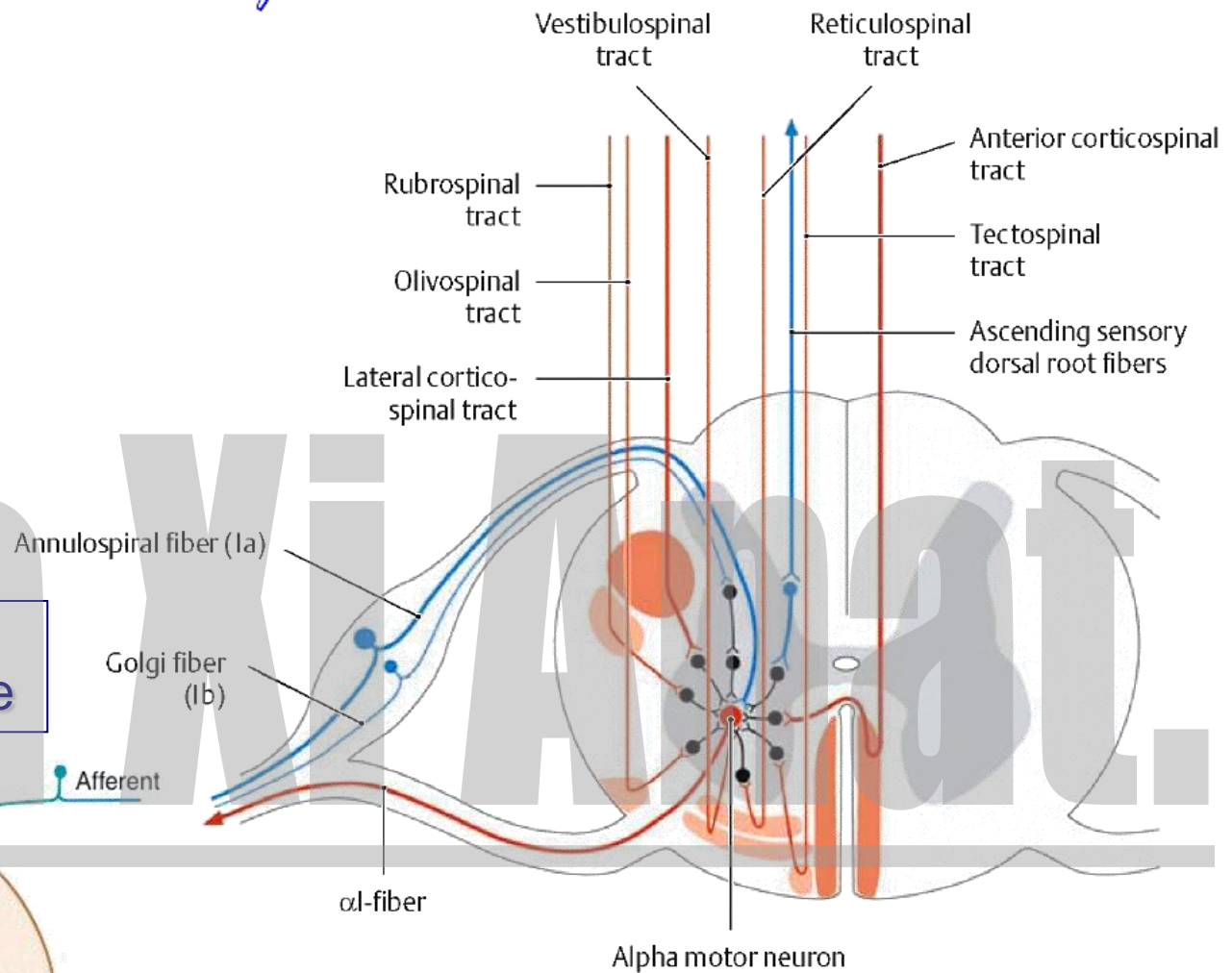
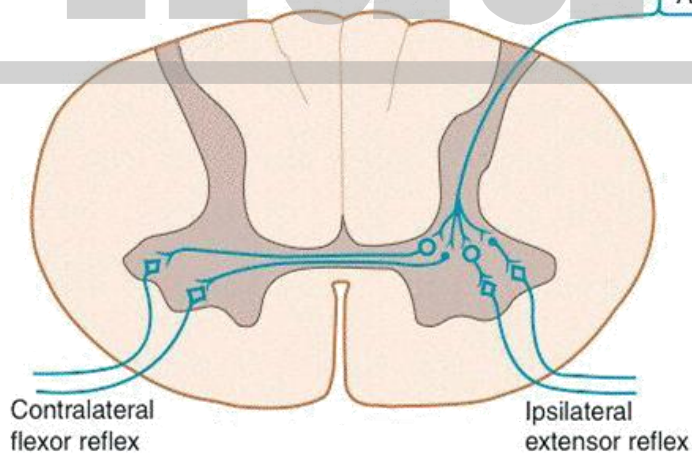




# Human Anatomy: Neuroanatomy



## Fasciculus Proprius & Anterior Commissure



- long tracts: ascending & descending tracts
- short tracts: fasciculus proprius



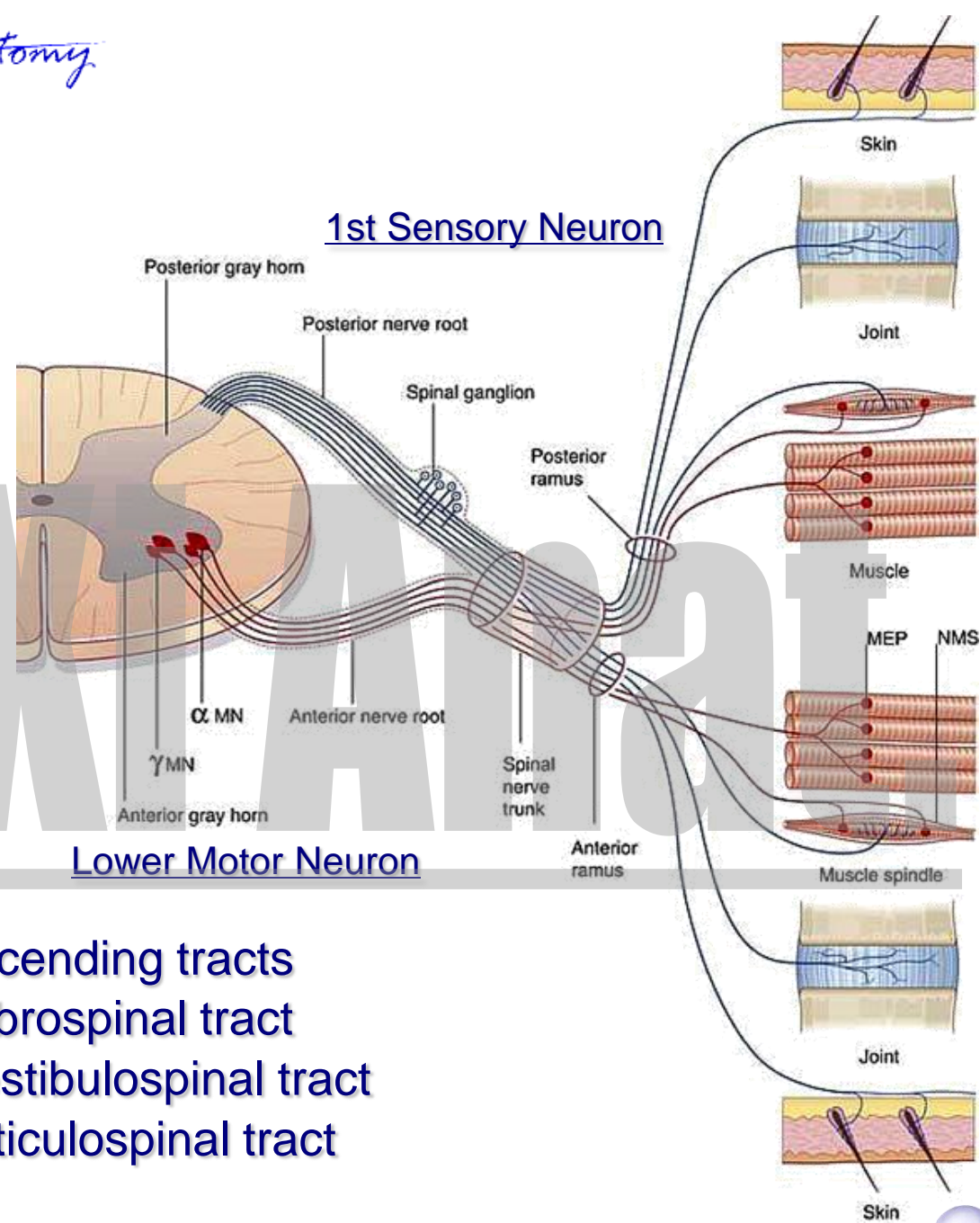


## Conscious Long Tracts

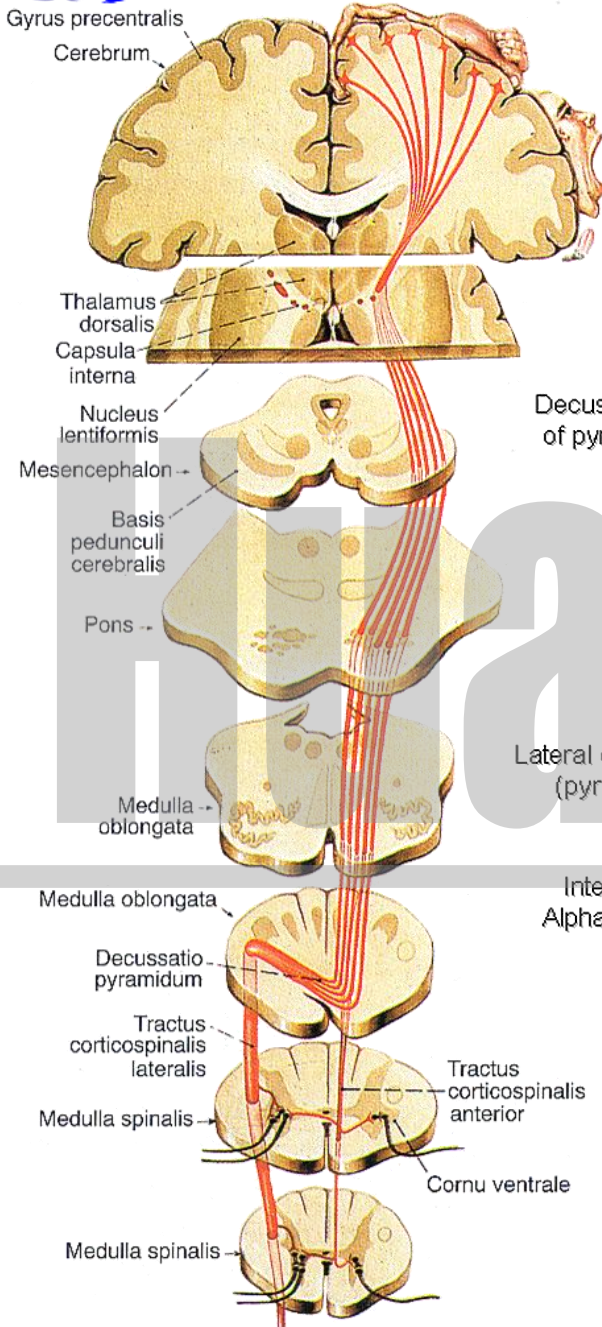
- descending tract
  - corticospinal tract
- ascending tracts
  - fasciculi gracilis & cuneatus
  - spinothalamic tract

## Subconscious Long Tracts

- ascending tracts
  - spinocerebellar tract
  - spinoreticular tract
- descending tracts
  - rubrospinal tract
  - vestibulospinal tract
  - reticulospinal tract







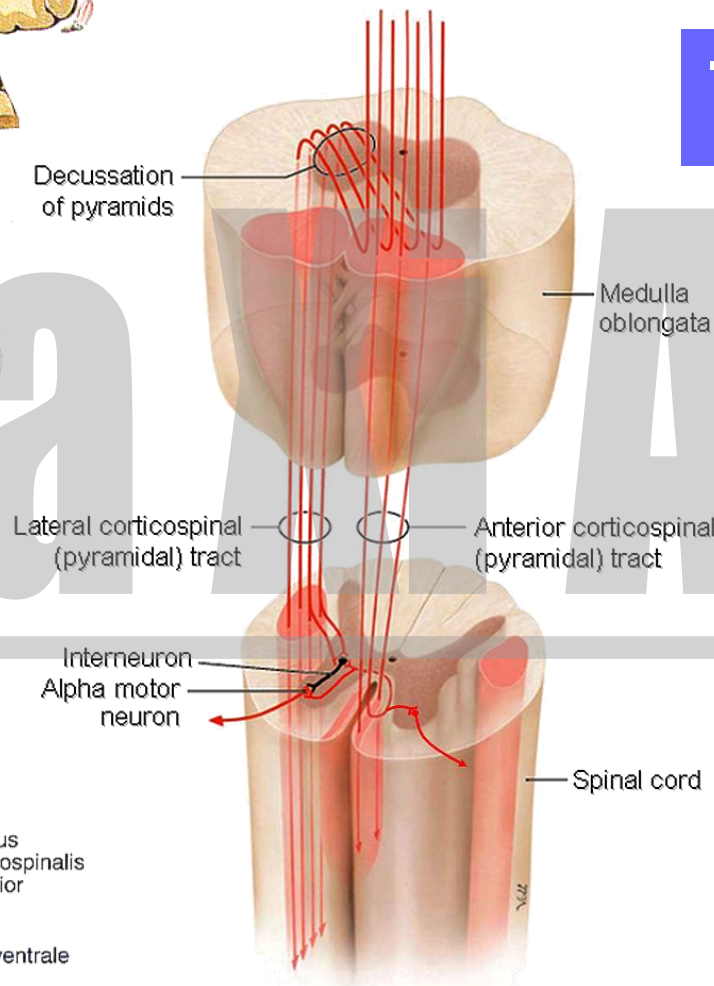
## Conscious Descending Tract: Corticospinal Tract (System)

- anterior corticospinal tract  
- axial muscles

- lateral corticospinal tract  
- distal muscles

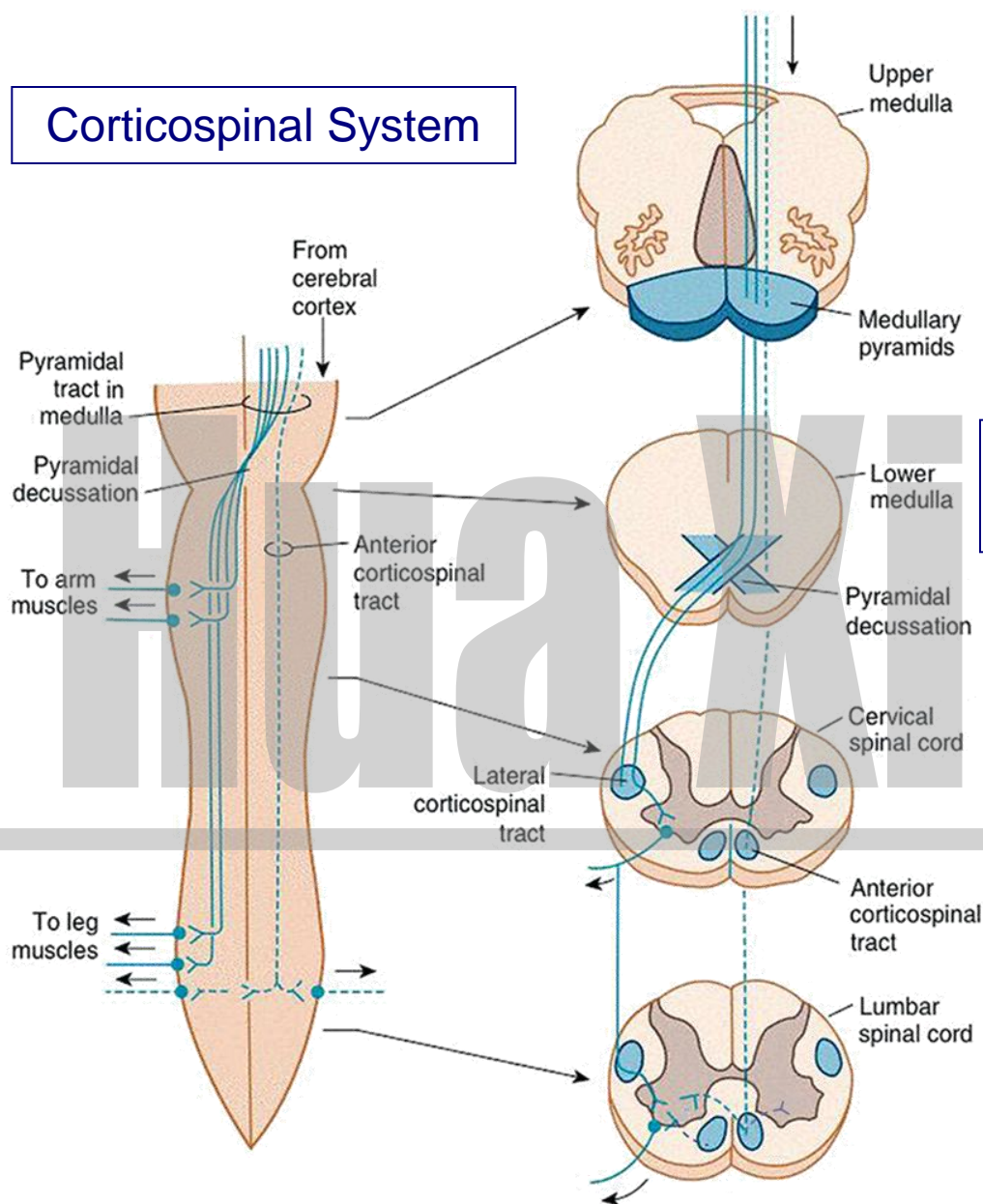
- Upper Motor Neuron  
- cerebral cortex
- Lower motor neuron  
- ant. horn of spinal cord

- Decussation  
- lateral corticospinal tract decussates at the medulla oblongata

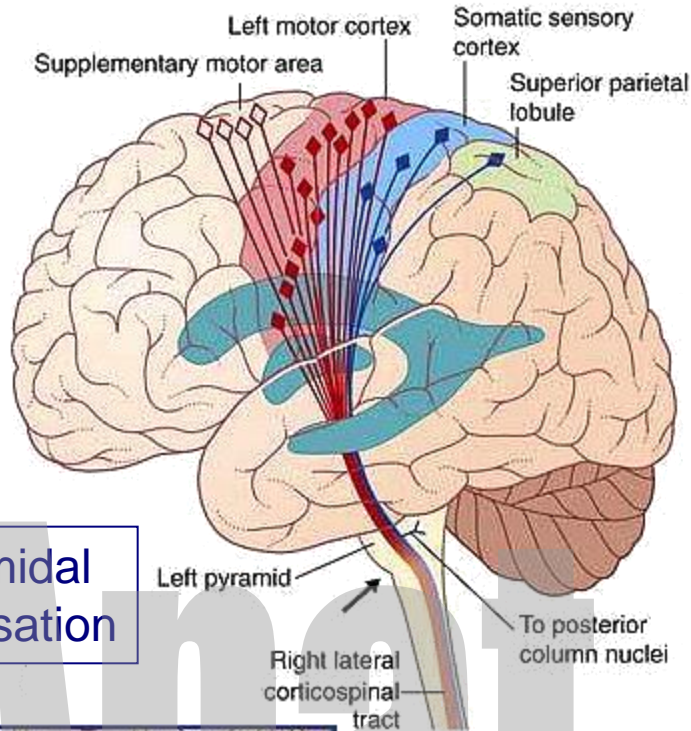
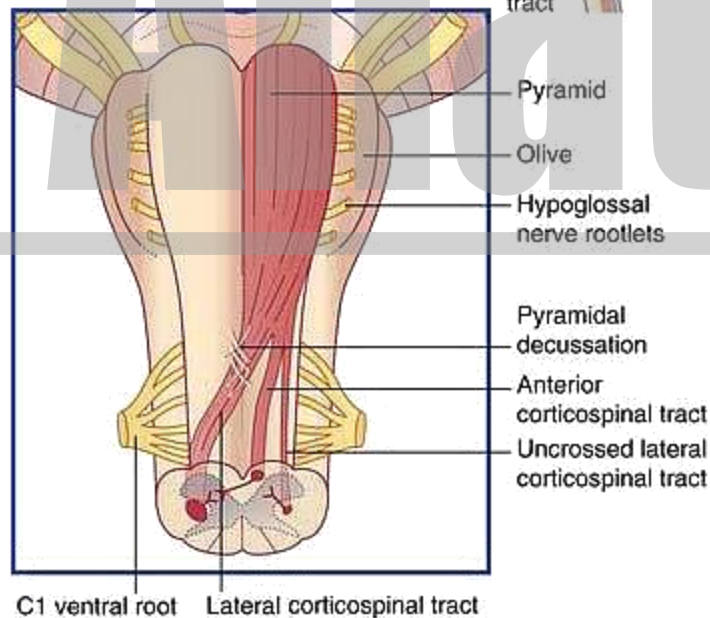




## Corticospinal System



## Pyramidal Decussation







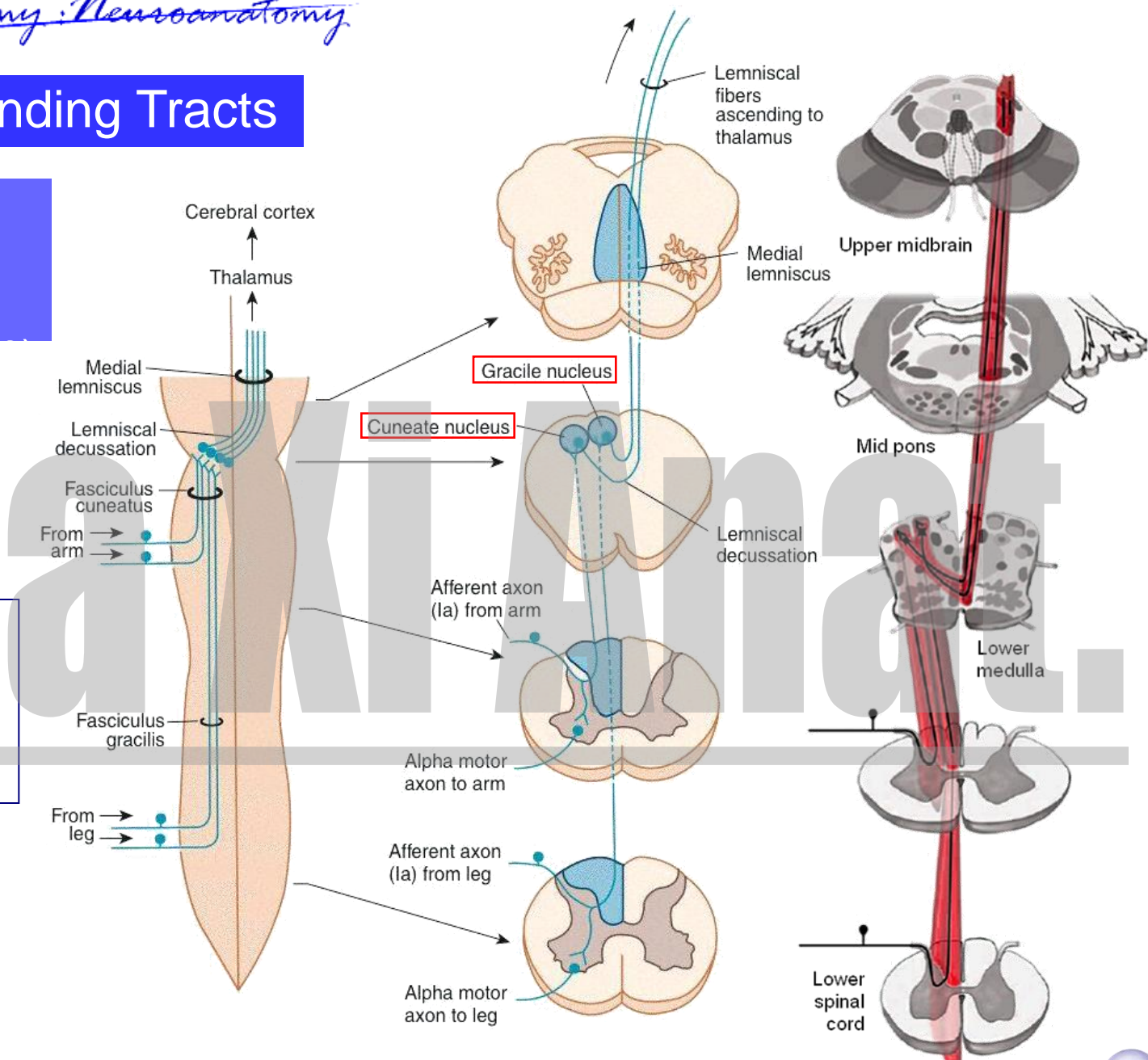
# Conscious Ascending Tracts

- fasciculus gracilis
- fasciculus cuneatus

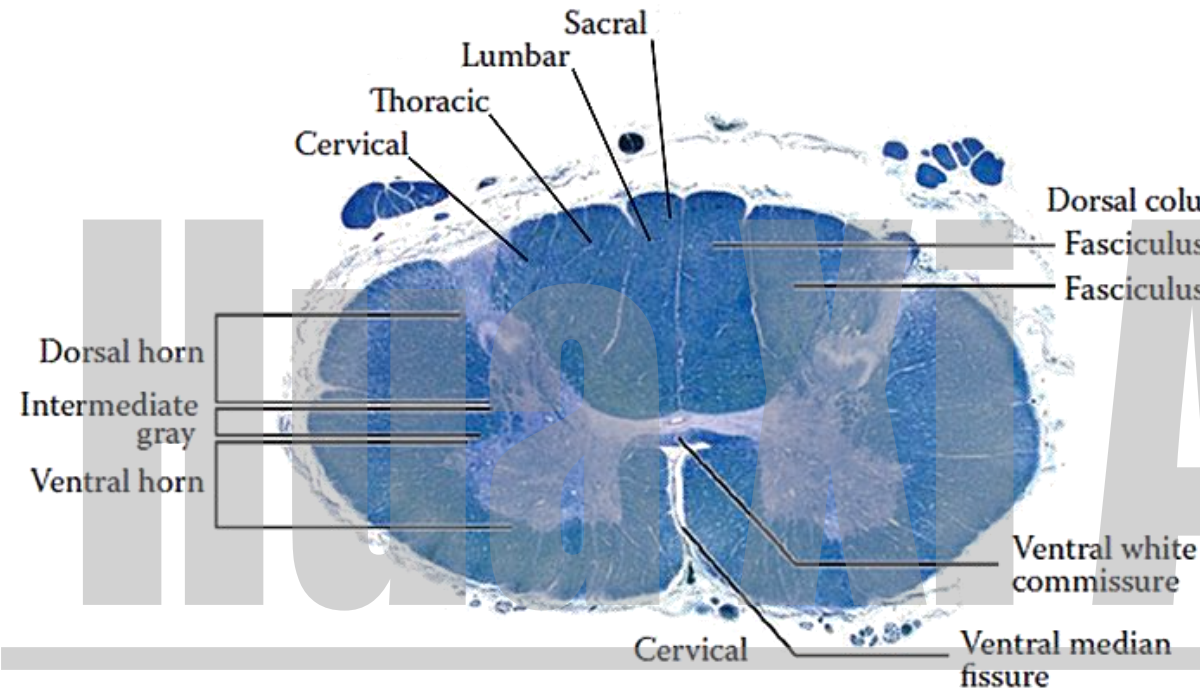
- proprioception & discriminative (fine) touch

- 1st sensory neuron - spinal ganglion
- 2nd sensory neuron - medulla oblongata

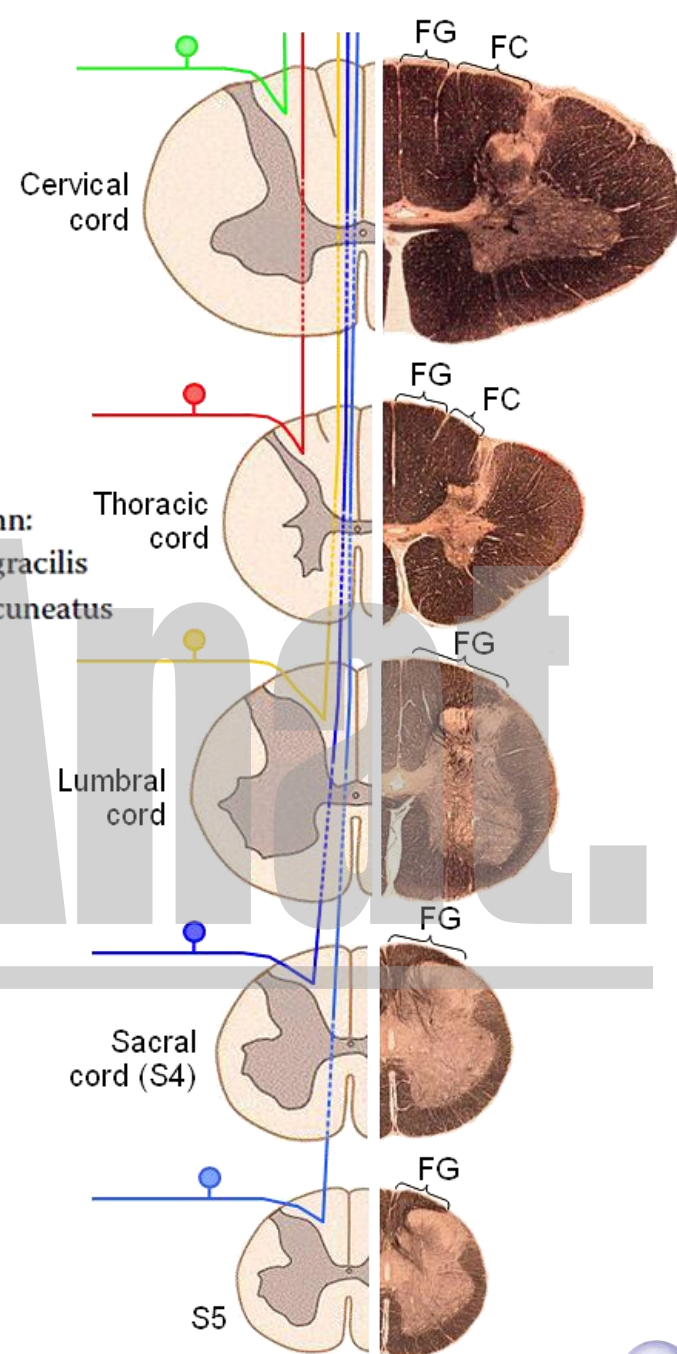
- Decussation - no decussation in spinal cord







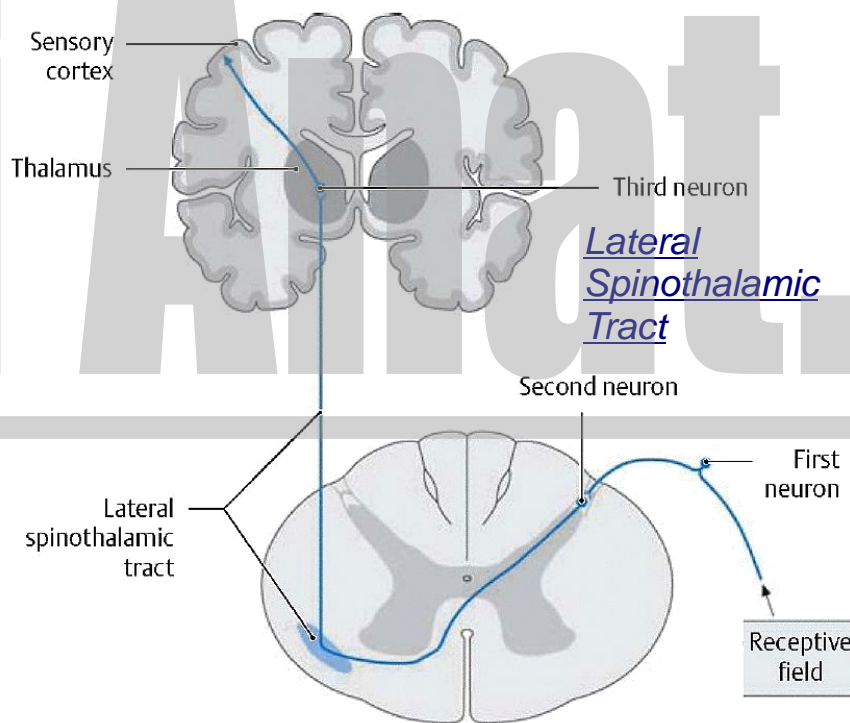
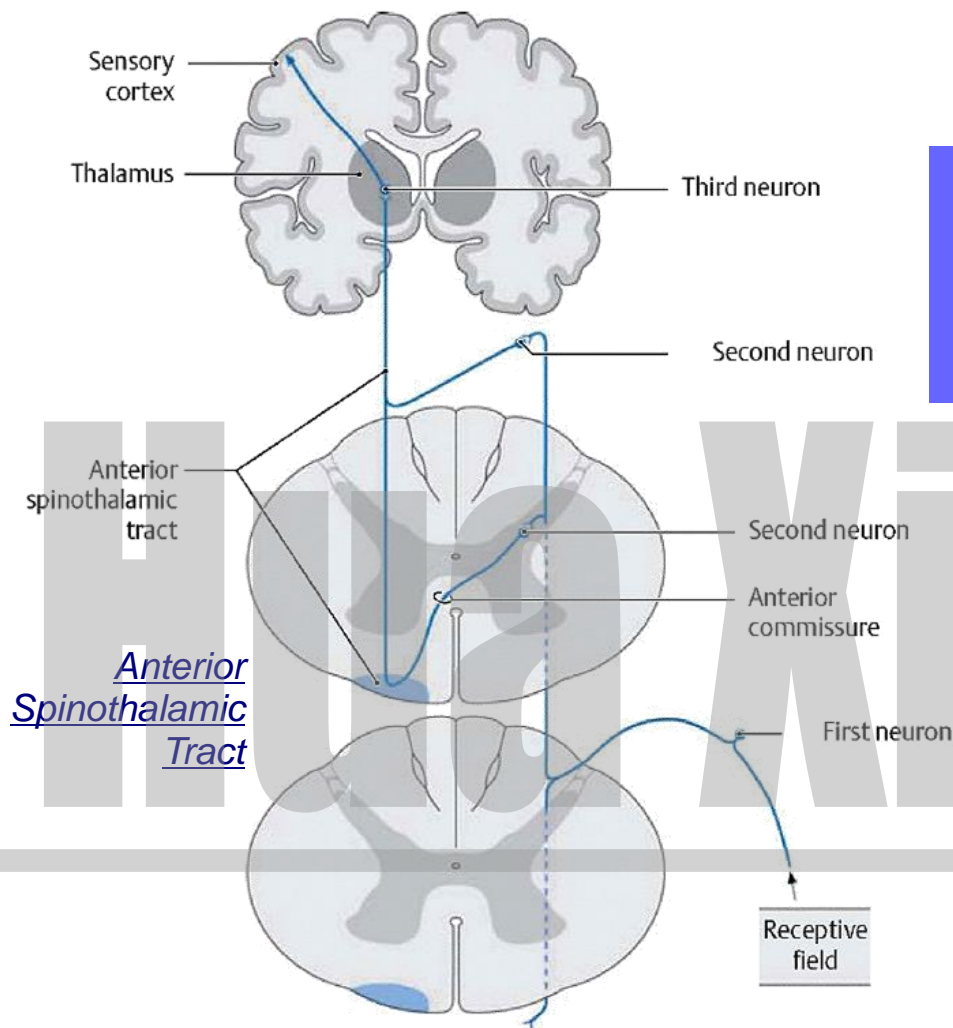
## Fasciculi Gracilis & Cuneatus





## Spinothalamic Tract

- anterior spinothalamic tract
  - non-discriminative touch & pressure
- lateral spinothalamic tract
  - pain & thermal sense (temperature)

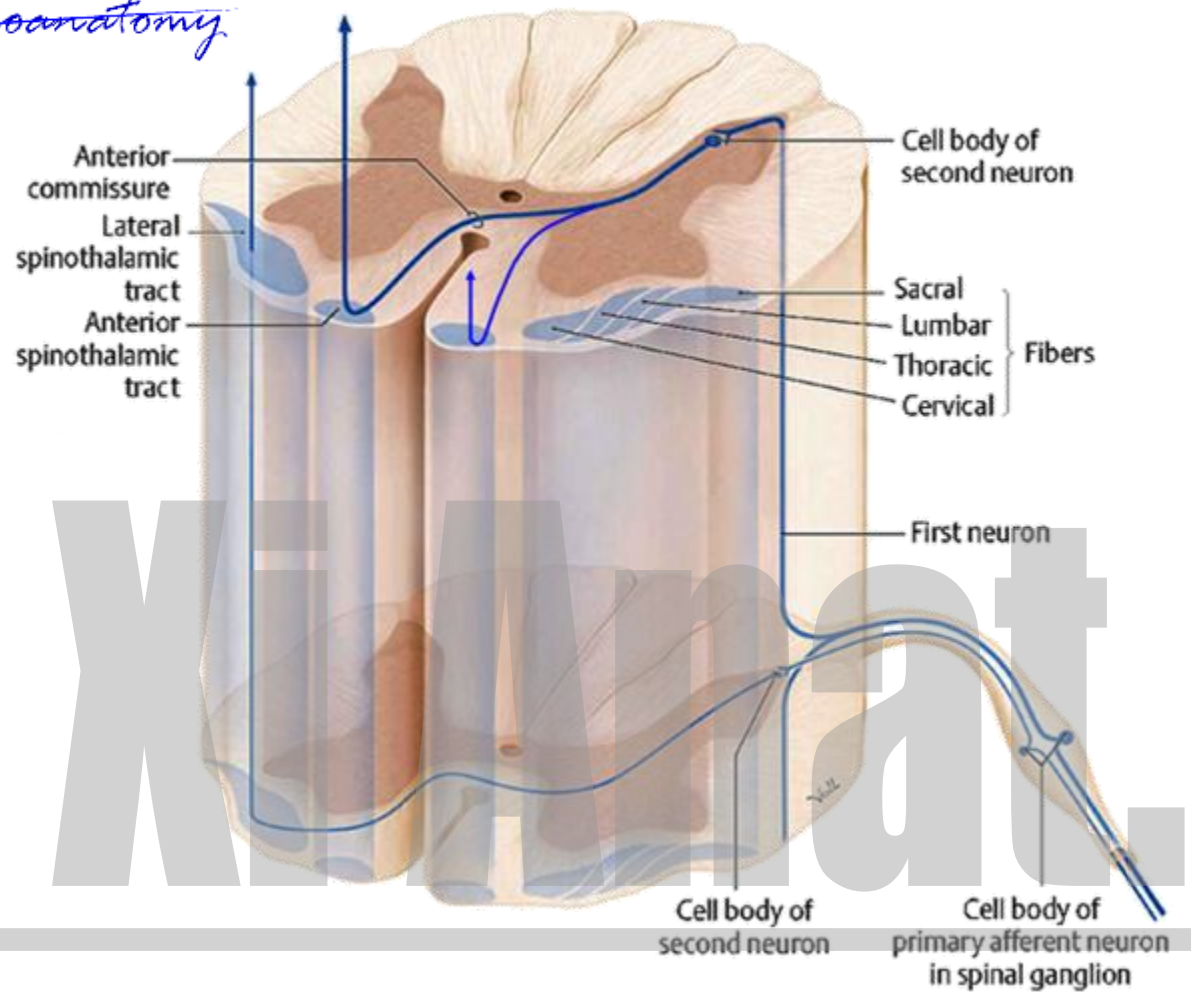
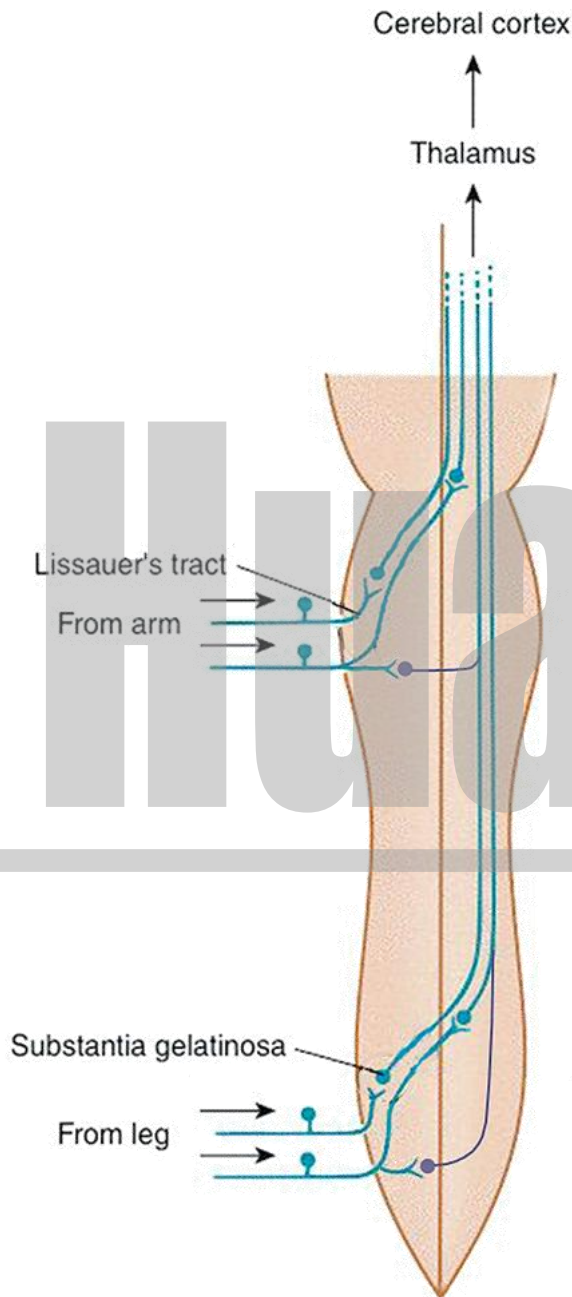


- 1st sensory neuron
  - spinal ganglion, fiber doesn't decussate
- 2nd sensory neuron
  - posterior horn, fiber decussates to opposite side by passing through anterior commissure





# Human Anatomy: Neuroanatomy



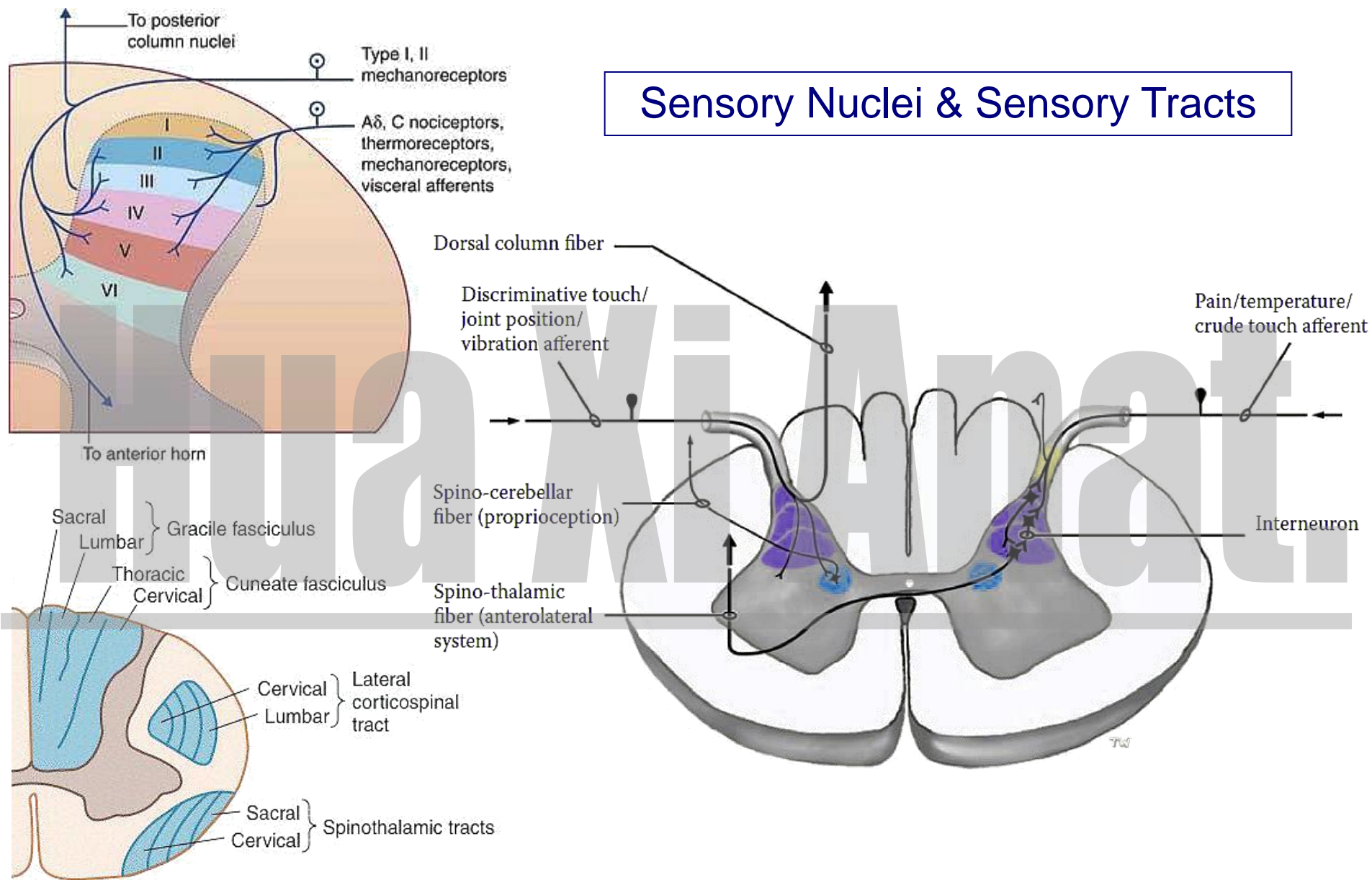
- **Anterior Spinothalamic Tract**
  - contains ascending fibers of both side
- **Lissauer's Tract**
  - ascend one to two segments before crossing somatotopically arranged

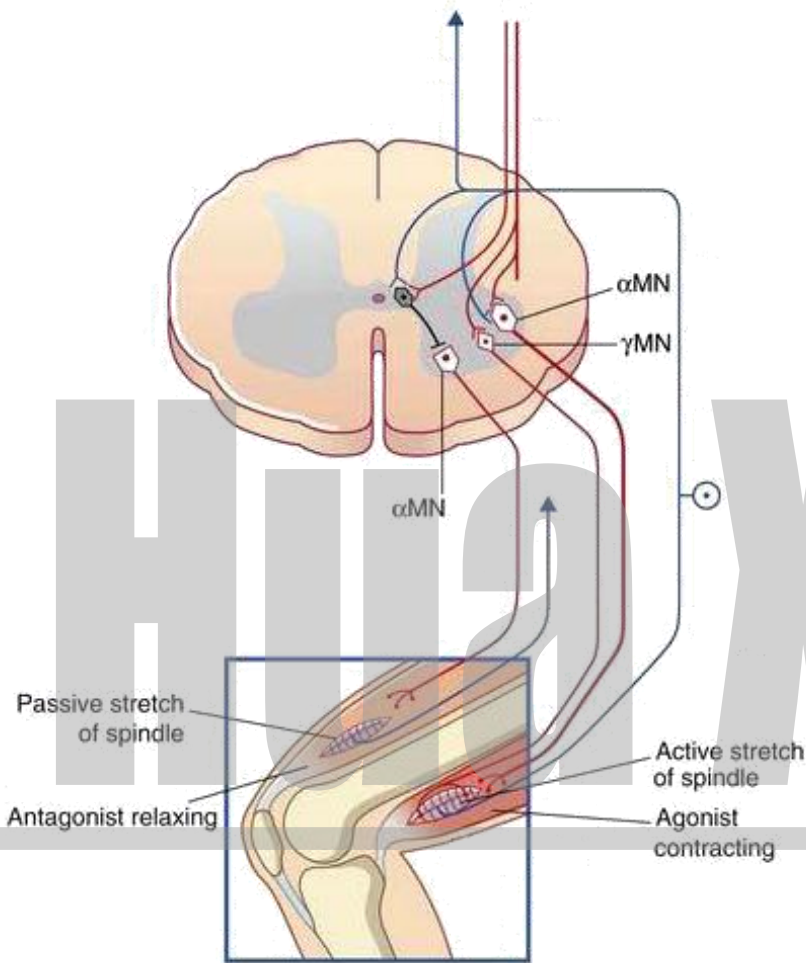




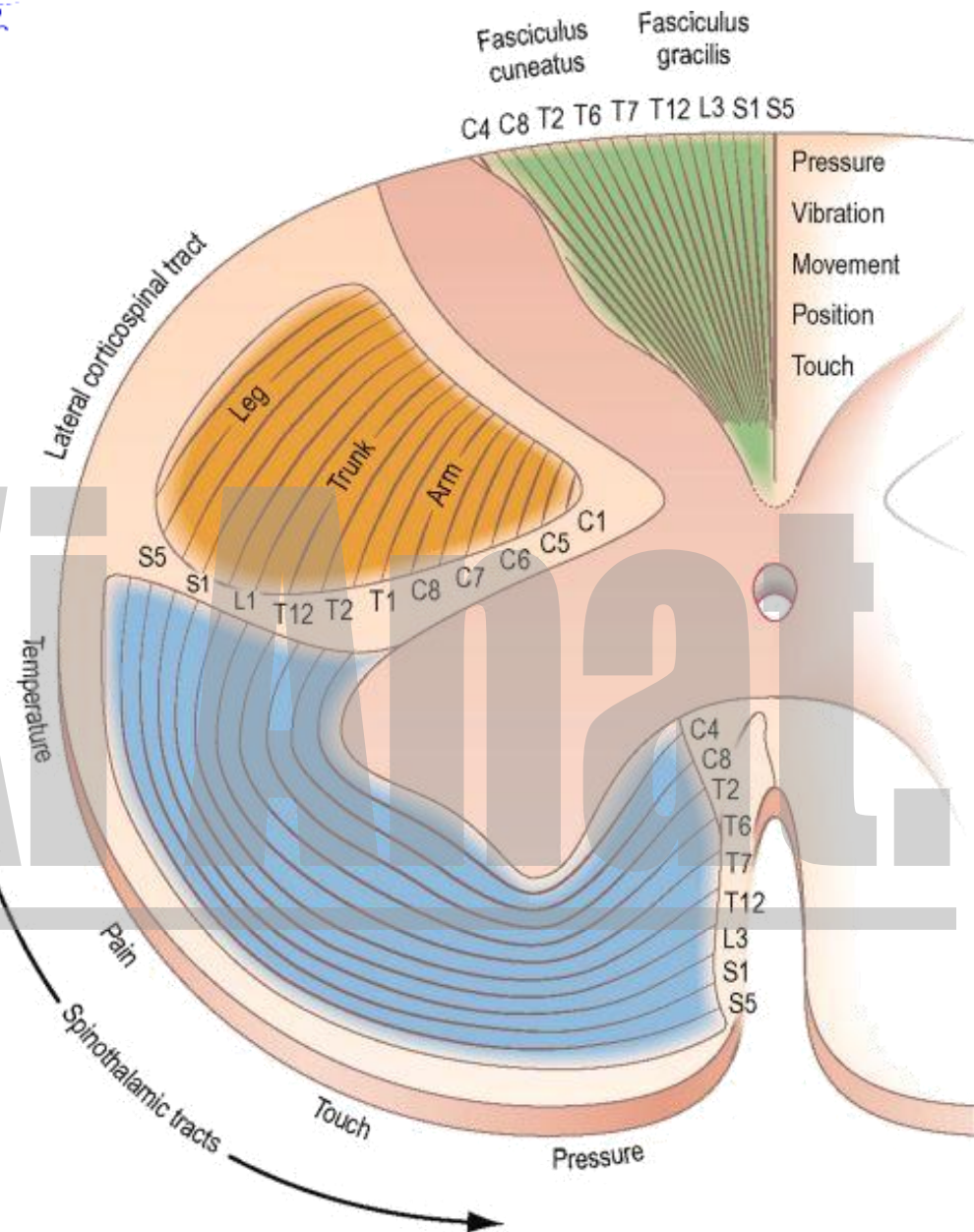


## Sensory Nuclei & Sensory Tracts





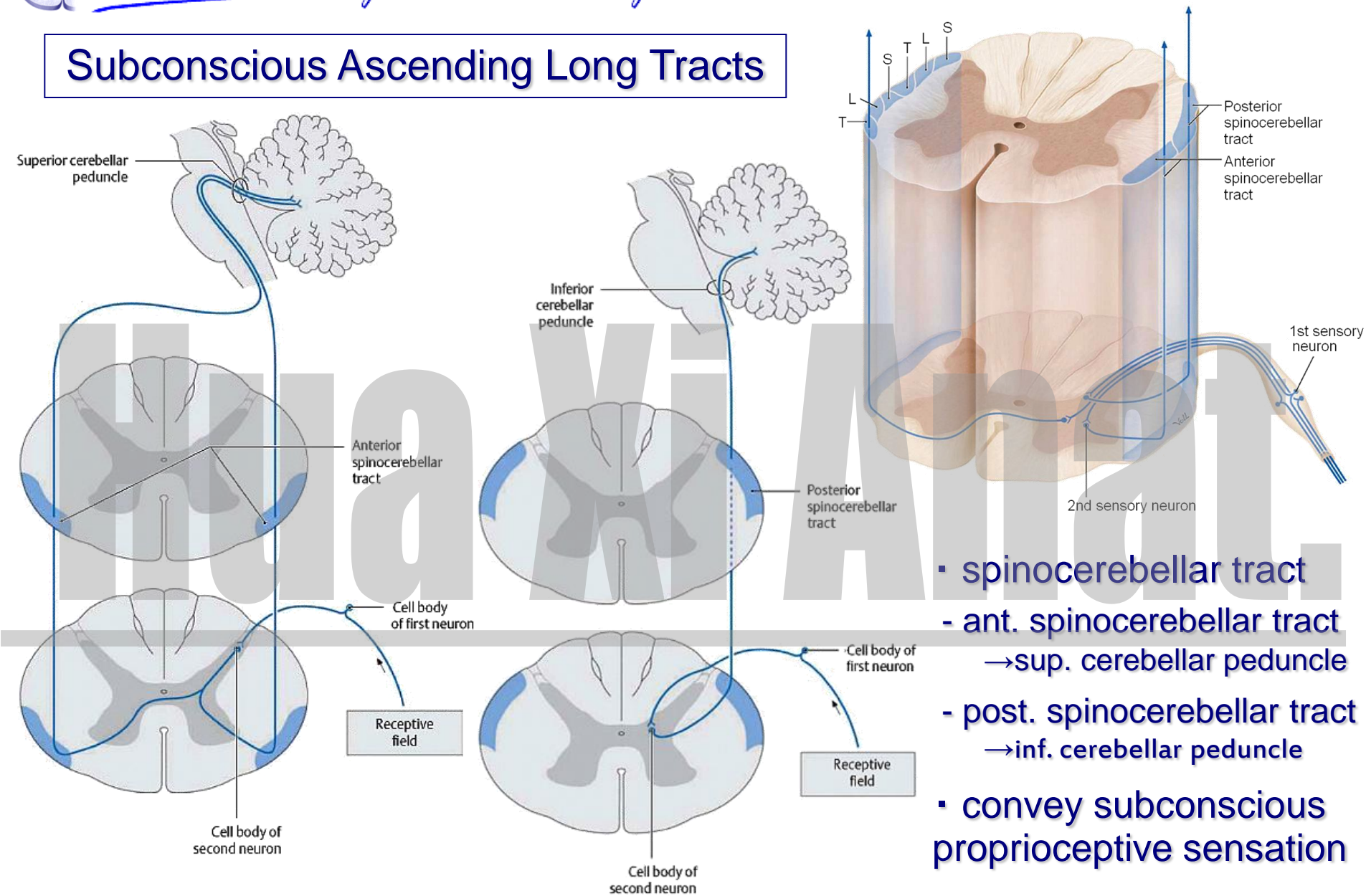
## Arrangement of the Major Ascending & Descending Tracts







## Subconscious Ascending Long Tracts



- **spinocerebellar tract**
  - ant. spinocerebellar tract → sup. cerebellar peduncle
  - post. spinocerebellar tract → inf. cerebellar peduncle
- **convey subconscious proprioceptive sensation**





- **spinoreticular tract**

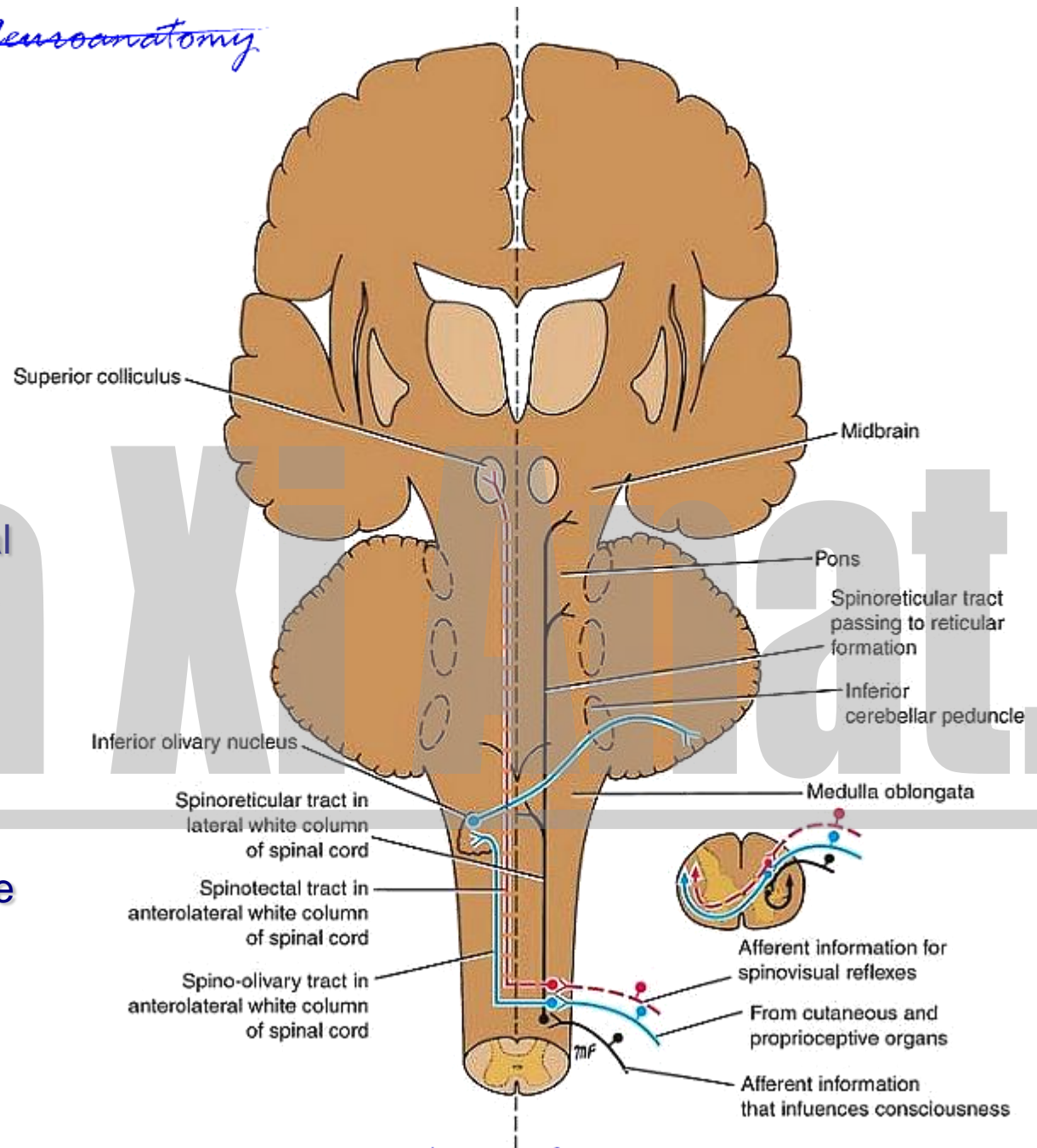
provides an afferent pathway for the reticular formation

- **spinotectal tract**

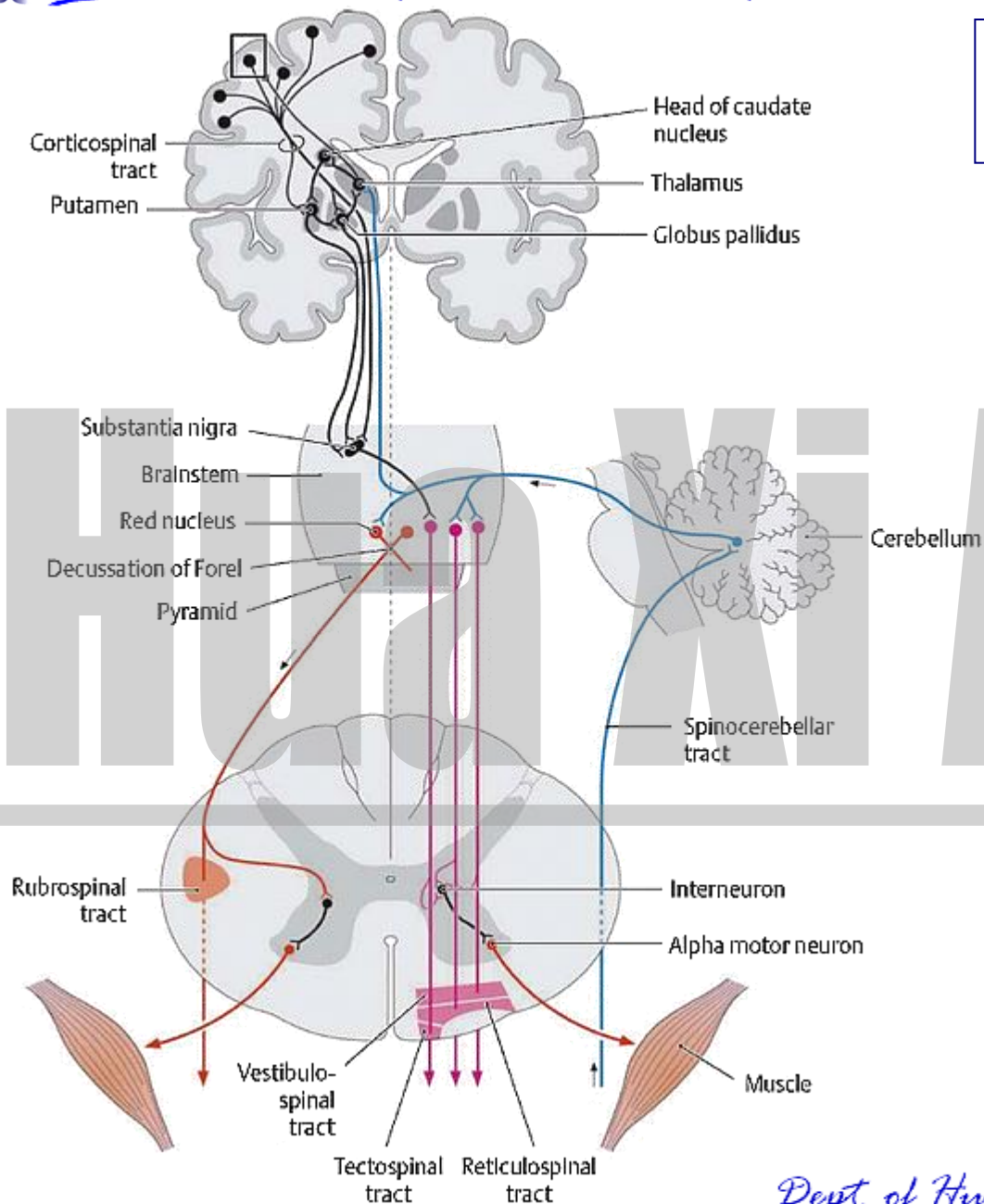
provides afferent information for spinovisual reflexes and brings about movements of the eyes and head toward the source of the stimulation.

- **spino-olivary tract**

conveys information to the cerebellum from cutaneous and proprioceptive organs







## Subconscious Descending Long Tracts

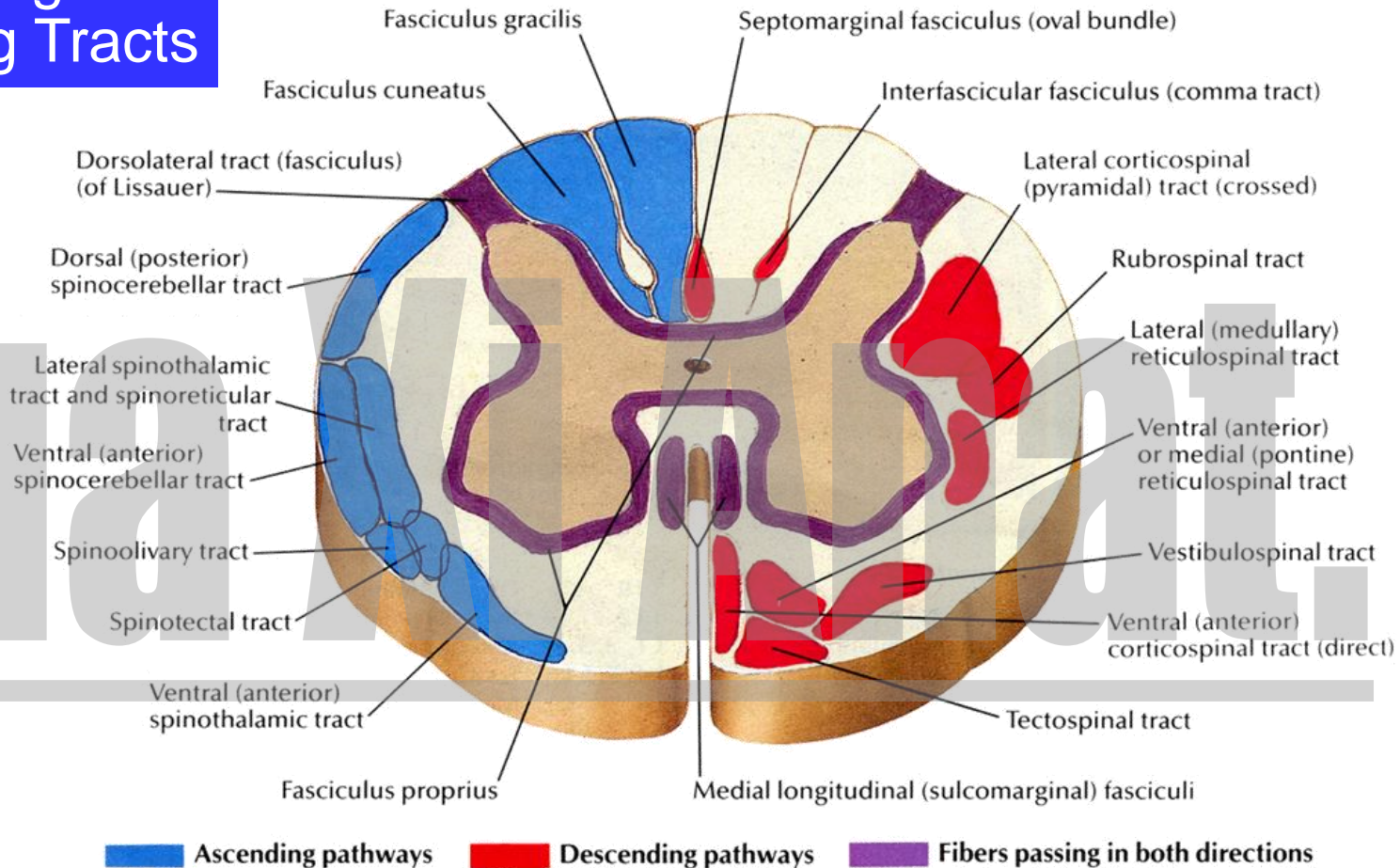
- **tectospinal tract**  
concerned with reflex postural movements in response to visual stimuli.
- **rubrospinal tract**  
facilitates the activity of the flexor muscles
- **vestibulospinal tract**  
facilitates the activity of the extensor muscles
- **reticulospinal tract**  
provides a pathway by which the hypothalamus can control the sympathetic outflow and the sacral parasympathetic outflow





## Short Ascending & Desending Tracts

- surrounding the grey matter of the spinal cord
- connecting two sides within one segment or connecting adjacent segments



## The Principal Tracts of the Spinal Cord







## CASE

23岁男性在开车回家的路上发生车祸。急诊检查发现TV9胸椎发生骨折，患者主诉左侧下肢无法运动并感觉不到自己左腿。皮肤敏感试验发现其脐水平左侧腹壁一带状皮肤区感觉过度敏感，在此敏感带之下有一狭窄带状麻木和痛觉缺失区。右侧脐平面以下痛觉温度觉缺失，触觉减弱或部分消失。

试分析脊髓损伤的水平。

脊髓是完全离断么？如果不是，是哪侧离断？

解释此患者表现出的各种症状原因。

