BHARATHIDASAN UNIVERSITY

Tiruchirappalli- 620024,
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Programme: M.Sc., Biomedical science

Course Title : Human Anatomy & Physiology

Course Code : BM12C2

Unit-II

TOPIC: Basic Neuro Anatomy

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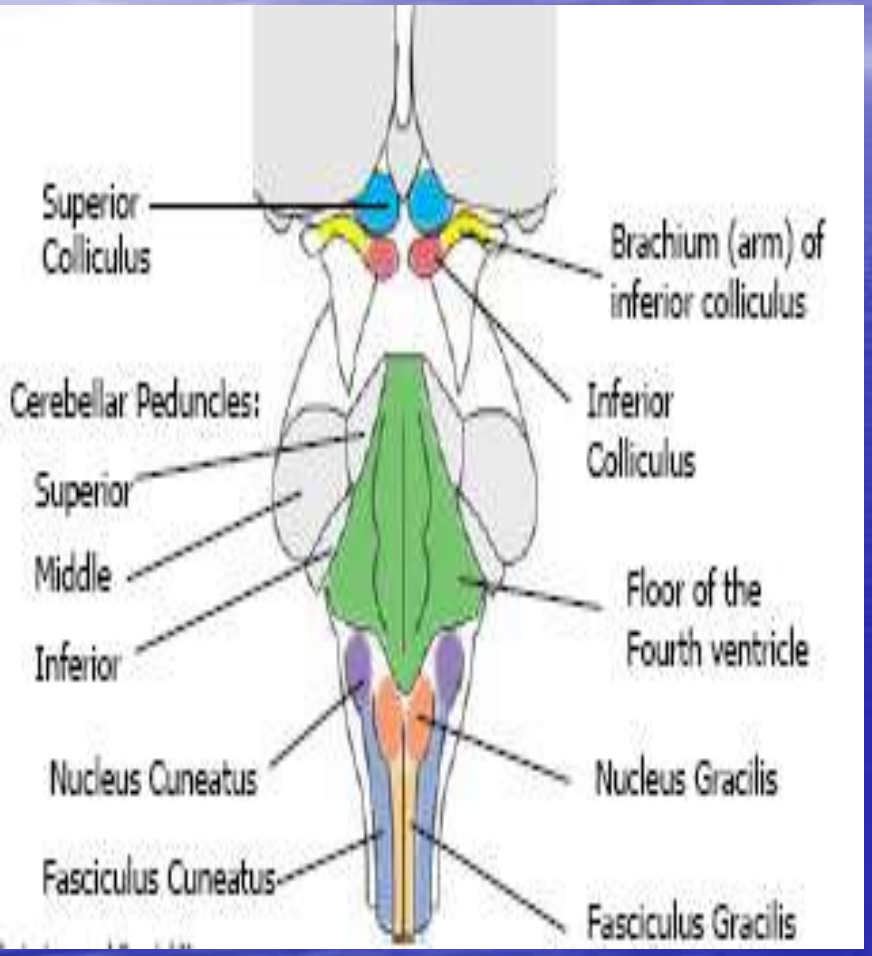
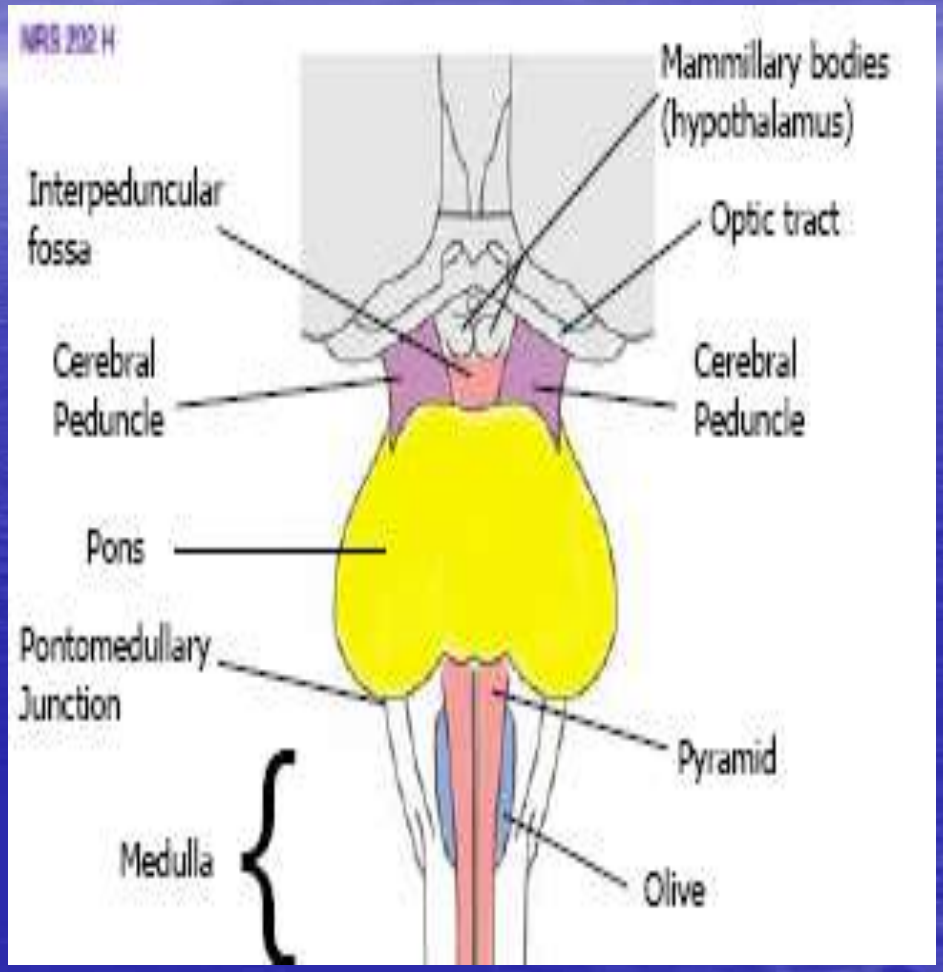
Basic Neuro Anatomy

Brainstem and Spinal cord

- Cerebrum
- Brain stem
- Midbrain
- Pons
- Medulla
- Cerebellum

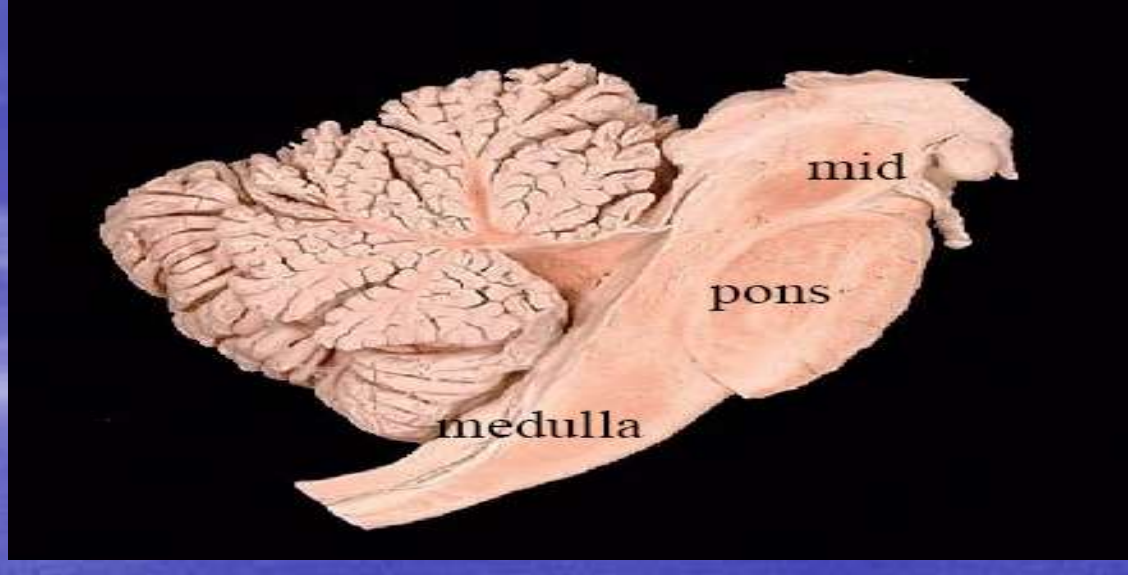
Dorsal and ventral view of Brain stem





Brain Stem

- three main parts
  - medulla, pons,midbrain.
- Cranial nerves



Midbrain - Functions

- Includes ascending sensory and descending motor pathways
- Includes the nuclei of cranial nerves III and IV
  - i.e. the midbrain plays a role in eye movements
- Dorsal surface composed of superior and inferior colliculi - centers for visual and auditory reflexes respectively
- Contains the red nucleus – a motor center of uncertain function in humans.
- Contains the Substantia Nigra (black stuff) – one of the basal ganglia (a motor center).

Pons - Functions

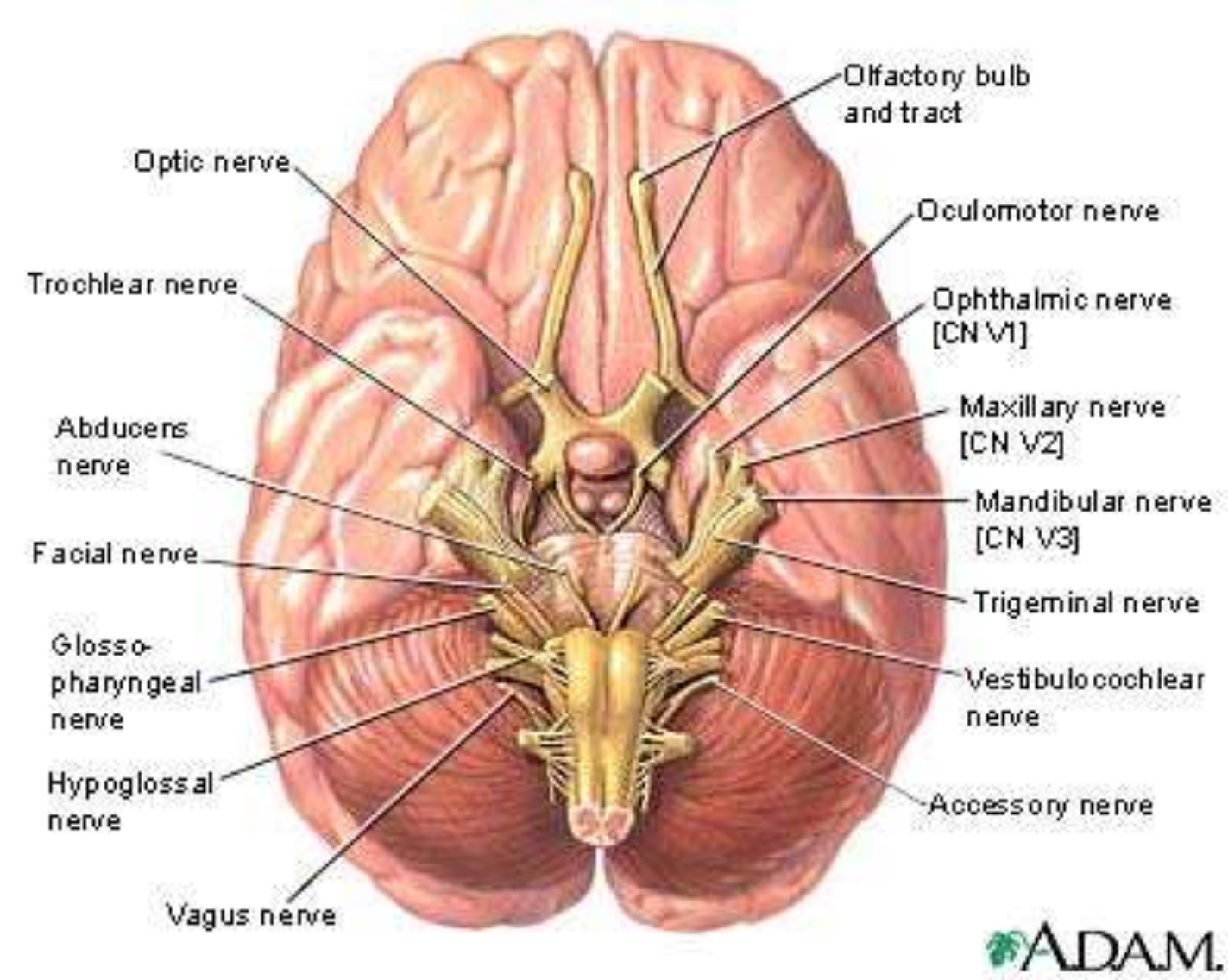
- Includes ascending sensory and descending motor pathways
- Includes the nuclei of Cranial Nerves V, VI and VII (junction of pons and Medulla)
  - i.e. the pons is responsible for sensation (touch) in the face and head, eye movements and muscles in the the face
- Contains Pontine nuclei – groups of neurons that form a synapse point between the cerebrum and the cerebellum.

Medulla - Functions

- Includes ascending sensory and descending motor pathways
- Includes the nuclei* of cranial nerves V, VII(partial), VIII, IX, X, and XII
  - i .e. the medulla is responsible for sensation in the face and head, hearing and balance and it coordinates movements of the face, pharynx and larynx, viscera.

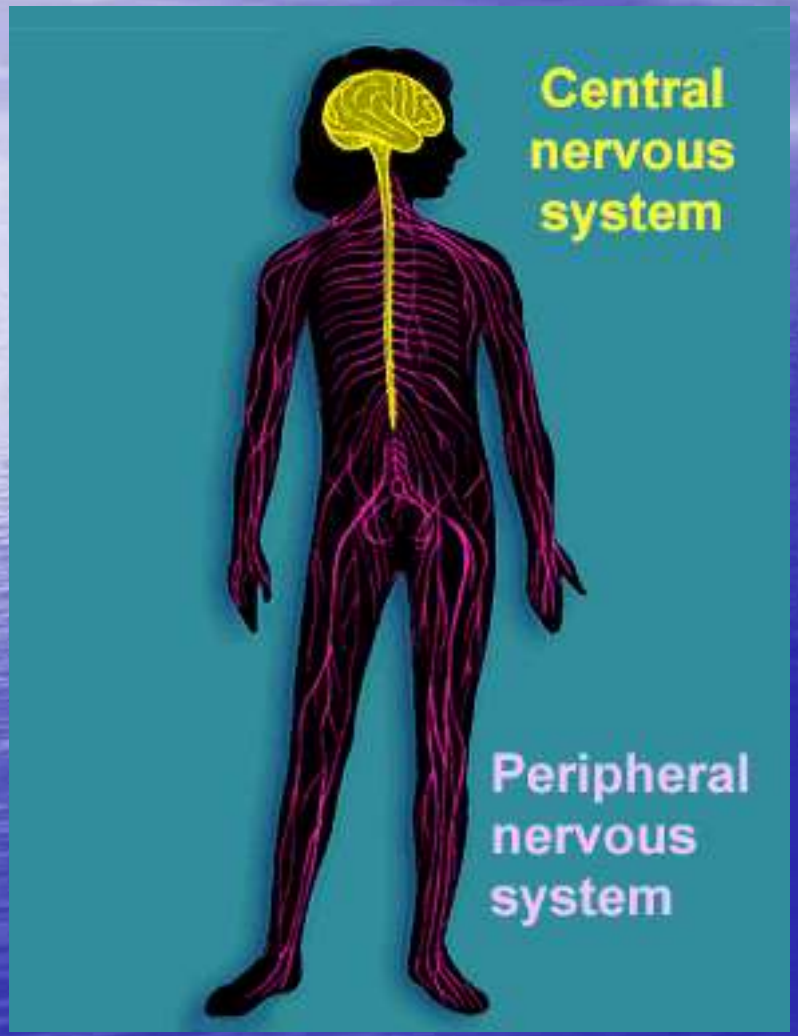
* A nucleus, in the neuroanatomical sense, is a group of neuronal cell bodies with a common function clustered together. (grey matter)

Attachment of Cranial Nerves



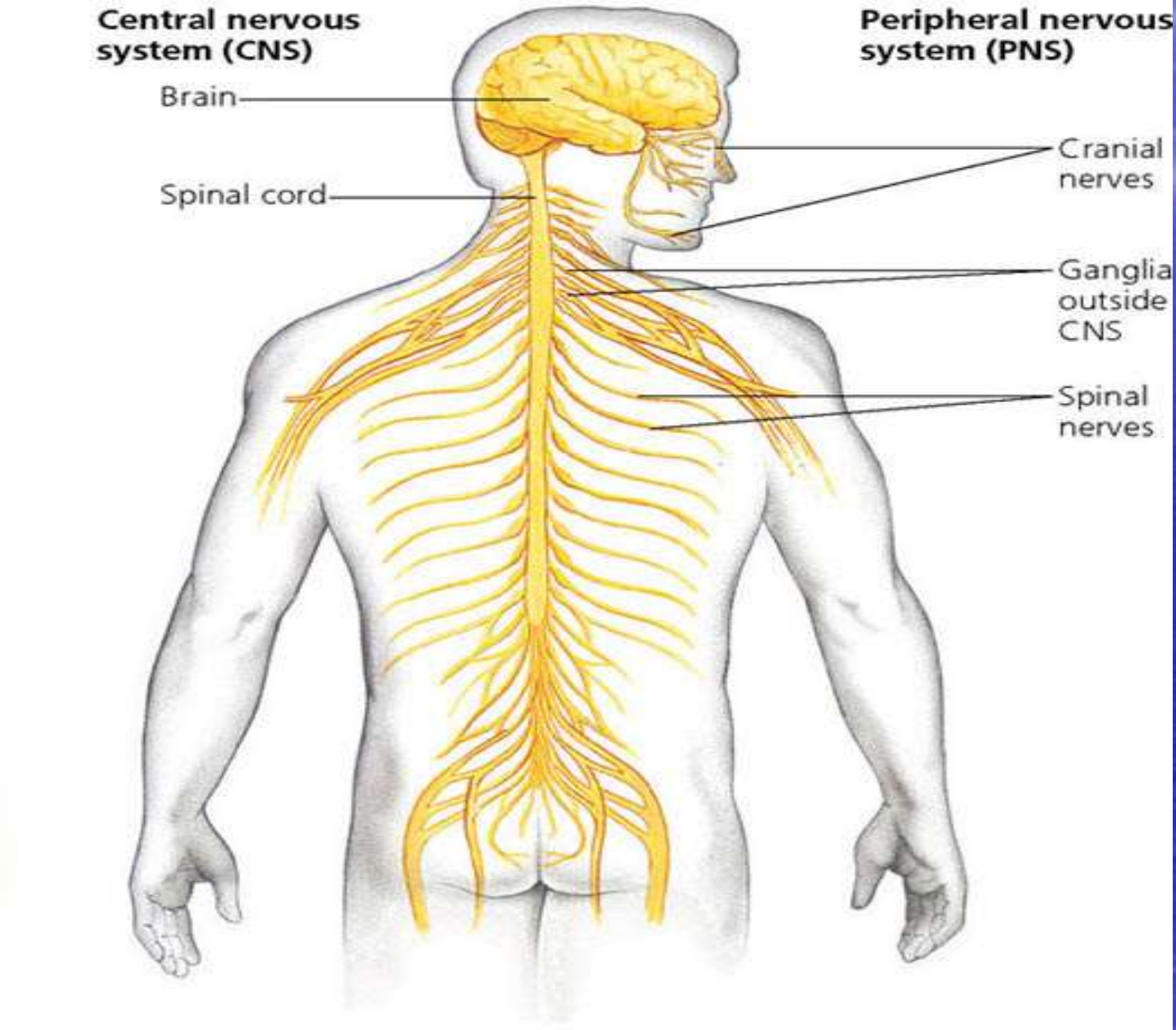
The Spinal cord

Organization of the Nervous System

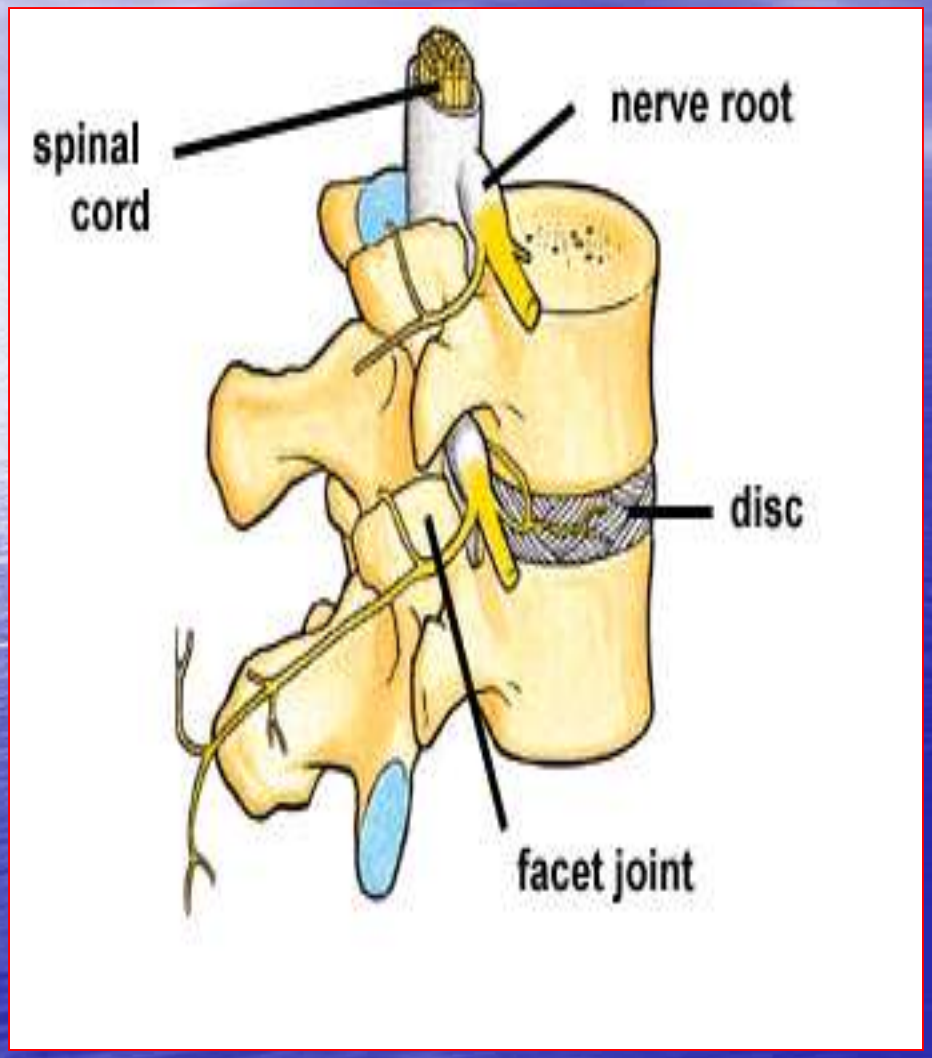


- CNS
  - Brain
  - Spinal cord
- PNS
  - Somatic
  - Autonomic
    - Sympathetic
    - Parasympathetic
    - Enteric

The Spinal cord and spinal Nerves

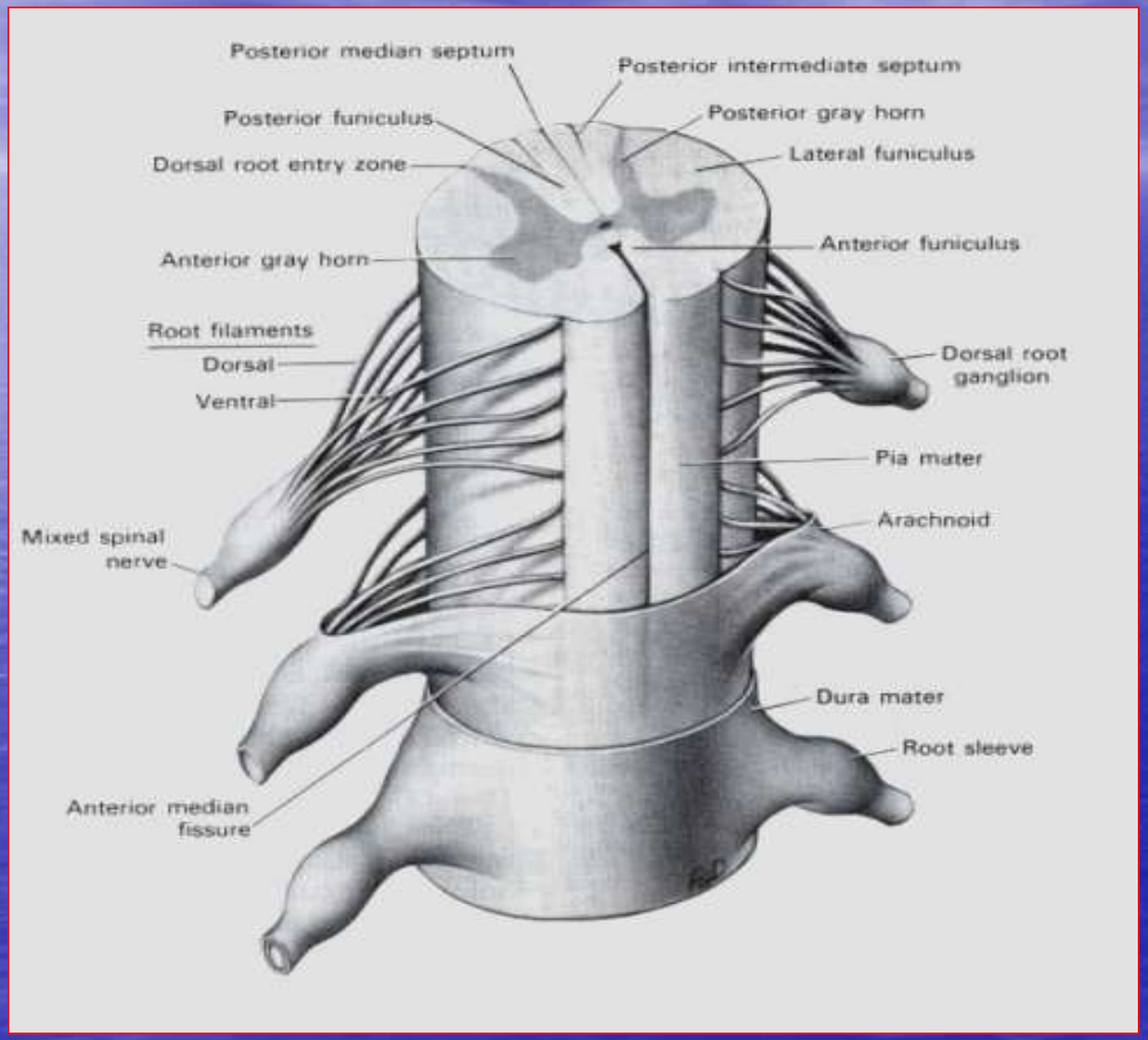


Functions of Spinal Cord



- Final common pathway for the somatomotor system
- Conveys somatosensory information from the body
- Autonomic neurons
- Reflexes
- Central pattern generators for rhythmic movements and other fixed action patterns

Organisation of Spinal Nerve



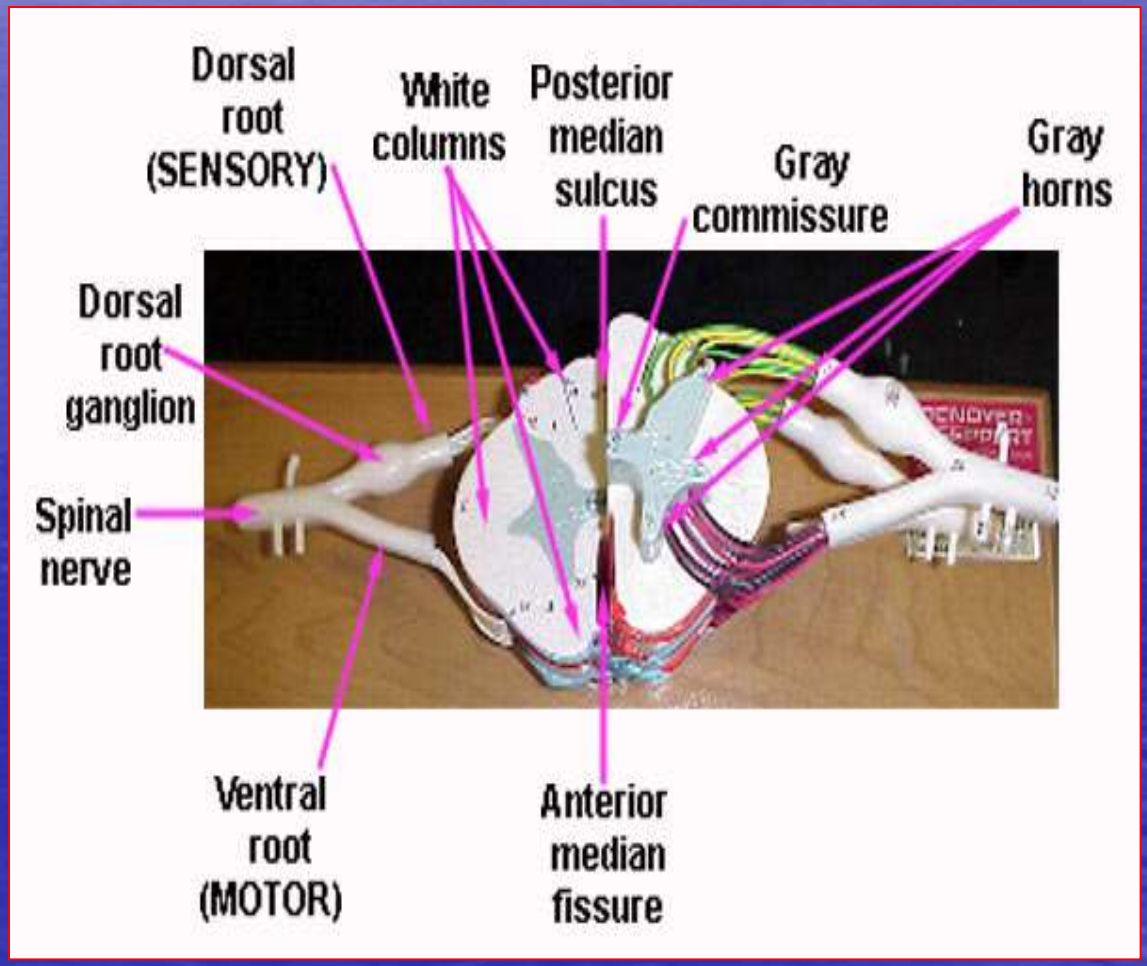
Sensory vs motor roots "Bell and Magendie Law"

Dorsal Root: Sensory (Afferents)

Ventral Root: Motor (Efferents)

Somatic motor & Visceral motor

"The nerve which supply muscle groups also supply the skin over the joint moved by the muscles"



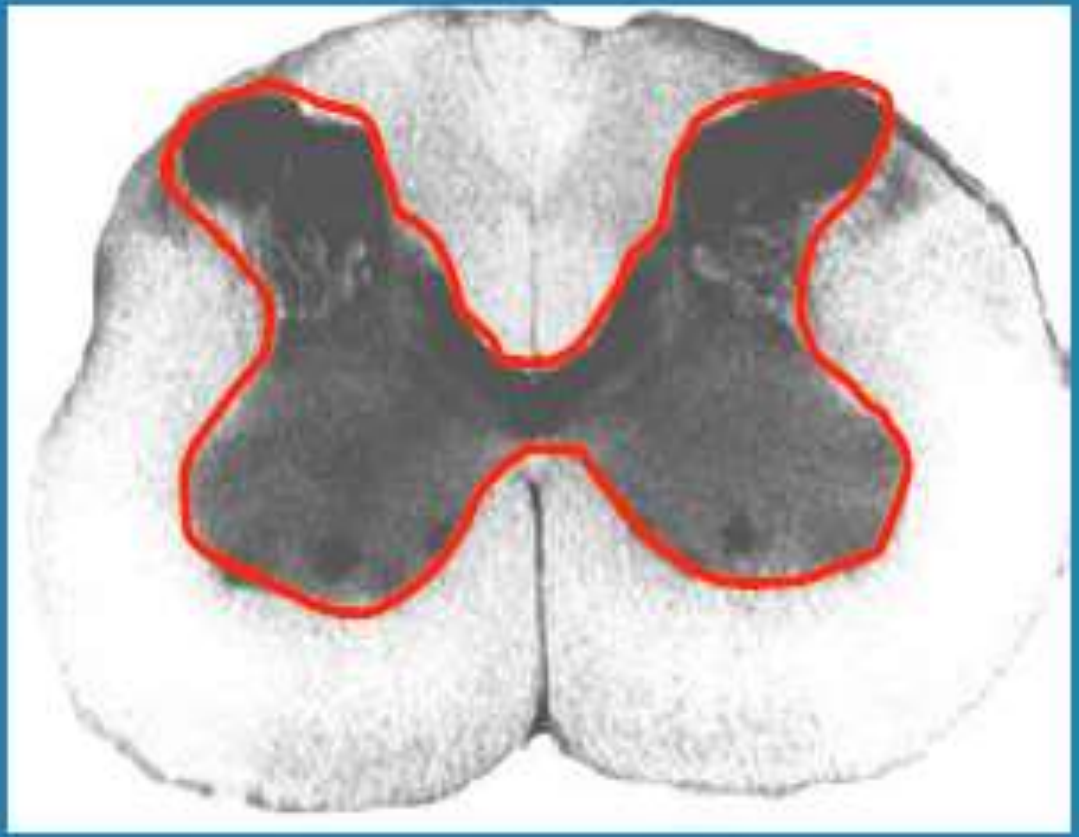
Spinal Cord Anatomy & Pathways

Gray Matter

- Contains neurons

White Matter

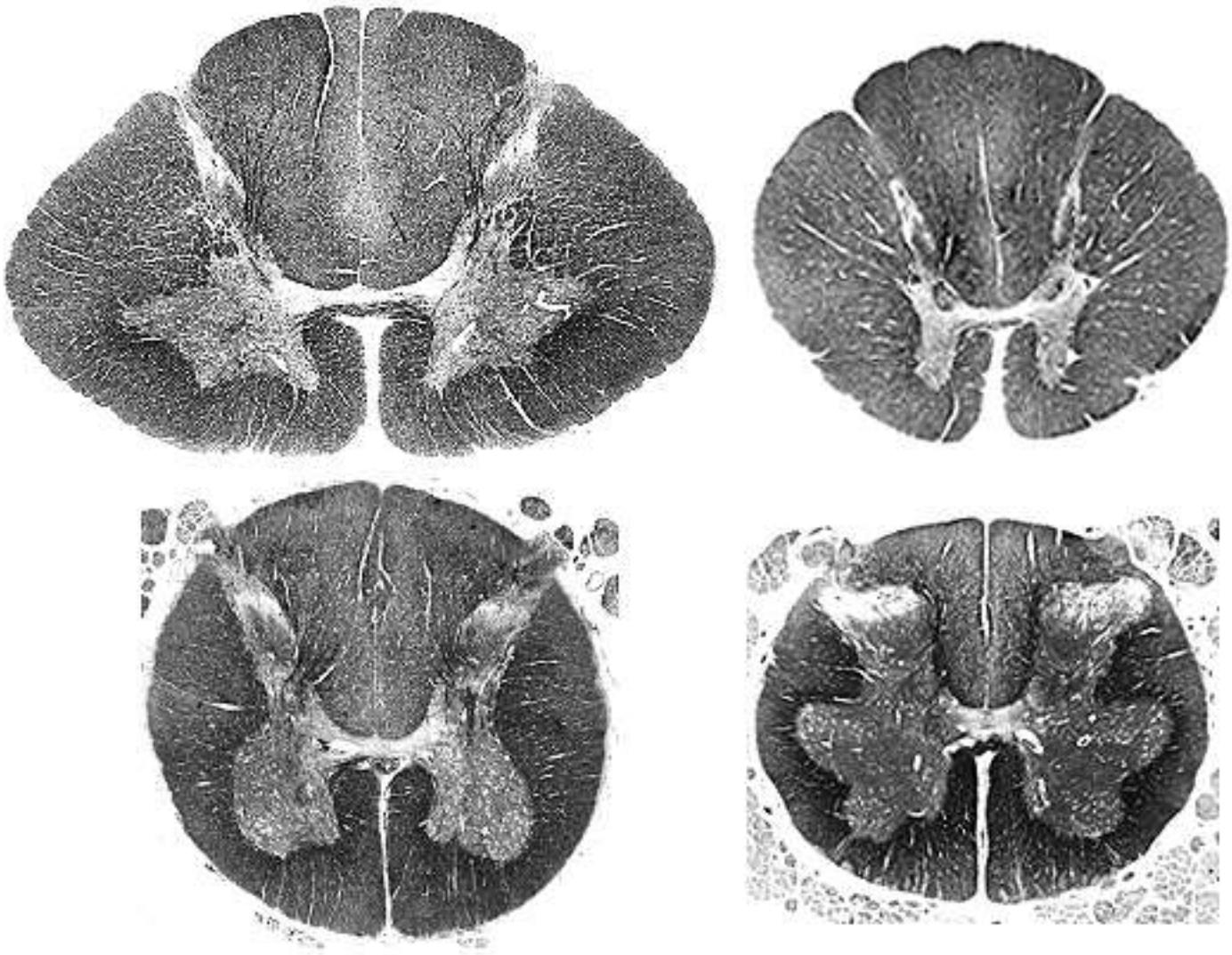
- Contains axons



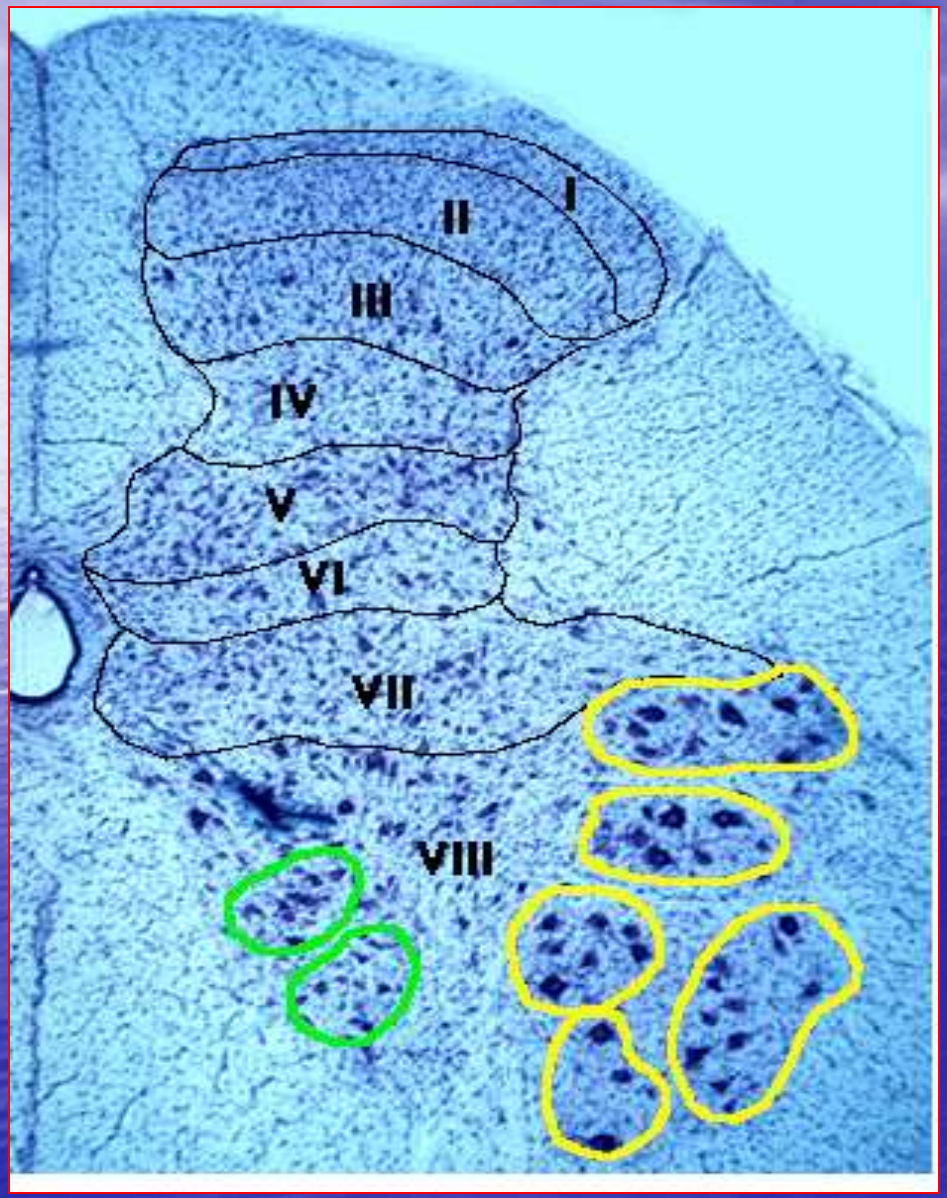
Internal Gross Anatomy

- Anterior median fissure
- Posterior median sulcus
- Central canal Anterior white commisure
- Dorsal, ventral and lateral horn
- Dorsal, ventral and lateral funiculus

Sections of the Spinal Cord

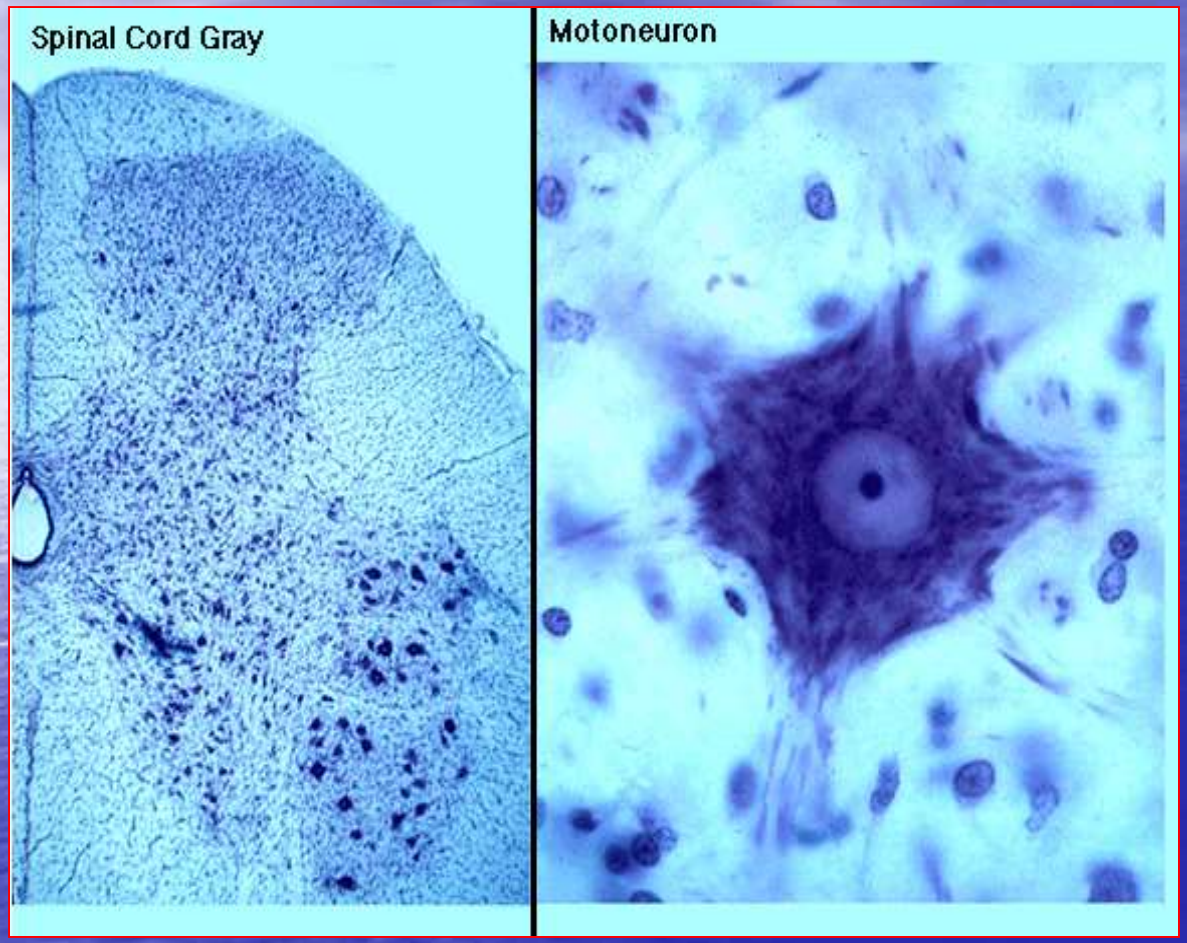


Rexed's Lamina



- Some important nuclei
  - Substantia gelatinosa (II)
  - Nucleus proprius (IV)
  - Dorsal nucleus of Clarke
- Intermediolateral cell column
  - Motor neuron pools

Motor Neurons

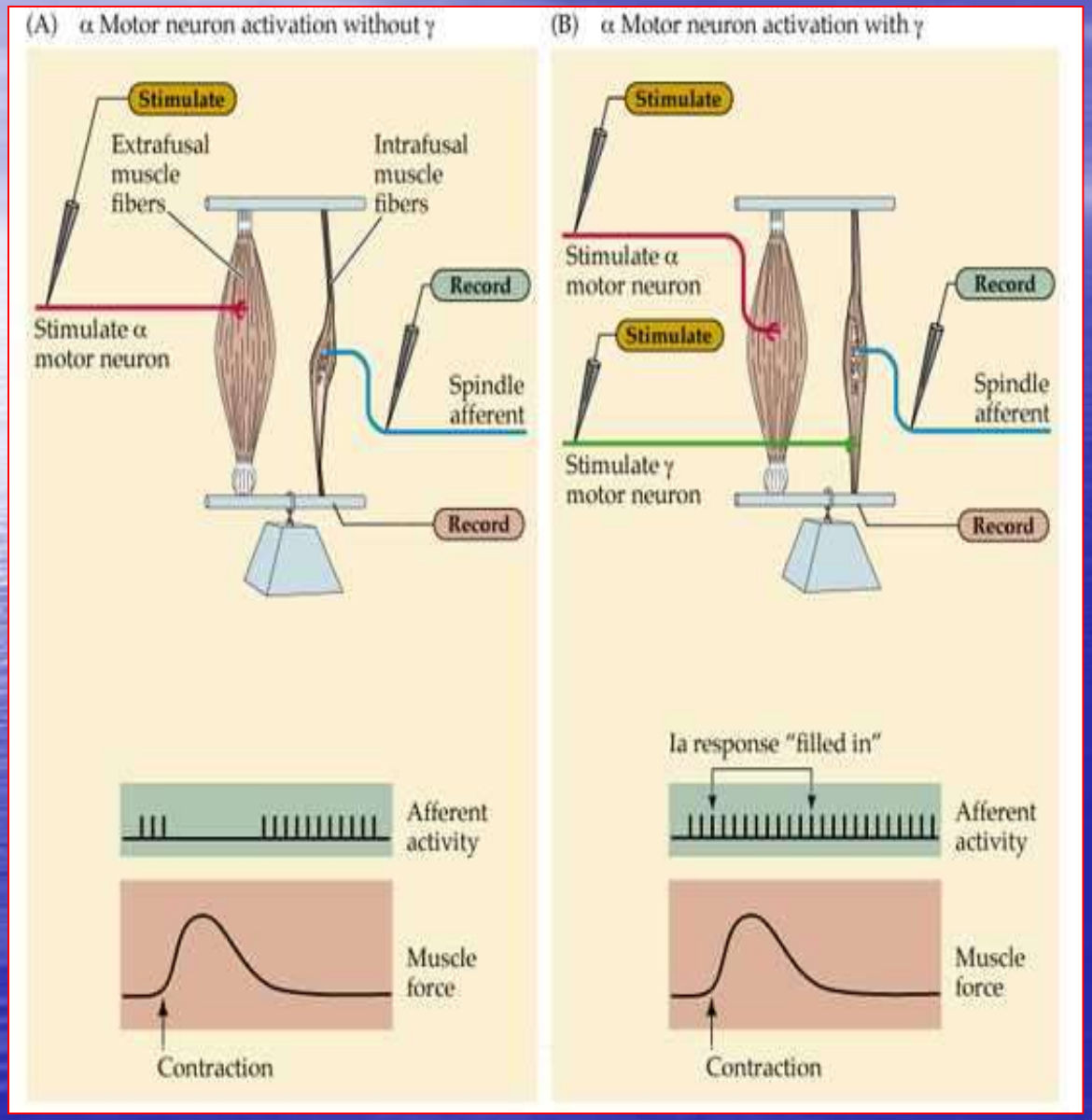


- Alpha and gamma motor neurons
- ventral horn cells, anterior horn cells
- Very elaborate dendritic tree
- Neurotransmitter=Ach
- Alpha: extrafusal fibers
- Gamma: intrafusal fibers
- Motor pool = set of neurons that innervate a set or group of muscles
- Motor unit: a motor neuron and its muscle cells (fibers)

Neuromuscular Junction

- Link between the nervous system and muscle
- Action allows skeletal muscle to contract and maintain motor tone
- Acetylcholine in the neurotransmitter

Muscle Spindles

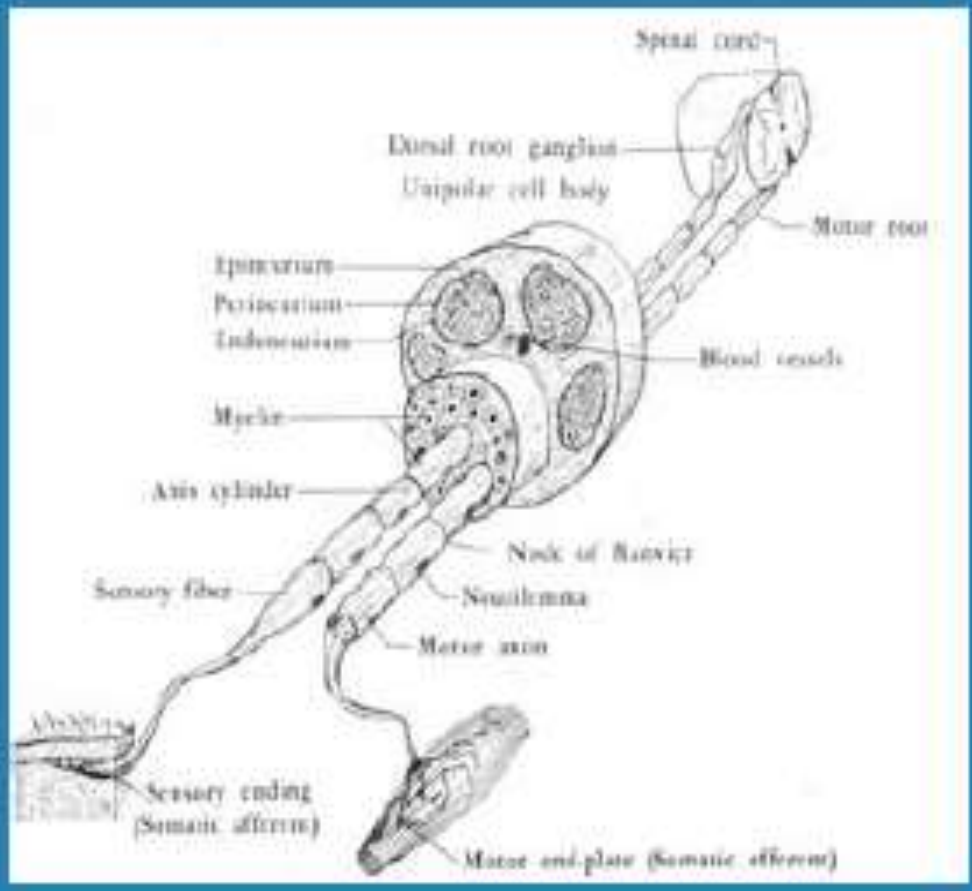


- Monitor stretch of muscle
- Consist of intrafusal fiber, gamma motor fiber and sensory ending
- Gamma motor neuron can alter sensitivity of muscle spindle

Peripheral Nerves

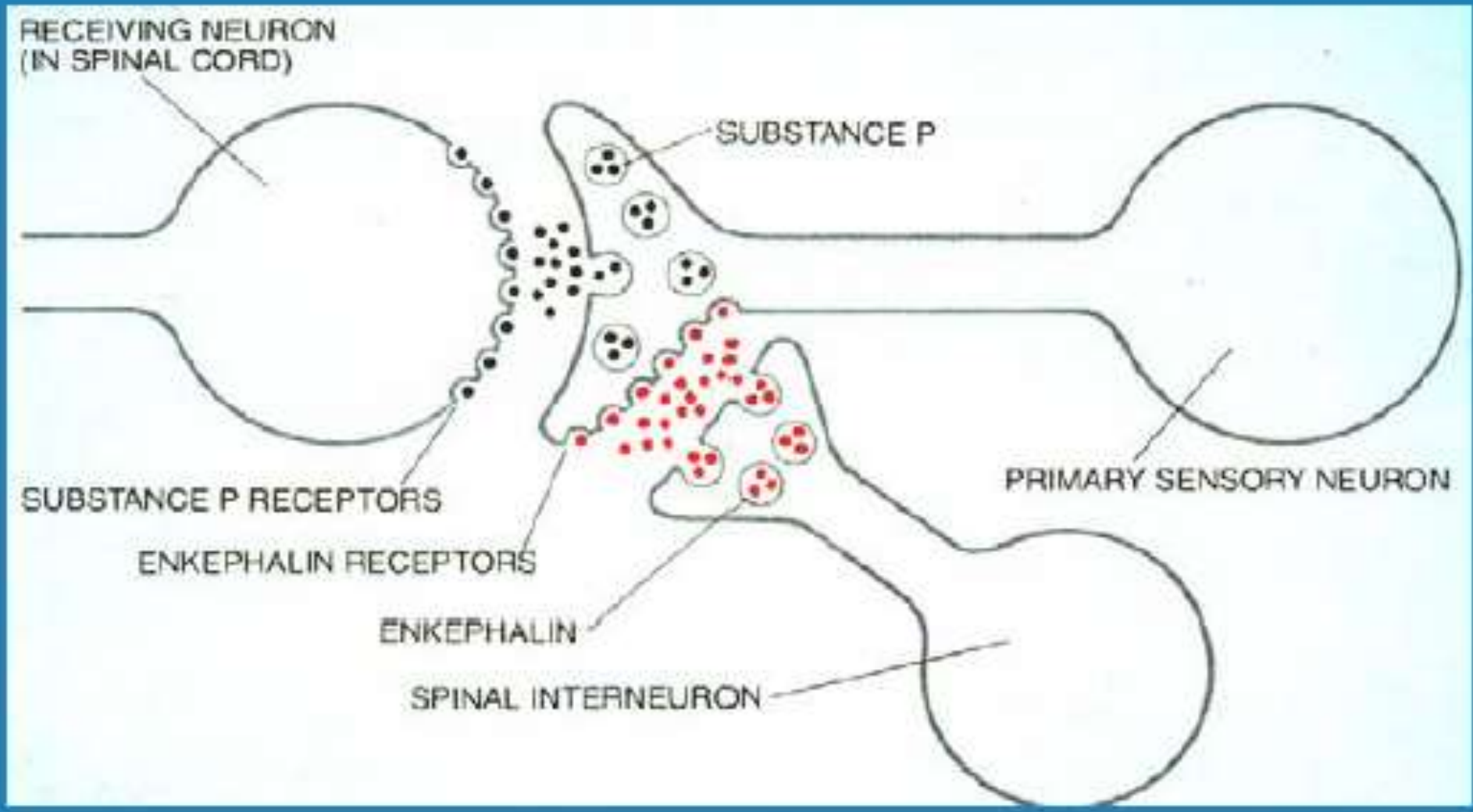
Cranial & Somatic nerves

- GSA
- GSE
- GVA
- GVE
- SSA
- SSE



Carry information to and from CNS

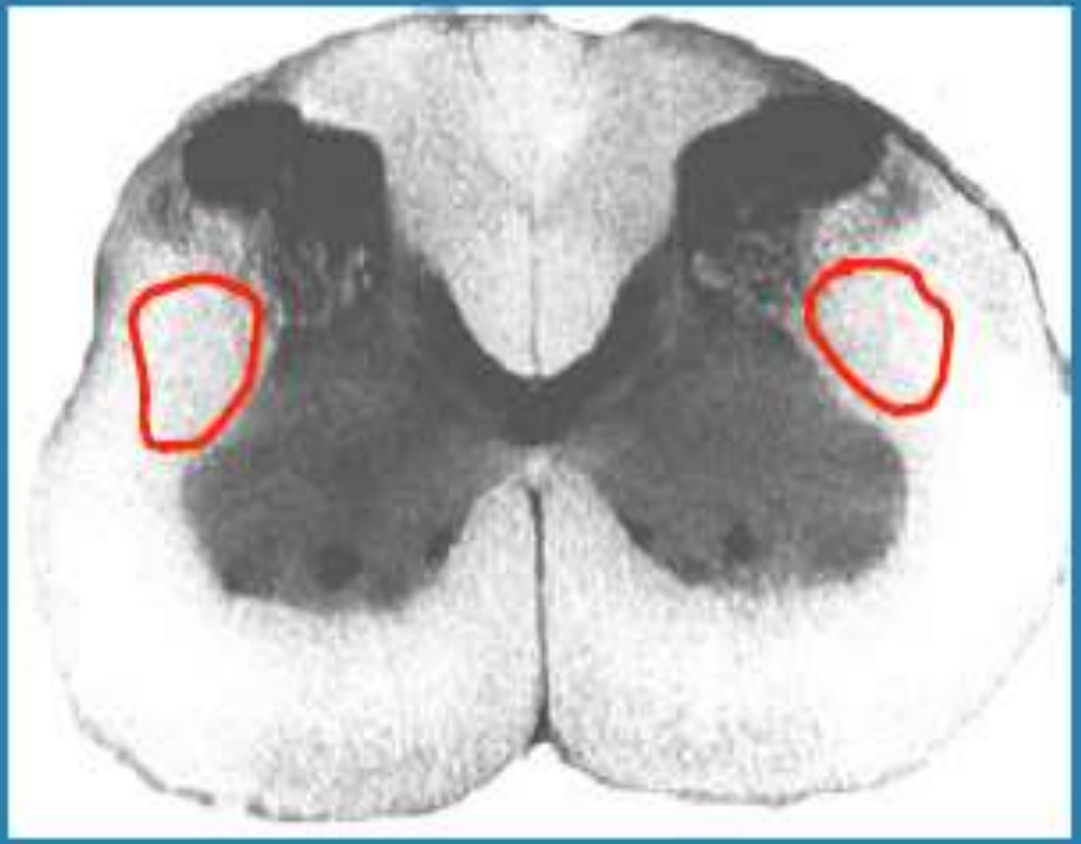
Information Processing (neurotransmission)

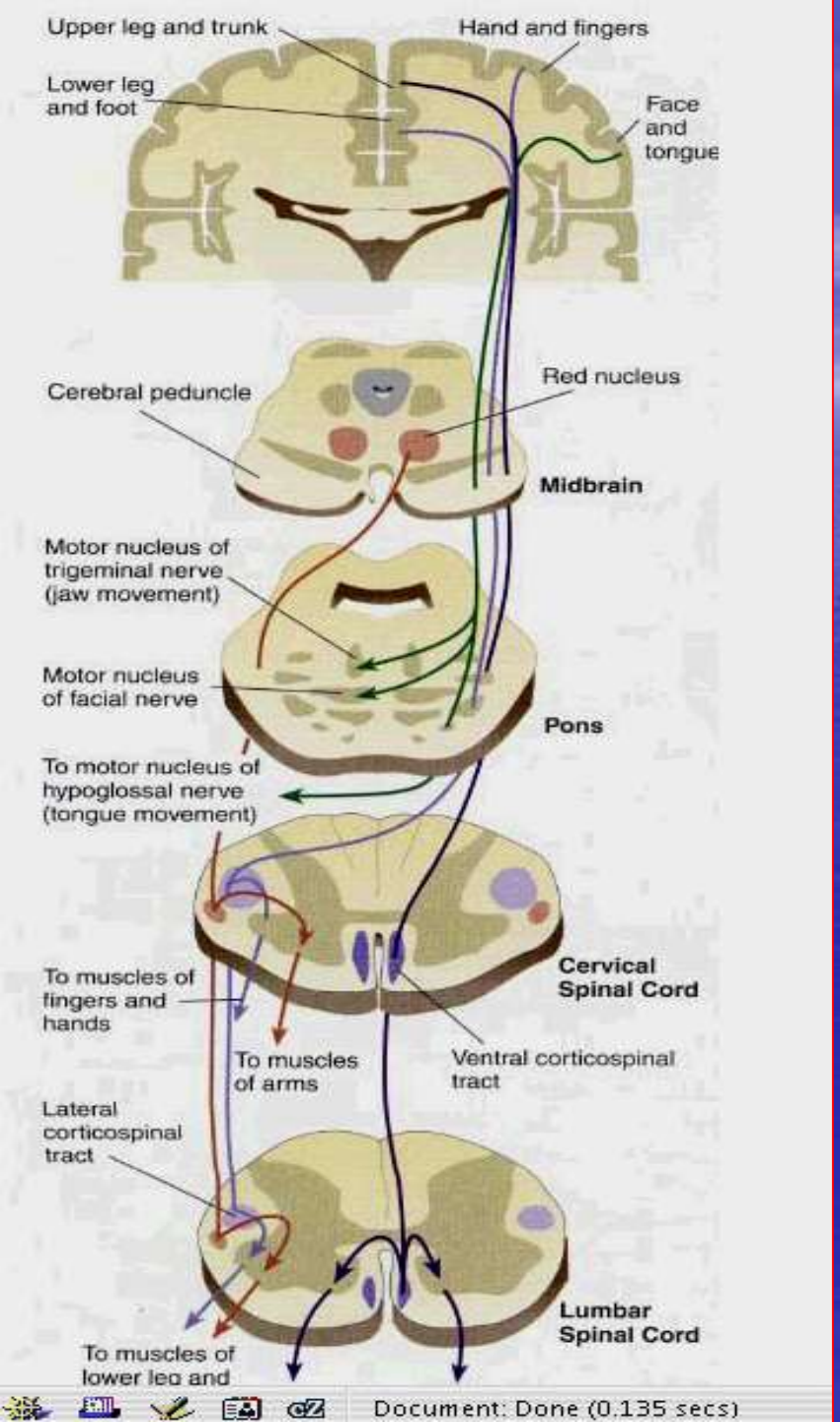


Spinal Cord Anatomy & Pathways

Corticospinal and Rubrospinal tracts

- fine digital movements

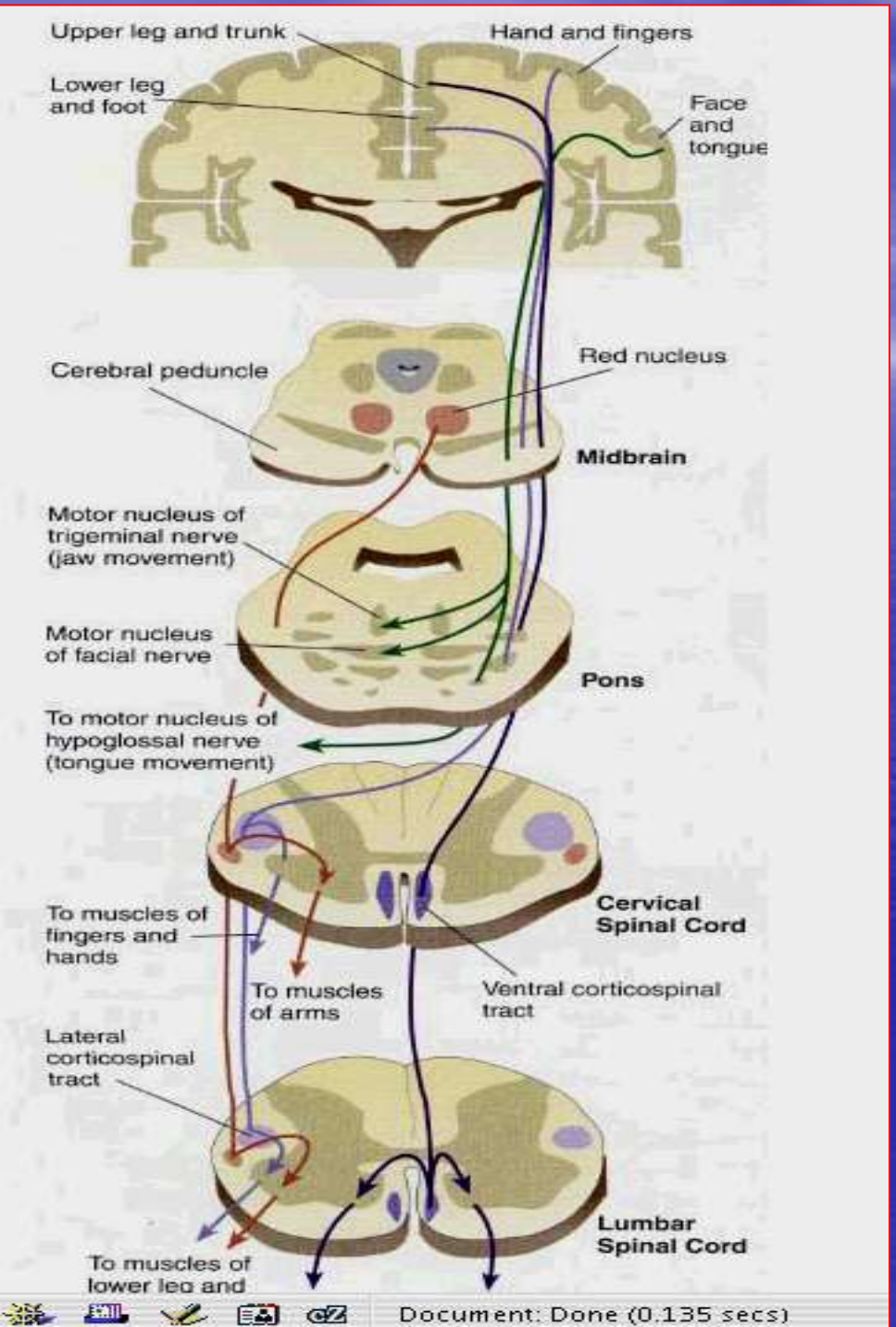




Motor Hierarchy (Swanson, 2003)

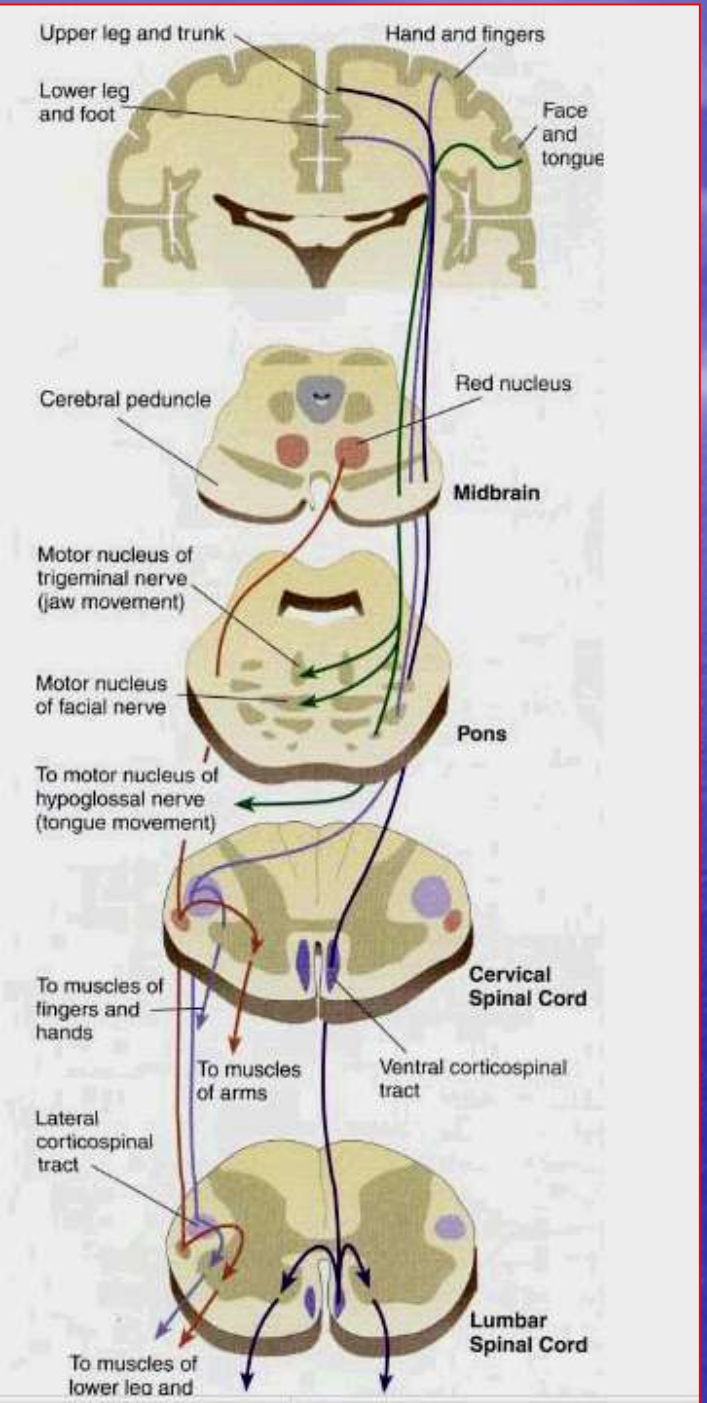
- Central pattern controllers
- Central pattern initiators
- Central pattern generators
- "Final common pathway": motor pool

"As we move up the motor system hierarchy, away from the motoneuron pools themselves, explanations become more and more vague and the true situation in terms of neural networks becomes more and more complex."



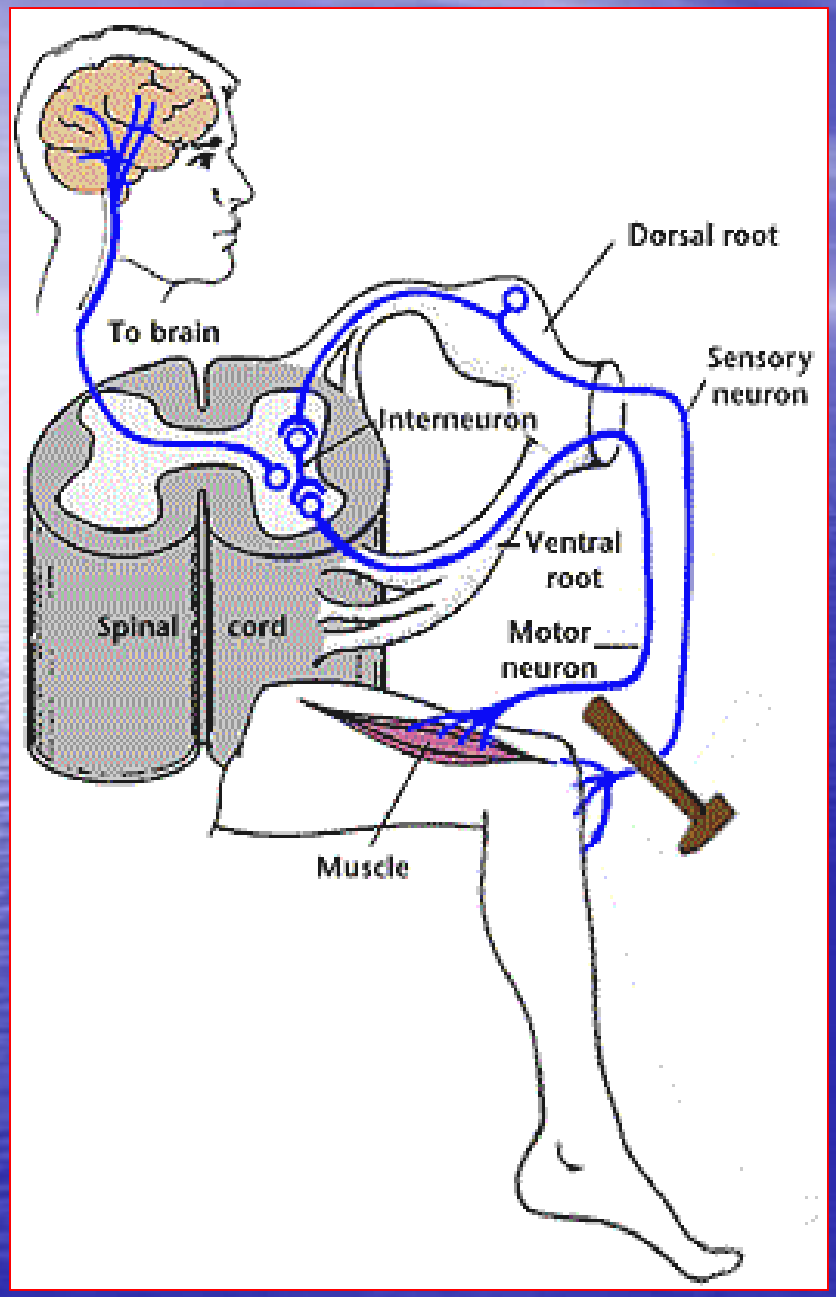
Motor Hierarchy

- **Lateral group (extremeties; fine motor control)**
  - **Corticospinal tract**
  - **Rubrospinal tract**
- **Medial group (axial musculature; rhythmic and postural movements)**
  - **Vestibulospinal tract**
  - **Tectospinal tract**
  - **Reticulospinal tract**
- **"Final common path": motor pool**



Corticospinal tracts

- Also called pyramidal tract
- Arises primarily from primary motor, premotor and supplementary motor cortex
- Somatosensory cortex also contributes
- 70-90% of fibers cross in the lower medulla (decussation of pyramids)
  - Crossed = lateral corticospinal tract
  - Uncrossed = anterior corticospinal tract
- Synapses with:
  - Interneurons
  - Alpha and gamma motor neurons
  - Priopriospinal neurons



Spinal Reflexes

- Programmed stereotypical reactions that occur in response to stimuli
- Simplest reflex: monosynaptic stretch reflex
- Examples of polysynaptic reflexes: withdrawal reflex
- Reflexes are subject to higher level control

Submodalities are carried by different tracts

- **Dorsal columns**
  - **Fine, discriminitive touch, conscious proprioception, pressure and vibration sense**
  - **Faciculus gracilis vs fasciculus cuneatus**
  - **First synapse: relay nuclei in the medulla (nucleus gracilis and nucleus cuneatus)**
- **Anterolateral system**
  - **Pain and temperature - First order neurons dorsal horn**
  - **Form Lissauer's tract**
  - **Cross in anterior white commisure: ascend as spinothalamic tract (also spinoreticular and spinomesencephalic tracts)**
- **SpinocerebellarTracts**
  - **Dorsal and ventral: ipsilateral**
  - **Unconscious proprioception**

Organization of Somatosensory System

Dorsal Column : -

Gracilis & cuneate tracts -

Conscious proprioception ,

Pressure and vibration, Fine discriminitive touch

Lateral Column :-

Lateral Spino thalamic Tract

Pain & Temperature

Posterior and anterior Spino cerebellar Tracts

Unconscious proprioception

- **Anterior Column:-**

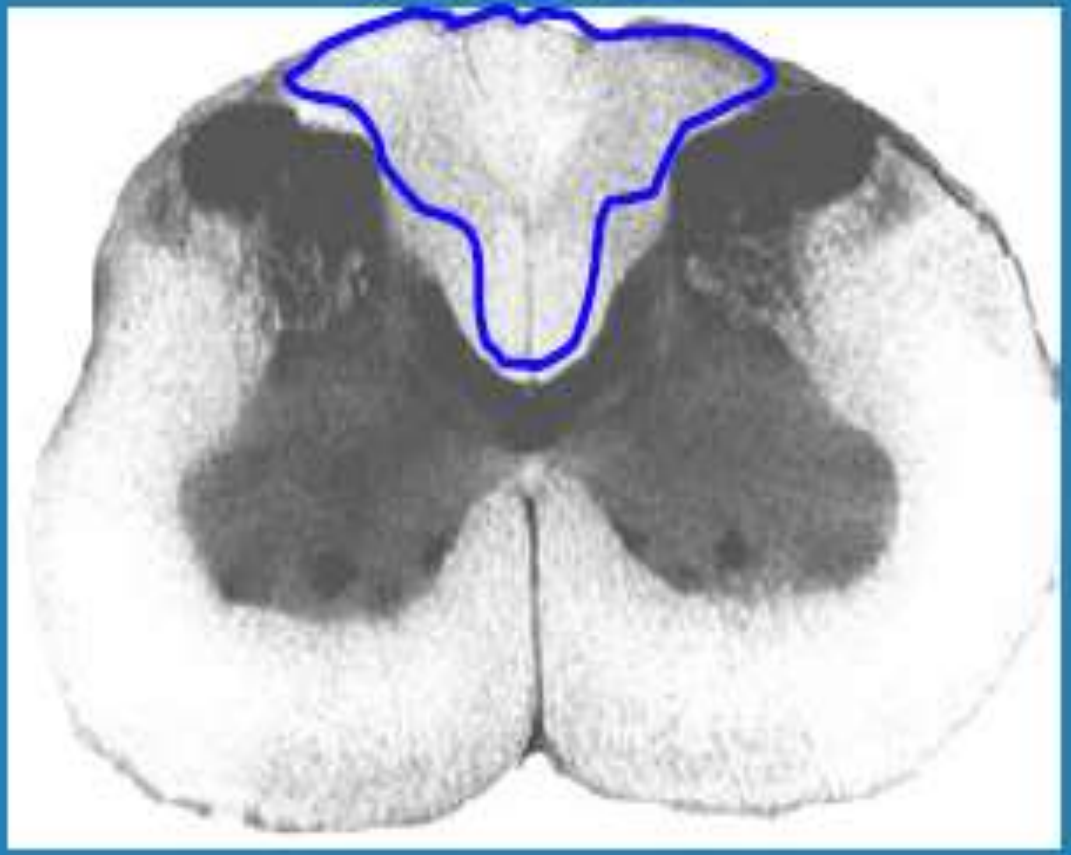
Anterior spinothalamic Tract

Crude touch, Itch and ticle sense

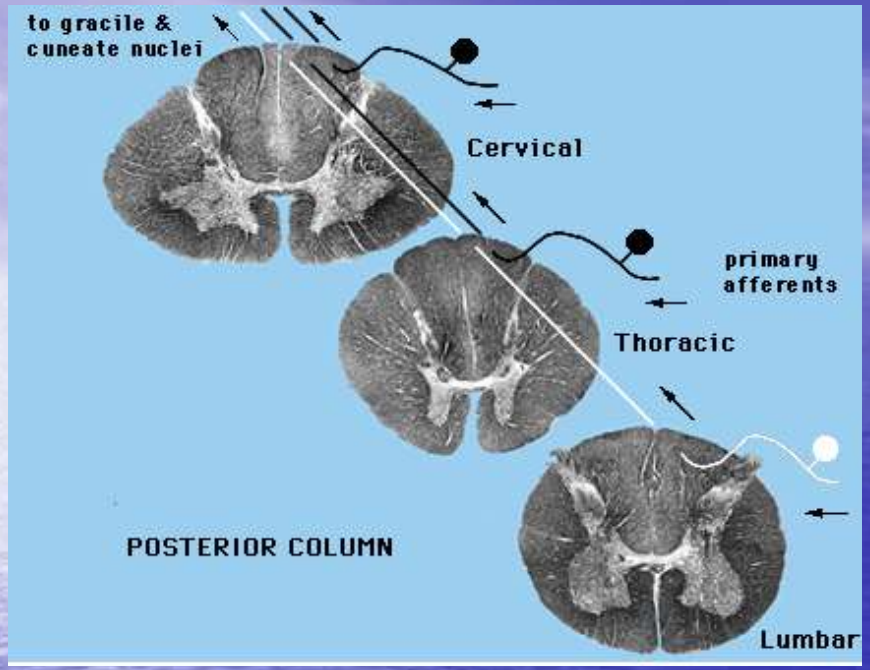
Spinal Cord Anatomy & Pathways

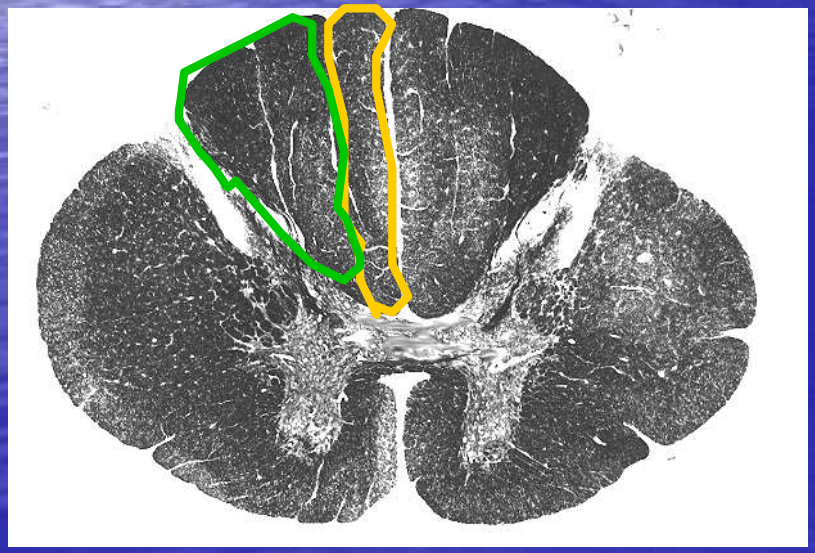
Dorsal Columns

- conscious proprioception

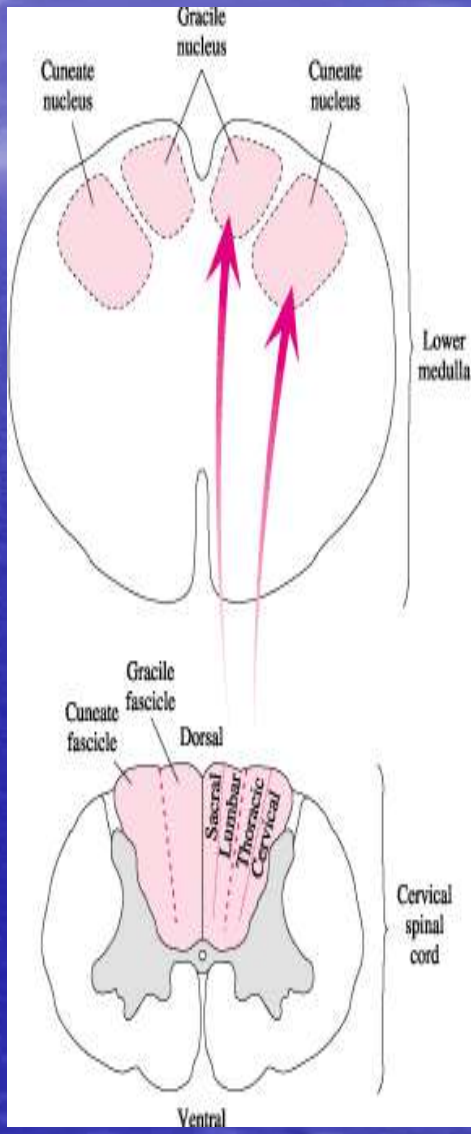


Dorsal Columns

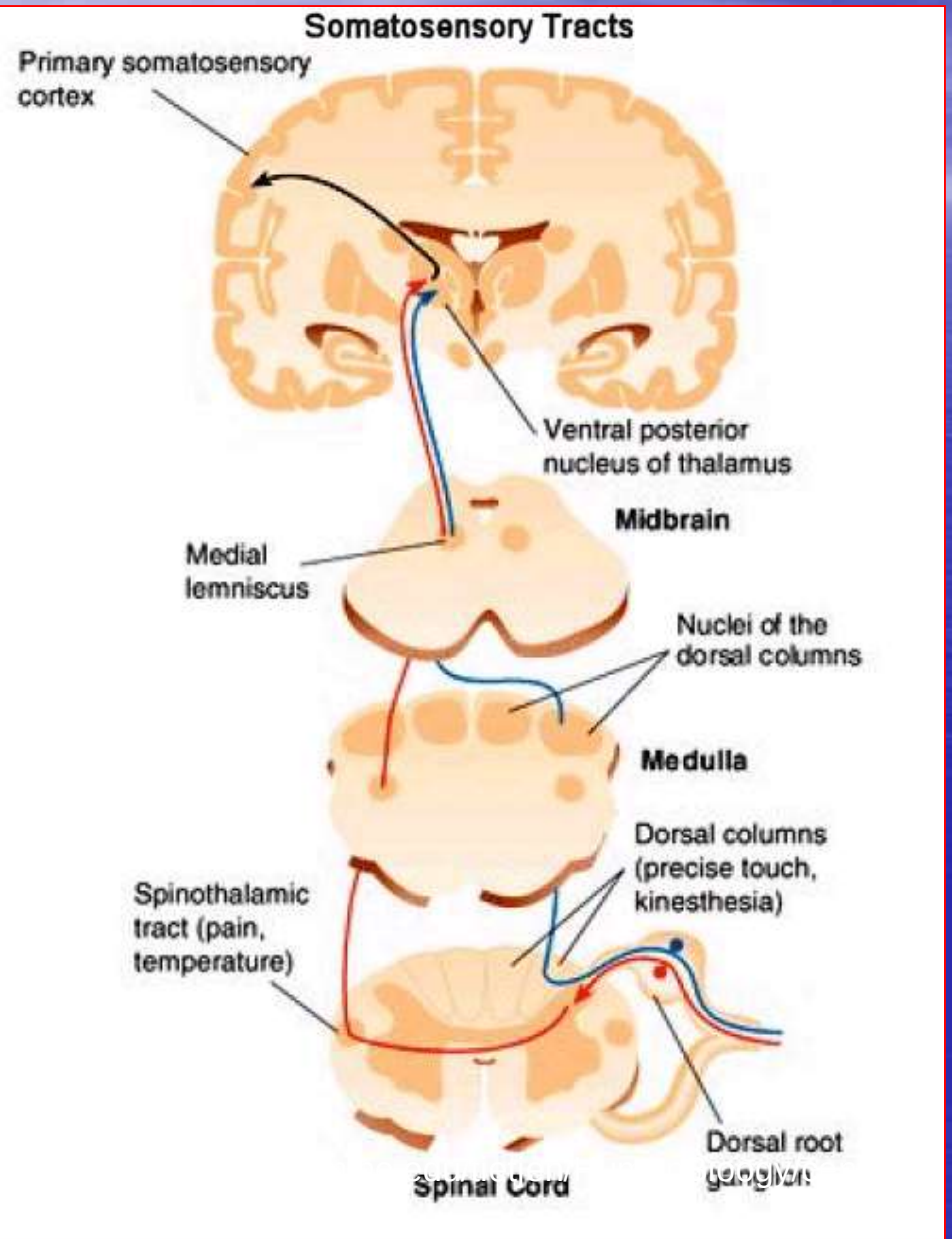




- Somatotopically organized
- Medial Faciculus Gracilis
- Lateral Faciculus Cuneatus
- Conscious touch on contralateral side of the body
- Concious proprioceptive sense
- Two point tactile discrimation
- Vibratiion and pressure



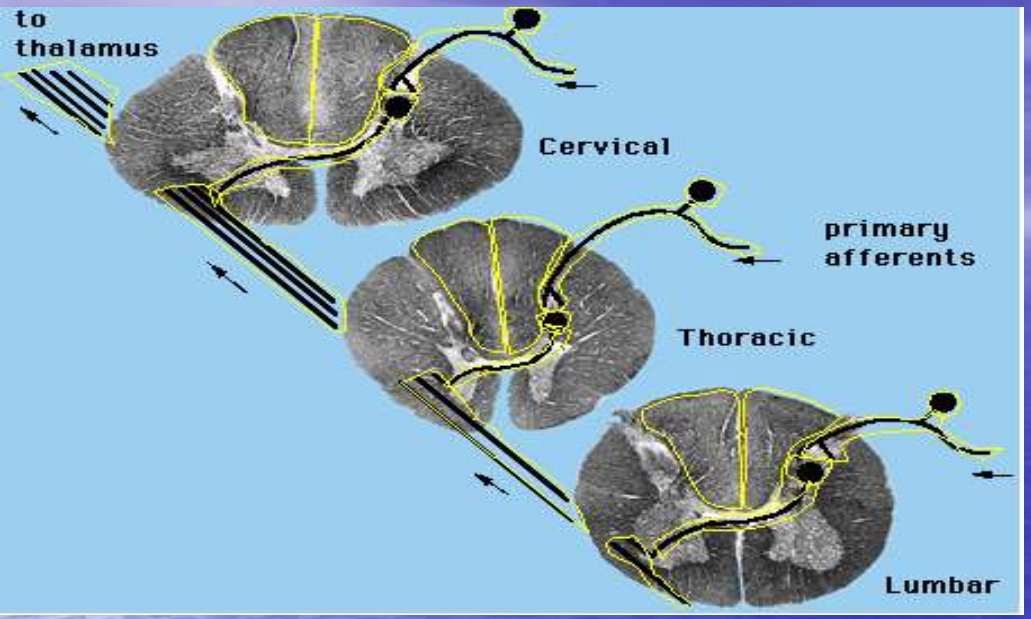
Dorsal Column/Medial Lemniscal system

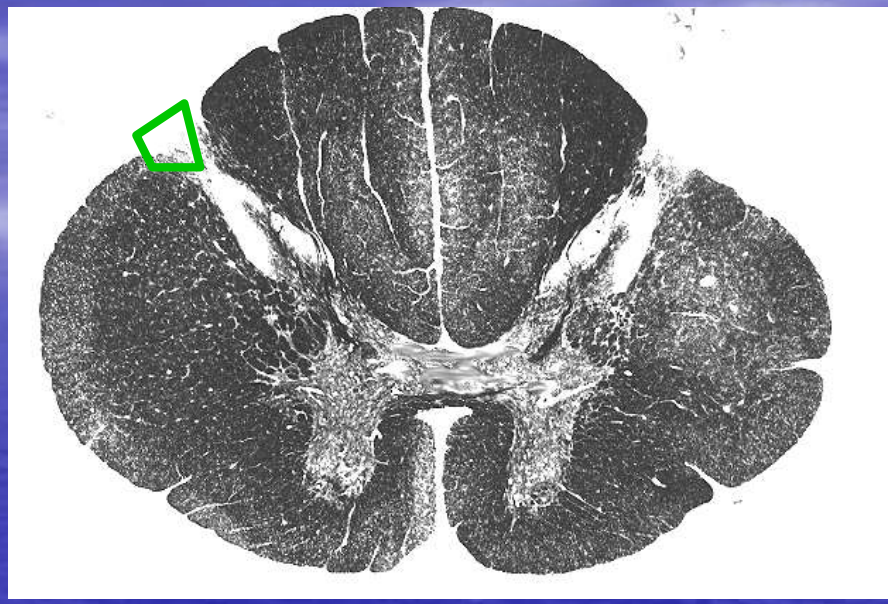


- Secondary neuron is in brainstem:
- nucleus gracilis and

  nucleus cuneatus
- Output of these crosses midline and forms recognizable bundle: medial lemniscus
- Medial lemniscus fibers synapse in the thalamus in the ventro posterior nuclei
- Thalamic axons synapse in primary somatosensory cortex in several somatotopic maps with some segregation of submodalities

Anterolateral system





- Ist order of Neurons –Dorsal root ganglion
- Run in Dorsolateral tract for few segements
- Fibers thought to use substance P as a transmitter
- Cross to form Lateral Spinothalamic,

  Spinoreticular, & Spinomesencephalic tracts

Cerebral dominance

Voluntary Movement and Cognitive Functions

***Lateralization* =**

segregation of functions in the left and right Cerebral hemispheres of the brain

Left hemisphere – language, math, logical operations, & serial processing of info sequences

- **Specializes in focused perception**

for the detailed, speed-optimized activities &

the processing of fine visual and auditory details

Cerebral Dominance

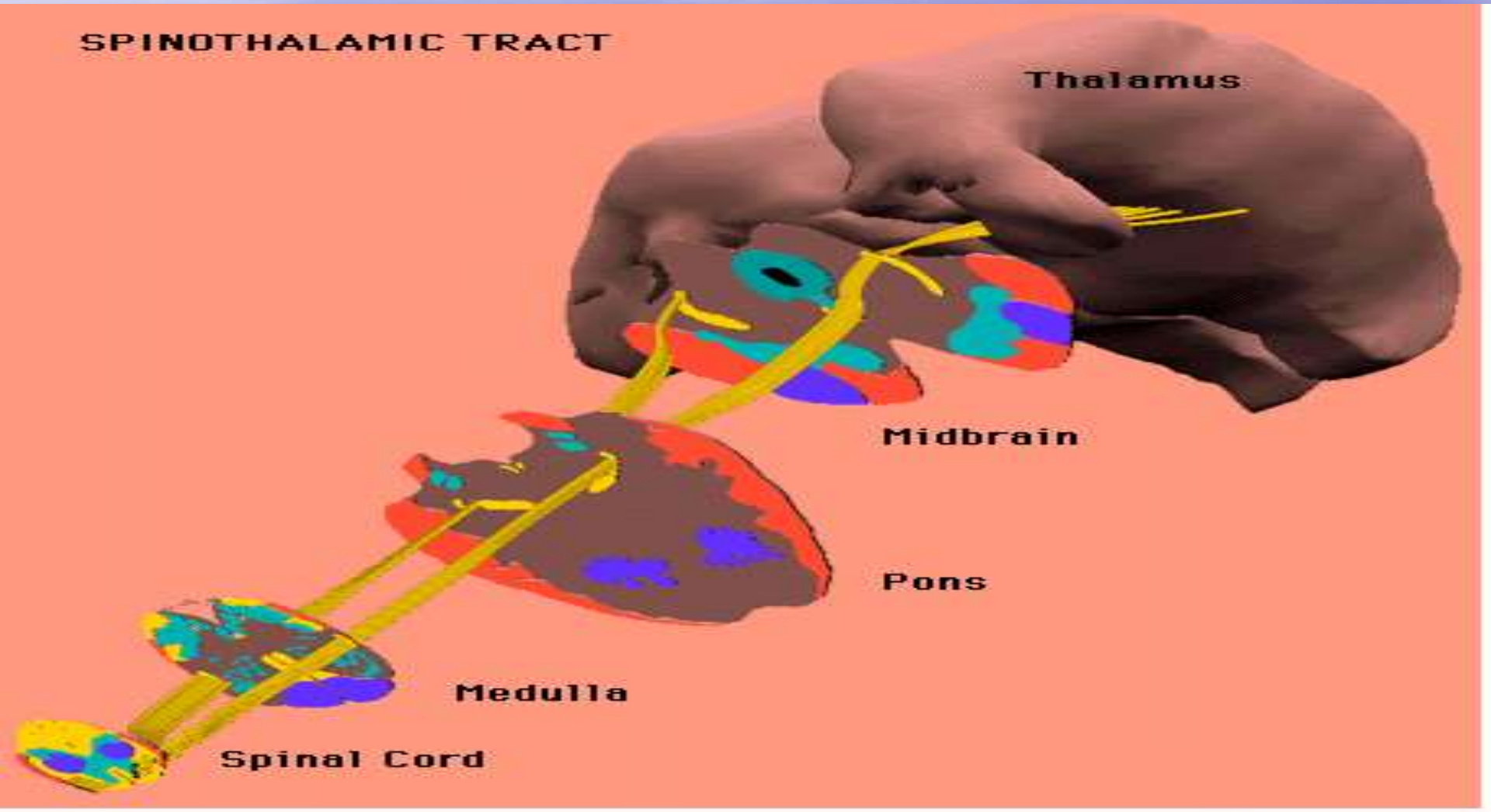
Right hemisphere – pattern recognition, face recognition, spatial relations nonverbal thinking, emotional processing in general; the simultaneous processing of many kinds of info

Emphasis on *understanding* and generating *stress* & *intonation patterns* of *speech* that convey *emotional* content

Specializes in perceiving the relationship between images and the whole context in while they occur

Lateral Spino thalamic tract

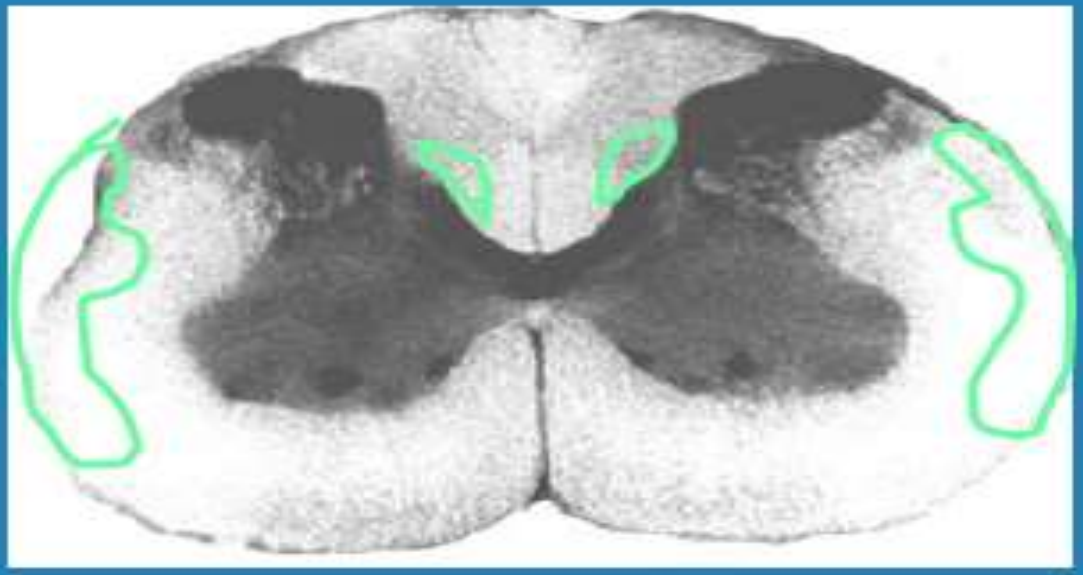
Pain and Temperature sense



Spinal Cord Anatomy & Pathways

Spinocerebellar system

- unconscious proprioception



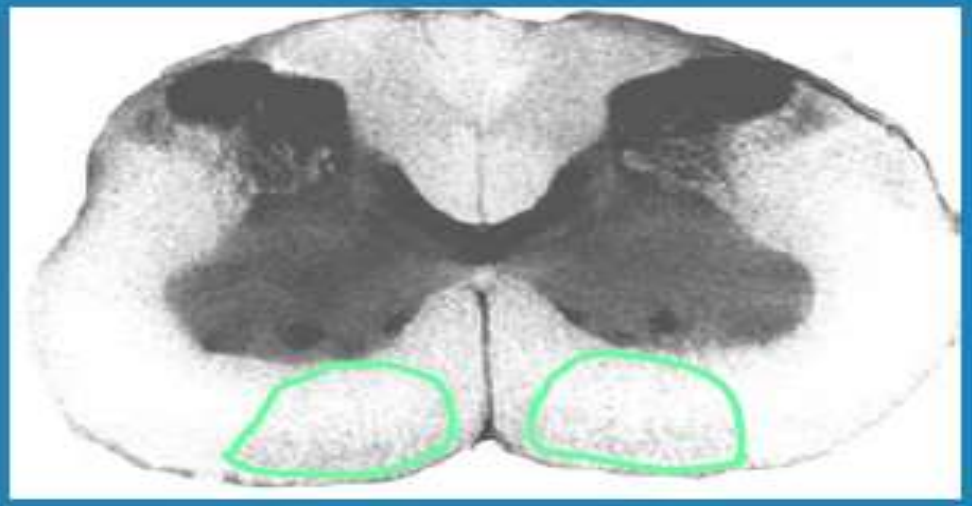
- **Posterior and anterior Spino cerebellar Tracts**

Unconscious proprioception

Spinal Cord Anatomy & Pathways

Vestibulospinal tract

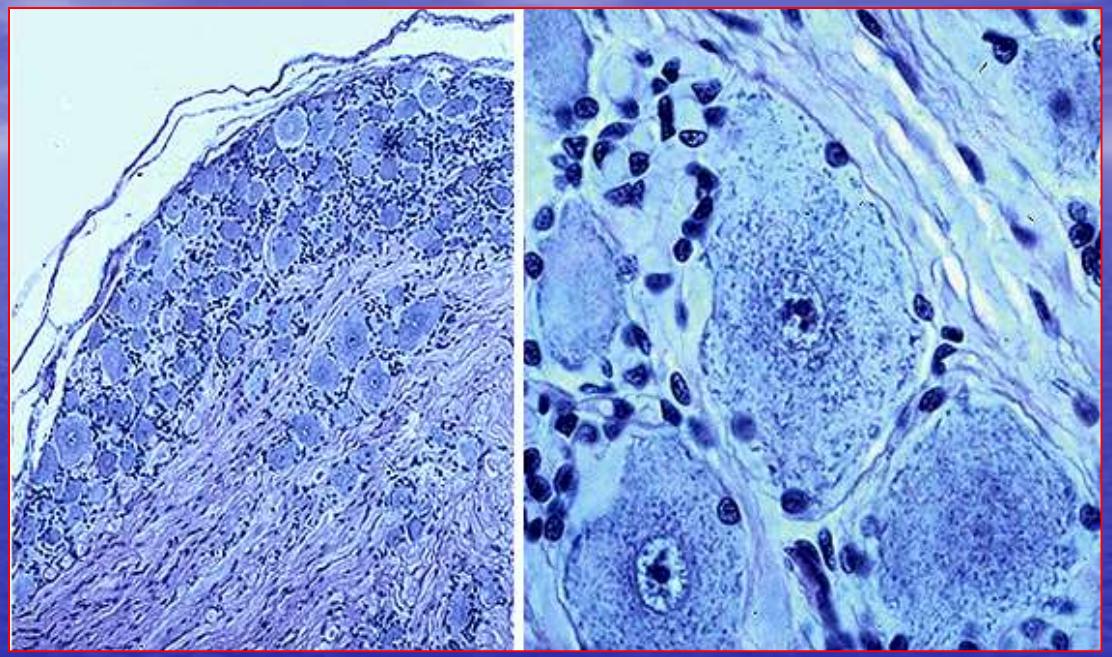
- weight bearing

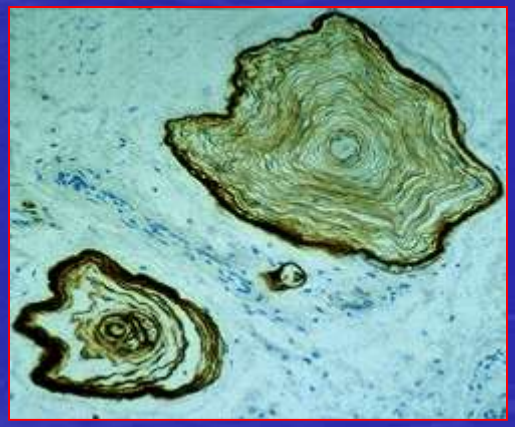


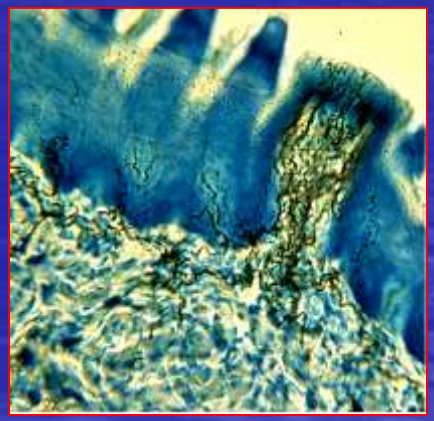
Somatosensory Transduction

•Sensory neurons in dorsal root ganglia
  - –Touch
  - –Prioprioception
  - –Pain
  - –Temperature

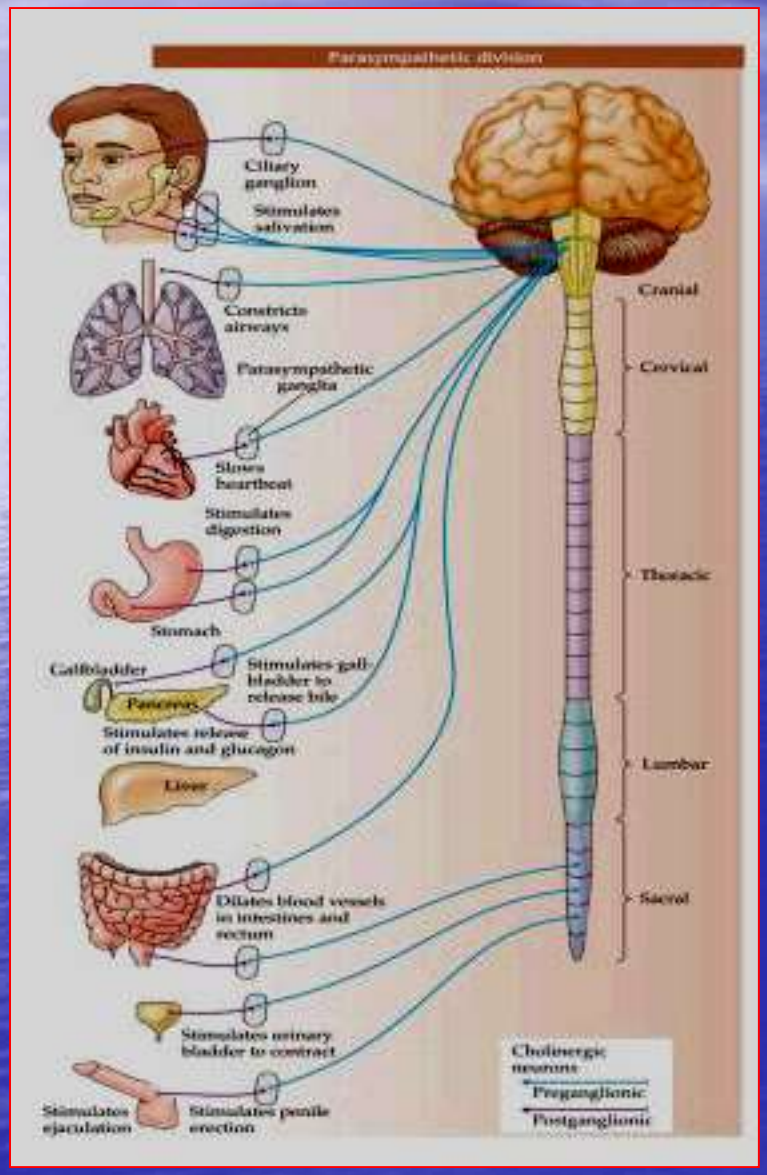
- Pseudomonopolar
- Use glutamate as a neurotransmitter
- Also contain peptides, e.g., Substance P
- Cell types have specialized endings for each modality
  - Encapsulated
    - (touch, proprioception)
  - Unencapsulated (free nerve endings)
    - Pain and temperature





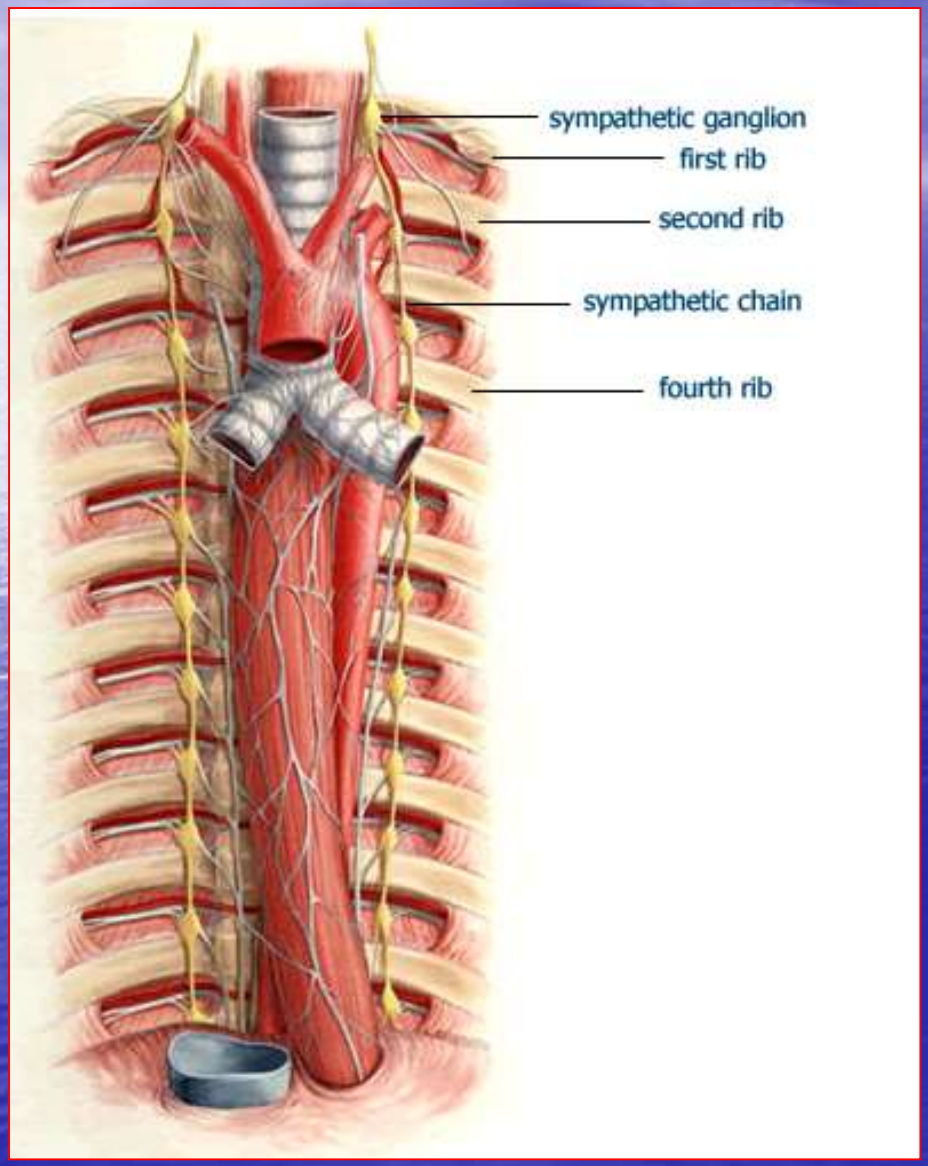


Parasympathetic System



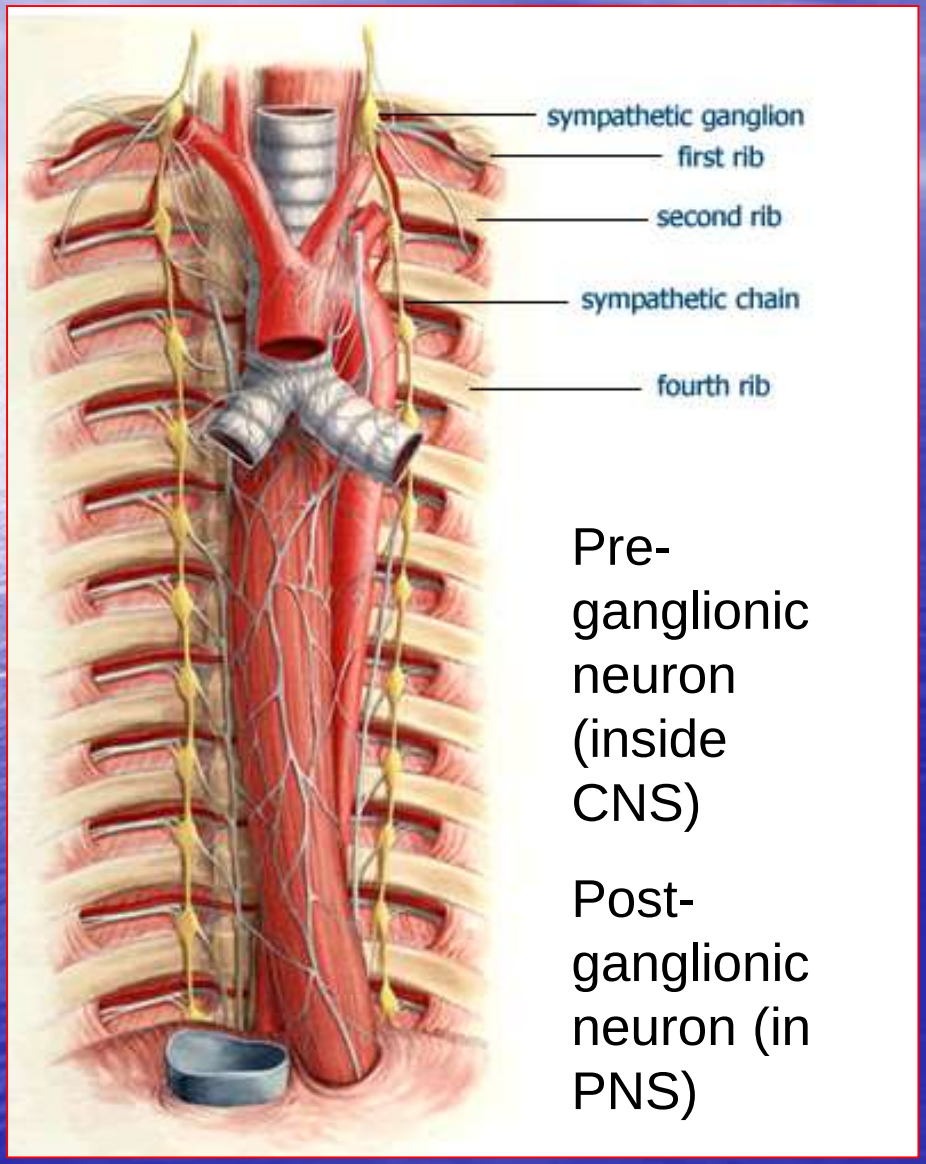
- Generally associated with restorative functions, e.g., stimulation of peristaltic and secretory activities of the GI tract
- Pre-ganglionic
  - Brainstem and sacral cord "Craniosacral division of ANS"
  - ACh as neurotransmitter
- Post-ganglionic
  - Located either in the wall of the organs they innervate or in close proximity to target=more localized action
  - ACh as neurotransmitter (also peptides)

Sympathetic Nervous System



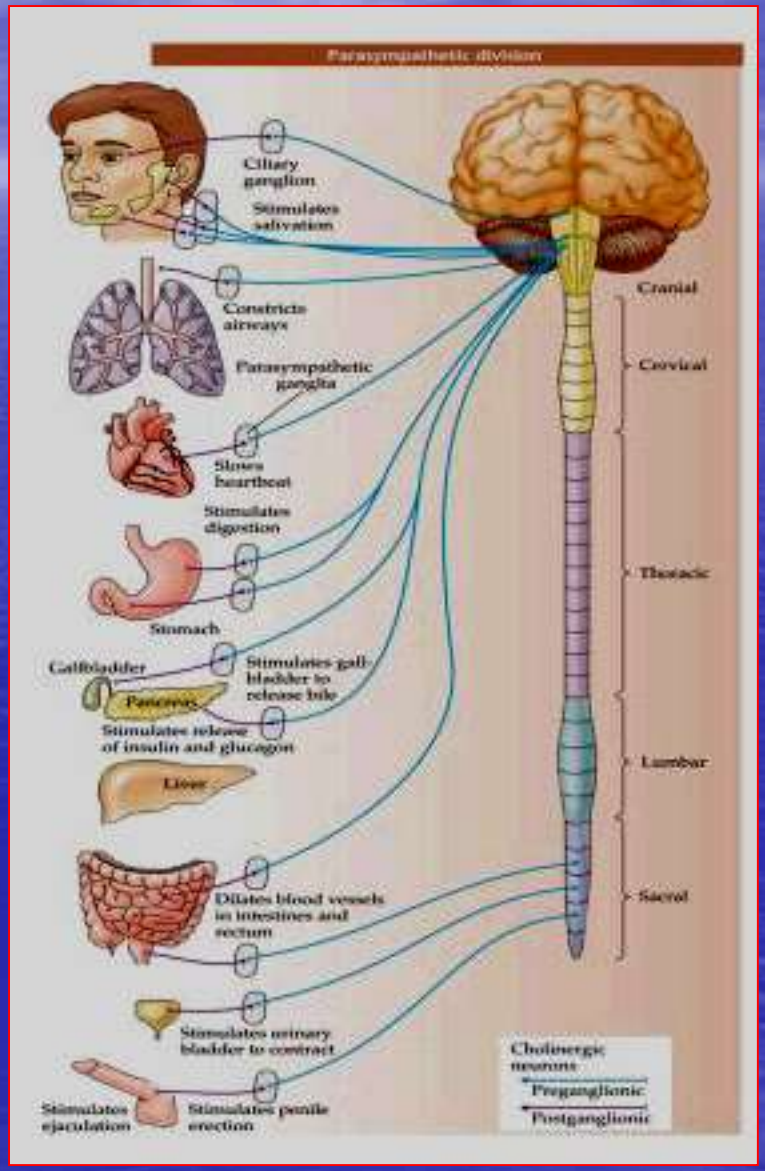
- Mobilization of bodily resources
- Flight or fight reactions
- Pre-ganglionic neuron
  - spinal cord
  - ACh as transmitter
- Post-ganglionic neuron
  - paravertebral chain=widespread action
  - Thoracic and lumbar regions of the cord="Thoracolumbar division of ANS"
  - NE as neurotransmitter (except sweat glands = ACh) also peptides

Autonomic Ganglia



Pre-ganglionic neuron (inside CNS)

Post-ganglionic neuron (in PNS)



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