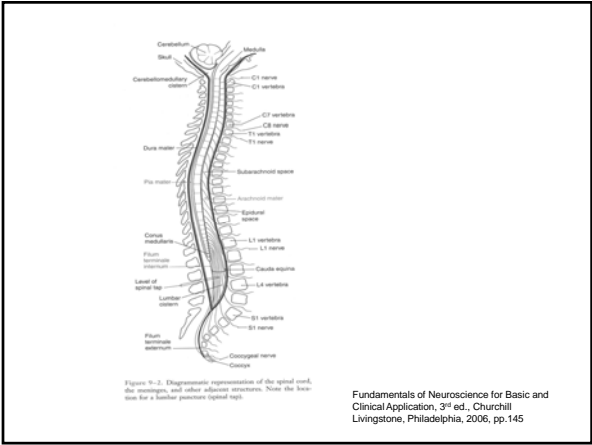


Spinal Cord and Spinal Lamina

Spinal Cord

- Extends from the base of the skull to the coccygeal area of the vertebral canal.
 - 32 - 33 Spinal Nerves designated by region
 - 8 Cervical
 - 12 Thoracic
 - 5 Lumbar
 - 5 Sacral
 - 2 - 4 Coccygeal

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The Spinal Cord ends at the level of the body of lumbar vertebra 2 to form the **Conus Medullaris**. The Lumbar and Sacral spinal nerves travel through a meningeal encased cerebrospinal fluid filled space called the *lumbosacral cistern*, to form the portion of the spinal cord referred to as the **Cauda Equina**.

The core of each spinal cord segment if viewed in transverse section demonstrates two distinct regions:

- White Matter - the outer shell of the cord consisting of myelinated fibers.
- Gray Matter - the central core consisting of non-myelinated nerve cell bodies.

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A Typical Spinal Cord Region

The Gray Matter of the Spinal cord can be divided into two functional regions behind or in front of a developmental groove called the *sulcus limitans*.

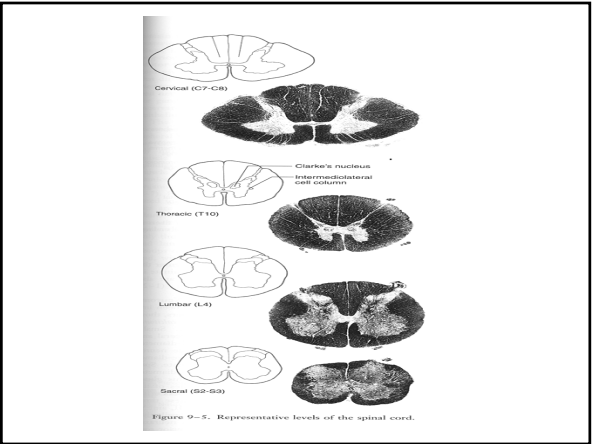
- Posterior (Dorsal) Gray Horn: consists of sensory or afferent nerve cell populations.
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Entering and leaving the spinal cord are two nerve trunks called *Roots*.

- Posterior or Dorsal Root: is the point of entry of sensory or afferent nerve cell processes to the spinal cord.
- Anterior or Ventral Root: is the point of exit of motor or efferent nerve processes from the spinal cord.

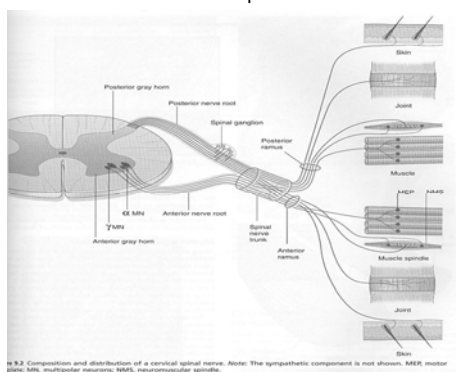
Posterior roots contain pseudounipolar sensory neurons whose cell bodies are found in specialized structures called Dorsal Root *Ganglia.

The anterior and posterior roots come together to form a spinal nerve, or Primary Rami. The primary rami divide into a short *posteriorly directed rami* and a long *anteriorly directed rami*. All of the rami are mixed nerves containing both muscular and cutaneous components.

These fibers will impact the cells of the CNS or will arise from nuclei of the CNS.

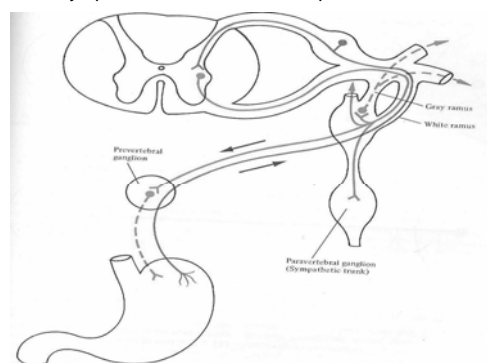
* Ganglia are aggregations of nerve cell bodies outside the central nervous system.

Overview of the Spinal Cord

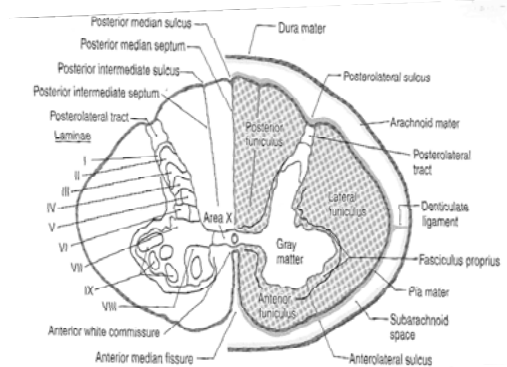


Clinical Neuroanatomy and Neuroscience 6th ed., by M.J.T. Fitzgerald, et al., Elsevier, 2012, pp.113.

Sympathetic Motor Fibers & Spinal Cord

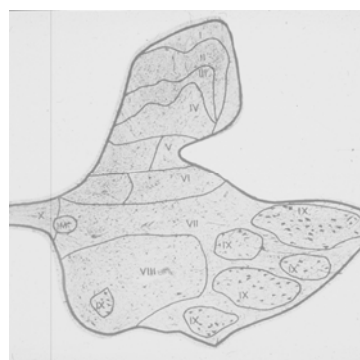


The Human Brain & Spinal Cord: Functional Neuroanatomy & Dissection guide, by L. Heimer, Springer Verlag, New York, 1983, pp.311



Fundamentals of Neuroscience for Basic and Clinical Application, 3rd ed., Churchill Livingstone, Philadelphia, 2006, pp.146

Spinal Cord Lamina



Human Neuroanatomy, 8th ed., by Carpenter, M. B., et al., Williams & Wilkins, Baltimore, 1983 pp.243

Spinal Cord Lamina (Nuclei) & Tracts

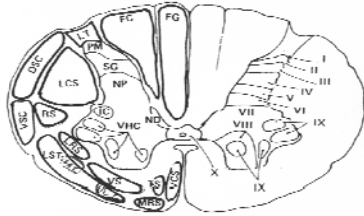


FIGURE 9. Cross section of the spinal cord at approximately the C5-S1 segment level. Tracts and nuclei of the cord are illustrated on the left; Rexed's laminar organization of the gray matter is illustrated on the right. DFC = dorsal funicular tract; FC = fasciculus cuneatus; FG = fasciculus gracilis; IL = intermediolateral cell column; LCT = lateral corticospinal tract; LIT = lateral reticulospinal tract; LST = lateral spinothalamic tract; ST = Lissauer's tract; MRS = medial reticulospinal tract; NTS = nucleus dorsalis; NP = nucleus proprius; PMS = posterior median sulcus; RS = reticulospinal tract; ST = substantia gelatinosa; TS = reticulospinal tract; VL2 = ventral lateral tract; VHC = ventral horn cell column; VS = ventrolateral tract; VSC = ventral spinothalamic tract.

AST = Anterior Spinothalamic Tract

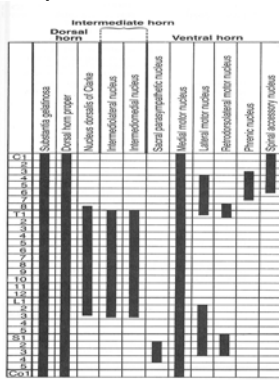
SRT = Spinothalamic Tract

NMS for Independent Study Neuroanatomy, 2nd ed., W. DeMyer, Williams & Wilkins, Baltimore, 1998, pp.113

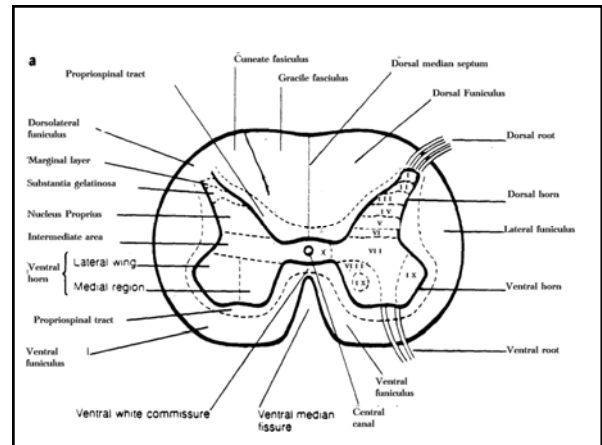
Spinal Cord Nuclei (Lamina of Rexed)

- Sensory:
 - I Posterior Marginal Nucleus
 - II Substantia Gelatinosa
 - III (similar to II)
 - IV,V Nucleus Proprius
 - VII Nucleus Dorsalis of Clarke
 - VII Intermediomedial Nucleus
- Motor:
 - VII Intermediolateral Cell Column
 - VII Nucleus of Onufrowicz
 - VIII Interneuron Pool
 - IX α Motoneurons
 - Dorsomedial
 - Ventromedial
 - Dorsolateral
 - Retrodorsolateral
 - Central
 - Spinal Accessory
 - X Periependymal Gray Matter

Spinal Cord Lamina



NMS for Independent Study Neuroanatomy, 2nd ed., W. DeMyer, Williams & Wilkins, Baltimore, 1998, pp. 113



SPINAL CORD LAMINA (Nuclei)				
LAMINA #	LAMINA NAME	INPUT	OUTPUT	FUNCTIONAL ROLE
I (Entire cord)	Posterior Marginal Nucleus	small non-myelinated afferent fibers for pain & temperature	fibers ascend crossed and uncrossed to brainstem and thalamus, contributes to contralateral spinothalamic tract	perception of light touch, pain & temperature stimuli
II (Entire cord)	Substantia Gelatinosa	receives nociceptive fibers via Lissauer's tract	ascend and descend in Lissauer's tract, synapse on fibers of lamina III,IV.	Relay nuclei for pain and temperature, modulation of pain, pain gates.
III (Entire cord) IV (Entire cord)	Nucleus Proprius	Large caliber fibers for light touch. Receives descending pathways, interacts with lamina II.	Fibers crossed or uncrossed to the brainstem and thalamus. Gives rise to Anterior Lateral system	proprioception and referred pain, temperature
V (entire cord)	Reticular Nucleus	receives info from IL,III, & IV, receives from corticospinal, rubrospinal, reticulospinal, and spinothalamic tract	anterior spinothalamic tract, lateral spinothalamic tract	pain temperature & light touch
VI (C4-T1, L2-S3)	Comissural Nucleus	Proprioceptive afferents	anterior spinothalamic tract	conscious proprioception

VII (C8-L5)	Nucleus Dorsalis of Clarke (Thoracic Nucleus)	Large caliber proprioceptive afferents	Posterior spinocerebellar and uncusocerebellar pathways	unconscious proprioception
VII (T1-L3, S2-S4)	Intermediomedial cell column	Receives visceral afferents	Origin of Anterior Spinothalamic Tract	Visceral sensations
VII (T1-L3)	Intermediolateral cell column		Preganglionic Sympathetic	Visceral Motor
VII (S2-S4)	Nucleus of Onufrowicz		Preganglionic Parasympathetic	Visceral Motor
X (entire cord)	Periependymal gray matter			Autonomic integration area
VIII (Entire cord)	Interneuron Pool	receives descending pathways from corticospinal, vestibulospinal, and reticulospinal systems	Project to cells of Lamina IX	Motor control and integration
IX (C5-C8, L2-S2)	Dorsomedial Ventromedial	Receives info from upper motor pathways, and I-4, I-4 & pain afferents	Trunk Flexors Trunk Extensors	Axial Motoneurons
IX (C6-C8, L3-S3)	Ventrolateral	"	Arm and thigh flexors and extensors	Appendicular motoneurons
IX (C6-C8, L3-S3)	Dorsolateral	"	Forearm and leg flexors and extensors	Appendicular motoneurons
IX (C8-T1, S1-S2)	Retrodorsolateral	"	Hand and foot flexors and extensors	Appendicular motoneurons

IX (C3-C5)	Central	“	Diaphragm	Motor control
IX (C1-C6)	Spinal Accessory	“	Lower Sternomastoid and Trapezius	Motor control

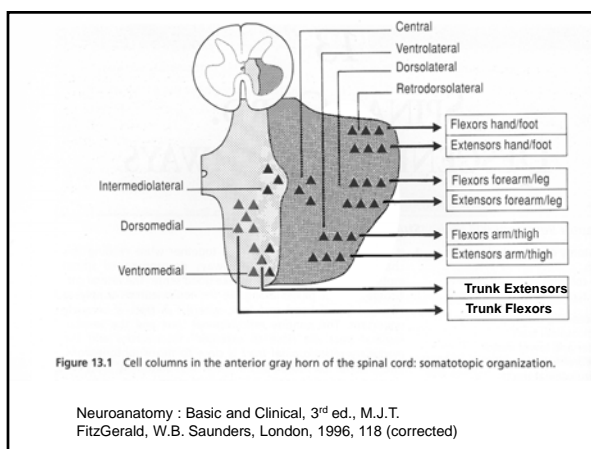
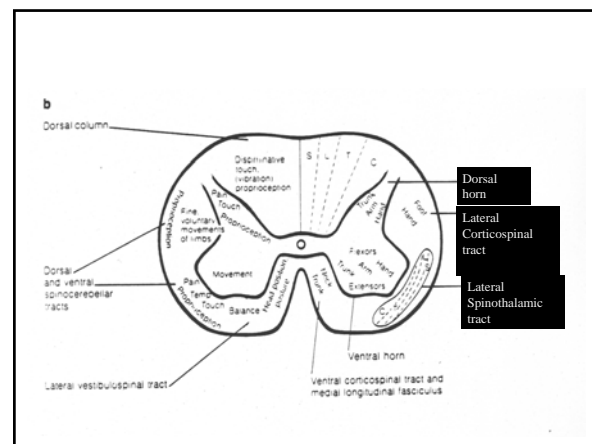


Table 13.1 The somatomotor cell columns

Cell column	Muscles
Ventromedial (all segments)	Erector spinae
Dorsomedial (T1-L2)	Intercostals, abdominals
Ventrolateral (C5-8, L2-S2)	Arm/thigh
Dorsolateral (C6-8, L3-S3)	Forearm/leg
Retrodorsolateral (C8, T1, S1-2)	Hand/foot
Central (C3-5)	Diaphragm

