MOTOR PATHWAYS

Kenneth Alonso, MD, FACP

Slices through the brain stem relating nuclei to cranial nerves and major tracts

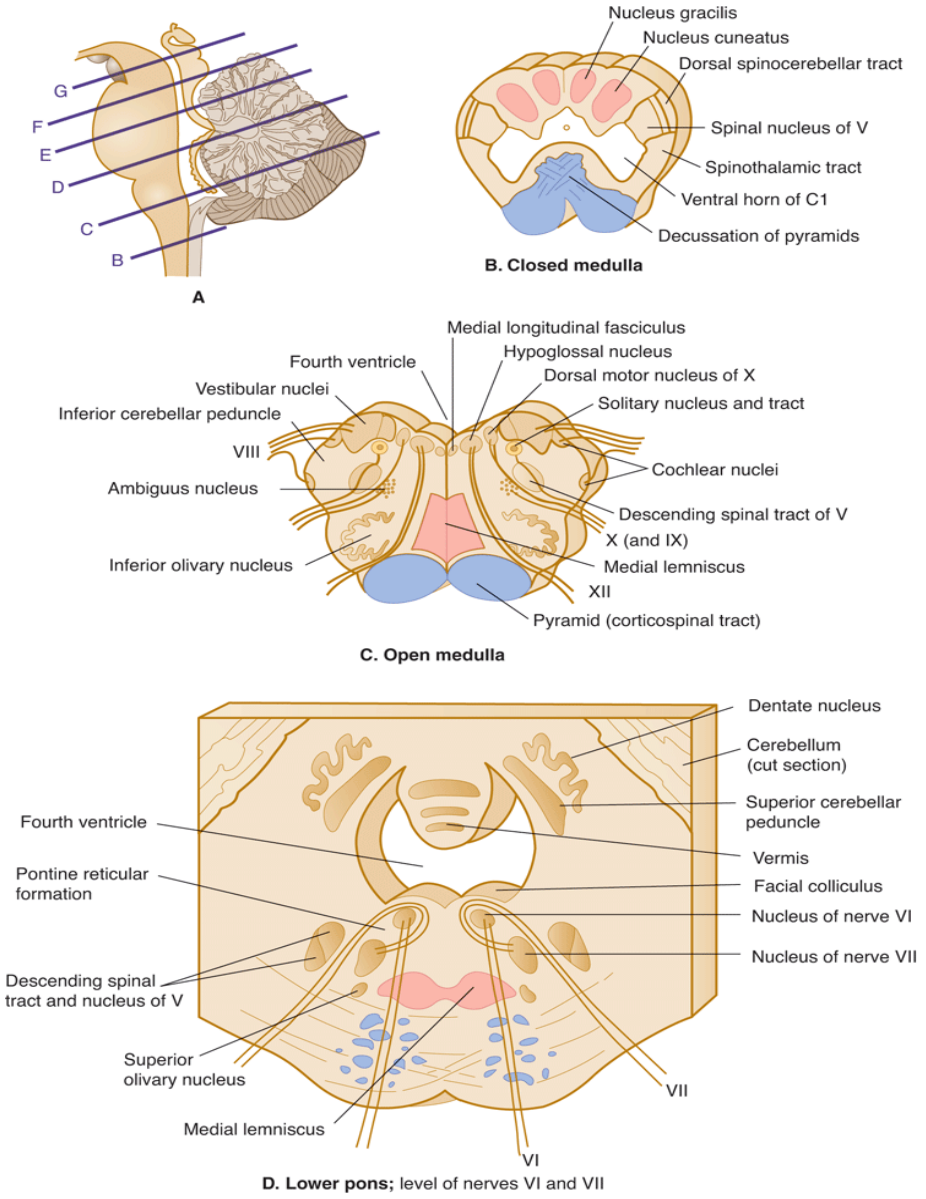

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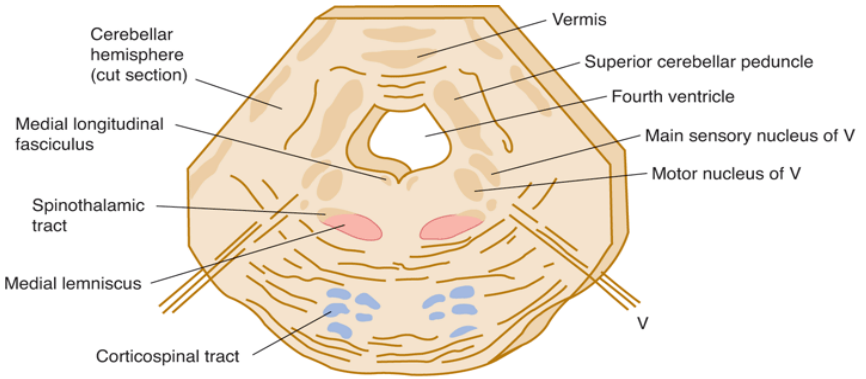
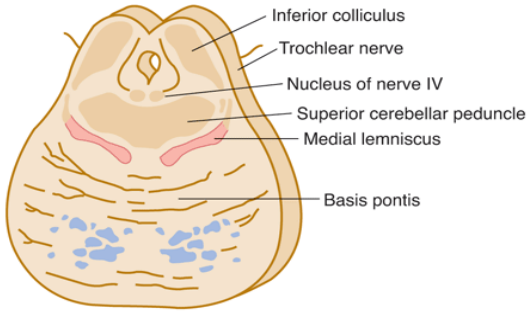
Fig. 7-7 Accessed 02/01/2010

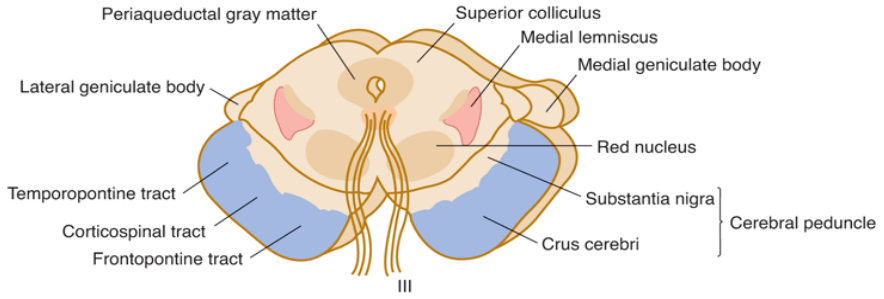
Slices through the brain stem relating nuclei to cranial nerves and major tracts



E. Middle pons; level of nerve V



F. Pons/midbrain; level of nucleus VI



G. Upper midbrain; level of nerve III

Fig. 7-7 Accessed 02/01/2010

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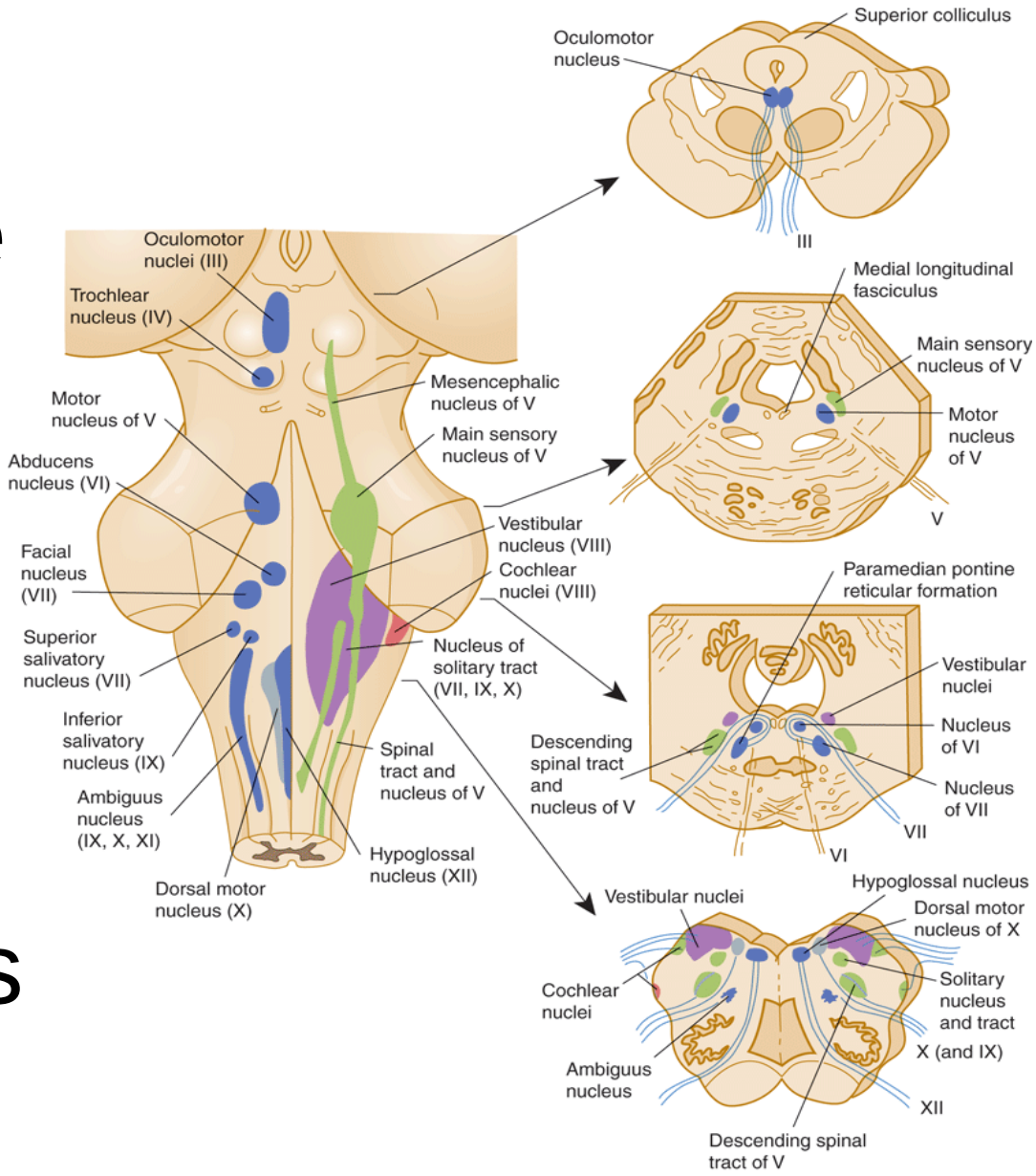

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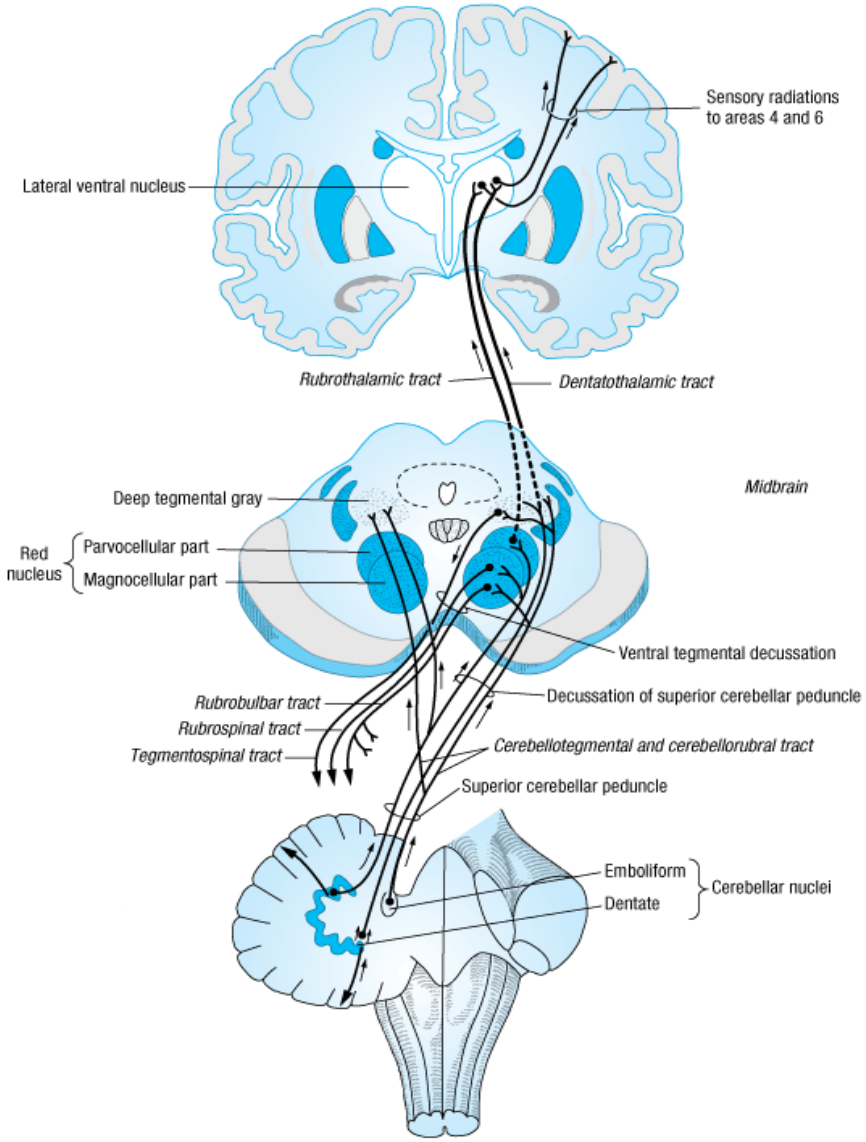
Fig. 7-6 Accessed 02/01/2010

Cerebellar projections



Source: Ropper AH, Samuels MA: *Adams & Victor's Principles of Neurology 9th Edition*: http://www.accessmedicine.com

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Fig. 5-2 Accessed 02/01/2010

Descending tracts

System	Function	Origin	Ending	Location in Cord
Lateral corticospinal (pyramidal) tract	Fine motor function (controls distal musculature) Modulation of sensory functions	Motor and premotor cortex	Anterior horn cells (interneurons and lower motor neurons)	Lateral column (crosses in medulla at pyramidal decussation)
Anterior corticospinal tract	Gross and postural motor function (proximal and axial musculature)	Motor and premotor cortex	Anterior horn neurons (interneurons and lower motor neurons)	Anterior column (uncrossed until after descending, when some fibers decussate)
Rubrospinal	Motor function	Red nucleus	Ventral horn interneurons	Lateral column

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Descending tracts

System	Function	Origin	Ending	Location in Cord
Reticulospinal	Modulation of sensory transmission (especially pain) Modulation of spinal reflexes	Brain stem reticular formation	Dorsal and ventral horn	Anterior column
Descending autonomic	Modulation of autonomic functions	Hypothalamus, brain stem nuclei	Preganglionic autonomic neurons	Lateral columns
Tectospinal	Reflex head turning	Midbrain	Ventral horn inter-neurons	Ventral column
Medial longitudinal fasciculus	Co-ordination of head and eye movements	Vestibular nuclei	Cervical gray	Ventral column

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Corticospinal tract

- Originates in primary motor cortex in precentral gyrus. Other sources include the supplementary motor area on the medial side of the hemisphere and the premotor cortex on the lateral side.
- Sensory fibers from the somatic sensory cortex and the superior parietal lobule travel with the corticospinal tract and terminate in the sensory nuclei of the brainstem and spinal cord, where they modulate sensory transmission.
- The corticospinal tract descends through the corona radiata and internal capsule to the medulla. As the tract passes through the brainstem it gives off fibers to activate cranial nuclei.

Corticospinal tract

- Just above the spinomedullary junction, 80% of fibers decussate (pyramid) and descend as the lateral corticospinal tract; 10% decussate and enter the anterior corticospinal tract which occupies the anterior funiculus at cervical and upper thoracic levels. They cross in the white commisure and supply motor neurons serving the deep muscles in the neck. 10% of the pyramidal fibers do not cross and enter the lateral corticospinal tract on the same side; are medial or anterior.

Corticospinal tract

- All corticospinal fibers are excitatory and use glutamate as their transmitter substance.
- In the anterior gray horn, axons synapse upon the dendrites of α and γ motor neurons supplying limb muscles Selectively activate small groups of neurons (fractionation), permitting fine movement.
- Synapse also on Renshaw cells, permitting co-contraction of prime movers and their antagonists.

Corticonuclear tract lesions

- Innervation to the cranial nerve motor nuclei are mainly bilateral with these exceptions:
- Facial nucleus. The part that innervates the lower part of the face gets only contralateral input.
- Hypoglossal nucleus. The neurons that innervate the genioglossus muscle only get contralateral input.
- Nucleus Ambiguous. The neurons that innervate the soft palate and uvula get only contralateral input.
- Spinal Accessory. Mainly ipsilateral input

Other tracts

- Pontine reticulospinal tract descends ipsilaterally in the anterior funiculus; the medullary reticulospinal tract descends, partly crossed, in the lateral funiculus. Both tracts act via internuncials share with the corticospinal tract.
- The pontine reticulospinal tract acts on upper motor extensor neurons; the medullary, on flexor motor neurons. Exhibit reciprocal inhibition.
- The tectospinal tract is a crossed pathway from the tectum of the midbrain to the medial part of the anterior gray horn at cervical and upper thoracic levels. It acts on axial musculature.

Other tracts

- The vestibulospinal tract originates in the vestibular nucleu and descends uncrossed in the anterior funicuilus. The tone of antigravity muscles is increased when the head is tilted to one side (maintaining the center of gravity between the feet).
- The raphespinal tract originates in and beside the raphe nucleus in the medulla midline. It descends bilaterally within the posterior tract of Lissauer. It modulates sensory transmission between first and second order neurons in the posterior gray horn (nociception).
- The rubrospinal tract is vestigial in humans. Arise in red nucleus. Axons cross in ventral tegmentum. Facilitates flexors and inhibits extensors.

Central autonomic pathways

- Central autonomic pathways descend beside the intermediate gray matter. They originate in part from the hypothalamus and in part from nuclear groups in the brainstem. They terminate in the intermediolateral cell columns that give rise to the preganglionic sympathetic and parasympathetic fibers of the peripheral autonomic system.
- The central sympathetic system is required for normal baroceptor reflex activity.
- The central parasympathetic pathway is required for bladder and bowel function.

Lower motor neuron injury

- The rubrospinal tract and vestibulospinal tract innervate α-motor neurons that control distal muscles (delicate, precise movements).
- With an upper motor neuron lesion there is interruption of descending inhibitory pathways with increased activity of γ-motor neurons.
- Spasticity involves a lesion of both the corticospinal tract and the reticulospinal tract.
- Spasticity involves a velocity-dependent increase in resistance of muscles to passive stretch.