

String Art: Axon Tracts in the Spinal Cord

Use the descriptions in this document to trace the following:

- Spinal reflex arcs
- Corticospinal tracts
- Dorsal column tracts
- Spinothalamic tracts
- Spinocerebellar tracts

Please note that descriptions are somewhat simplified.

Spinal reflex arcs

Site	Neuron	Description
Hand	1	Sensory axons* originate in muscle spindle
Dorsal root ganglion	1	Cell bodies of sensory neurons
Cervical enlargement of spinal cord	1/2	Sensory axons synapse onto (lower) motor neurons in ventral horn
Hand	2	Motor axons terminate at neuromuscular junctions

Site	Neuron	Description
Foot	1	Sensory axons* originate in muscle spindle
Dorsal root ganglion	1	Cell bodies of sensory neurons
Lumbar enlargement of spinal cord	1/2	Sensory axons synapse onto (lower) motor neurons in ventral horn
Foot	2	Motor axons terminate at neuromuscular junctions

* Technically dendrites, but usually called axons.

Corticospinal tracts

Site	Neuron	Description
Cerebral cortex	1	Cell bodies of upper motor neurons lie in hand region of primary motor cortex. Axons descend through internal capsule.
Mid-brain	1	Axons of corticospinal tract descend in base of cerebral peduncle
Pons	1	Axons of corticospinal tract descend in bundles within basal pons
Open medulla	1	Axons of corticospinal tract descend through the medullary pyramid
Lower medulla	1	Axons cross at the pyramidal decussation
Cervical enlargement of spinal cord	1/2	Axons of the lateral corticospinal tract synapse with lower motor neurons in ventral horn
Hand	2	Motor axons terminate at neuromuscular junctions

Site	Neuron	Description
Cerebral cortex	1	Cell bodies of upper motor neurons lie in foot region of primary motor cortex. Axons descend through internal capsule.
Mid-brain	1	Axons of corticospinal tract descend in base of cerebral peduncle
Pons	1	Axons of corticospinal tract descend within basal pons
Open medulla	1	Axons of corticospinal tract descend through the medullary pyramid
Lower medulla	1	Axons crosses at the pyramidal decussation
Cervical enlargement of spinal cord	1	Axons descend in the lateral corticospinal tract (lateral fasciculus of spinal cord)
Thoracic spinal cord	1	Axons descend in the lateral corticospinal tract
Lumbar enlargement of spinal cord	1/2	Axons of the lateral corticospinal tract synapse with lower motor neurons in ventral horn
Foot	2	Motor axons terminate at neuromuscular junctions

Note that all of the fibres to muscles in the upper and lower limbs cross at the pyramidal decussation. Fibres going to the axial muscles (about 15% of corticospinal fibres) remain uncrossed, travel in the anterior corticospinal tract and then supply motor neurons on both sides of the spinal cord.

Dorsal column tracts

Site	Neuron	Description
Hand	1	Sensory axons* originate in sense organs for fine touch (Meissner's corpuscles, Pacinian corpuscles) or proprioception (muscle spindles)
Dorsal root ganglion	1	Cell bodies of 1° sensory neurons
Cervical enlargement of spinal cord	1	Axons enter via dorsal root then travel in dorsal column (cuneate fasciculus)
Lower (closed) medulla	1/2	Synapse with 2° sensory neurons in cuneate nucleus. Axons from cuneate nucleus cross over to medial lemniscus at the level of the upper medulla (decussation not shown on model).
Upper (open) medulla	2	Axons travel in the medial lemniscus
Pons	2	Axons travel in the medial lemniscus
Mid-brain	2	Axons travel in the medial lemniscus
Thalamus	2/3	Synapse with 3° neurons in thalamus (ventral posterior nucleus)
Cerebral cortex	3	Synapse in hand region of primary somatosensory cortex

Site	Neuron	Description
Foot	1	Sensory axons* originate in sense organs for fine touch (Meissner's corpuscles, Pacinian corpuscles) or proprioception (muscle spindles)
Dorsal root ganglion	1	Cell body of 1° sensory neuron
Lumbar enlargement of spinal cord	1	Axons enter via dorsal root then ascend in dorsal column (gracile fasciculus)
Thoracic spinal cord	1	Axons continue to ascend in dorsal column (gracile fasciculus)
Cervical enlargement of spinal cord	1	Axons continue to ascend in dorsal column (gracile fasciculus)
Lower (closed) medulla	1/2	Synapse with 2° sensory neurons in gracile nucleus. Axons from gracile nucleus cross over to medial lemniscus at the level of the upper medulla (decussation not shown on model).
Upper (open) medulla	2	Axons travel in the medial lemniscus
Pons	2	Axons travel in the medial lemniscus
Mid-brain	2	Axons travel in the medial lemniscus
Thalamus	2/3	Synapse with 3° neurons in thalamus (ventral posterior nucleus)
Cerebral cortex	3	Synapse in foot region of primary somatosensory cortex

* Technically dendrites, but usually called axons.

Spinothalamic tracts

Site	Neuron	Description
Hand	1	Sensory axons* originate from free nerve endings
Dorsal root ganglion	1	Cell bodies of 1 ^o sensory neurons
Cervical enlargement of spinal cord	1/i/2	Axons synapse with interneurons in substantia gelatinosa. Interneurons synapse with 2 ^o neurons. Axons from 2 ^o neurons cross over to contralateral spinothalamic tract
Lower medulla	2	Axons ascend in spinothalamic tract
Open medulla	2	Axons continue to ascend within spinal lemniscus
Pons	2	Axons continue to ascend within spinal lemniscus
Mid-brain	2	Axons continue to ascend within spinal lemniscus
Thalamus	2/3	Synapse with 3 ^o neurons in thalamus
Cerebral cortex	3	Synapse in hand region of primary sensory cortex

Site	Neuron	Description
Foot	1	Sensory axons* originate from free nerve endings
Dorsal root ganglion	1	Cell bodies of 1 ^o sensory neurons
Lumbar enlargement of spinal cord	1/i/2	Axons synapse with interneurons in substantia gelatinosa. Interneurons synapse with 2 ^o neurons. Axons from 2 ^o neurons cross over to contralateral spinothalamic tract
Thoracic spinal cord	2	Axons ascend in spinothalamic tract
Cervical enlargement of spinal cord	2	Axons continue to ascend in spinothalamic tract
Lower medulla	2	Axons continue to ascend in spinothalamic tract
Open medulla	2	Axons continue to ascend within spinal lemniscus
Pons	2	Axons continue to ascend within spinal lemniscus
Mid-brain	2	Axons continue to ascend within spinal lemniscus
Thalamus	2/3	Synapse with 3 ^o neurons in thalamus
Cerebral cortex	3	Synapse in foot region of primary sensory cortex

* Technically dendrites, but usually called axons.

Spinocerebellar tracts (dorsal)

Site	Neuron	Description
Hand	1	Sensory axons* originate in proprioceptive organs such as muscle spindle or golgi tendon organ
Dorsal root ganglion	1	Cell bodies of 1 ^o sensory neurons
Cervical enlargement of spinal cord	1	Axons ascend in cuneate fasciculus
Lower (closed) medulla	1	Axons ascend in cuneate fasciculus
Upper (open) medulla	1/2	Axons synapse with 2 ^o neurons in accessory cuneate nucleus. Axons from these 2 ^o neurons pass through the inferior cerebellar peduncle
Cerebellum	2	Axons synapse in cerebellar cortex

Site	Neuron	Description
Foot	1	Sensory axons* originate in proprioceptive organs such as muscle spindle or golgi tendon organ
Dorsal root ganglion	1	Cell bodies of 1 ^o sensory neurons
Lumbar enlargement of spinal cord	1	Axons ascend in gracile fasciculus to thoracic level
Thoracic spinal cord	1/2	Axons leave gracile fasciculus to synapse with 2 ^o neurons in Clarke's column/nucleus. Axons from these 2 ^o neurons enter the dorsal spinocerebellar tract
Cervical enlargement of spinal cord	2	Axons ascend in dorsal spinocerebellar tract
Lower (closed) medulla	2	Axons ascend in dorsal spinocerebellar tract
Upper (open) medulla	2	Axons pass through the inferior cerebellar peduncle
Cerebellum	2	Axons synapse in cerebellar cortex

* Technically dendrites, but usually called axons.

Note that there are also ventral spinocerebellar tracts, which are a bit more complicated. They are part of a system that integrates descending motor signals with ascending proprioceptive signals.

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