Spinal Cord

Figure 12.29a
Spinal Cord

- CNS tissue is enclosed within the vertebral column from the foramen magnum to L₁
- About 17” long
- Major reflex center
- Provides two-way communication to and from the brain
- Protected by bone, meninges, and CSF
- Epidural space – space between the vertebrae and the dural sheath (dura mater) filled with fat and a network of veins
- Cerebral spinal fluid fills the subarachnoid space between the arachnoid and pia mater
- Dural and Arachnoid membranes extend to S2
- Spinal taps (lumbar punctures) done below L3 (see first bullet)
Lumbar Tap

Figure 12.30

- **T_{12}**
- **L_{5}**
- **Ligamentum flavum**
- **Lumbar puncture needle**
- **Supraspinous ligament**
- **Filum terminale**
- **Vertebral disc**
- **Dura mater and arachnoid**
- **Cauda equina in subarachnoid space**

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Spinal Tap
Spinal Cord

- Spinal cord terminates at the conus medullaris
- Filum terminale – fibrous extension of the pia mater; anchors the spinal cord to the posterior surface of the coccyx
- Denticulate ligaments – delicate shelves of pia mater; attach the spinal cord to the vertebrae
Spinal Cord

- Spinal nerves – 31 pairs attach to the cord by paired roots
- Each nerve exits thru intervertebral foramina superiorly (cervical vertebrae) or inferiorly (the rest) at its corresponding numbered vertebra
- Cervical and lumbar enlargements – sites where nerves serving the upper and lower limbs emerge
- Cauda equina – collection of nerve roots at the inferior end of the vertebral canal
Cross-Sectional Anatomy of the Spinal Cord

- Anterior median fissure – separates anterior funiculi
- Posterior median sulcus – divides posterior funiculi

Figure 12.31a
Gray Matter and Spinal Roots

- Gray matter consists of soma, unmyelinated processes, and neuroglia
- Gray commissure – connects masses of gray matter; encloses central canal
- Posterior (dorsal) horns – interneurons
- Anterior (ventral) horns – interneurons and somatic motor neurons
- Lateral horns – present in the thoracic and superior lumbar segments of the spinal cord and contain sympathetic nerve fibers
Gray Matter and Spinal Roots

- All neurons whose cell bodies are in the gray matter are multipolar

- The amount of gray matter present at any given level of the spinal cord reflects the amount of skeletal muscle innervated at that level
  - E.g. ventral horns are the largest in the limb-innervating cervical and lumbar regions

- Lateral horn neurons are autonomic (sympathetic division) motor neurons that serve the visceral organs
  - Their axons leave the spinal cord via the ventral root

- The dorsal roots of the spinal cord are formed from afferent fibers carrying impulses from peripheral sensory receptors
Gray Matter: Organization

- Dorsal half – sensory roots
- Ventral half – motor roots
- Dorsal and ventral roots fuse laterally to form spinal nerves
- Four zones are evident within the gray matter – somatic sensory (SS), visceral sensory (VS), visceral motor (VM), and somatic motor (SM)
White Matter in the Spinal Cord

- Composed of myelinated and unmyelinated nerve fibers allowing communication between different parts of the spinal cord and between the spinal cord and brain
- Fibers run in three directions –
  - Ascending: most abundant
  - Descending: “”
  - Transversely (commissural fibers)
- Divided into three funiculi (columns): each contain several fiber tracts
  - Posterior
  - Lateral
  - Anterior
- Fiber tract names reveal their origin and destination
- Fiber tracts are composed of axons with similar functions
White Matter: Pathway Generalizations

- Pathways decussate at some point
- Most consist of two or three neurons
- Most exhibit somatotopy (precise spatial relationships, mapping of the body)
- Pathways are paired (one on each side of the spinal cord or brain)
White Matter: Main Ascending Pathways

- Conduct sensory impulses upward usually thru chains of three successive neurons (1\textsuperscript{st}, 2\textsuperscript{nd}, and 3\textsuperscript{rd} order neurons; the latter two are interneurons) to various areas of the brain

- 1\textsuperscript{st} order neurons: cell bodies reside in a ganglion (dorsal root or cranial) and conduct impulses from cutaneous receptors of the skin & proprioceptors to the spinal cord or brain stem where they synapse w/ 2\textsuperscript{nd} order neurons
Main Ascending Pathways

- $2^{nd}$ order neurons: cell bodies reside in the dorsal horn of the spinal cord and transmit impulses (from $1^{st}$ order neurons) to the thalamus or to the cerebellum

- $3^{rd}$ order neurons: cell bodies reside in the thalamus and conduct impulses (from $2^{nd}$ order neurons) to the somatosensory cortex of the cerebrum
Nonspecific Ascending Pathway

- Evolutionarily older
- Nonspecific pathway for pain, temperature, and crude touch within the lateral spinothalamic tract
- Cross over occurs in the spinal cord
- We are aware of the senses but have difficulty localizing it on the body surface
Specific and Posterior Spinocerebellar Tracts

- Specific ascending pathways:
  - Mediate precise, straight-thru transmission of inputs from a single type of sensory neuron that **can** be localized precisely on the body surface
  - Formed by the paired tracts of the dorsal white column (fasciculus cuneatus & fasciculus gracilis) and the medial lemniscal tracts
  - The medial lemniscal tracts arise in the medulla and terminate in the ventral posterior nuclei of the thalamus and then to the somatosensory cortex
The Anterior/Posterior Spinocerebellar Tract

- Convey info. about muscle or tendon stretch to the cerebellum which uses this info. to coordinate skeletal muscle activity
- Do not contribute to conscious sensation
- Either do not cross or double decussate
Descending (Motor) Pathways & Tracts

- Descending tracts deliver efferent impulses from the brain to the spinal cord, and are divided into two groups:
  - 1. Direct pathways equivalent to the pyramidal tracts
  - 2. Indirect pathways, essentially all others
- Motor pathways involve two neurons (upper and lower motor neurons)
  - Upper motor neuron: pyramidal cells of the motor cortex, neurons of the subcortical motor nuclei
  - Lower motor neuron: ventral horn motor neurons that innervate the skeletal muscle
The Direct (Pyramidal) System

- Direct pathways originate with the pyramidal neurons in the precentral gyri
- Impulses are sent through the corticospinal tracts and synapse in the anterior horn
- Stimulation of anterior horn neurons activates skeletal muscles
- The direct pathway regulates fast and fine (skilled) movements
Indirect (Extrapyramidal) System

- Includes the brain stem, motor nuclei, and all motor pathways not part of the pyramidal system
- These motor pathways are complex and multisynaptic
- Involved in regulating:
  - Axial muscles that maintain balance/posterior
  - Coarse limb movements
  - Head, neck, eye movements
- This system includes the rubrospinal, vestibulospinal, reticulospinal, and tectospinal tracts
- Heavily dependent on reflex activity