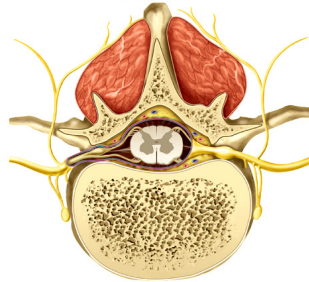


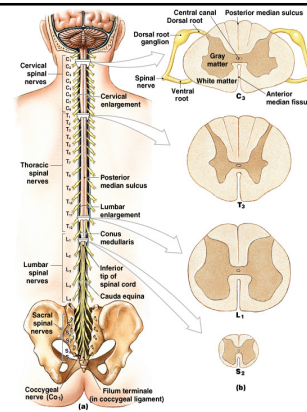
Chapter 13 Spinal Cord, Spinal Nerves and Somatic Reflexes

- Spinal cord
- Spinal nerves
- Somatic reflexes



Spinal Cord Word Scramble

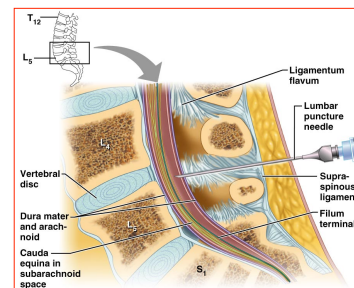
1. alnips
2. bamrul
3. trevarbe
4. veern
5. crumas
6. lexref
7. cyxocc
8. calvirec
9. ginnemes
10. yagr tertam



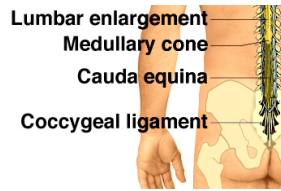
Spinal Cord Anatomy

- **Conus medullaris** – terminal portion of the spinal cord
- **Filum terminale** – fibrous extension of the pia mater; anchors the spinal cord to the coccyx
- **Denticulate ligaments** – delicate shelves of pia mater; attach the spinal cord to the vertebrae
- **Spinal nerves** – **31 pairs** attach to the cord by paired roots
 - Cervical nerves are named for inferior vertebra
 - All other nerves are named for superior 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 – L2 – S5 (horse's tail)

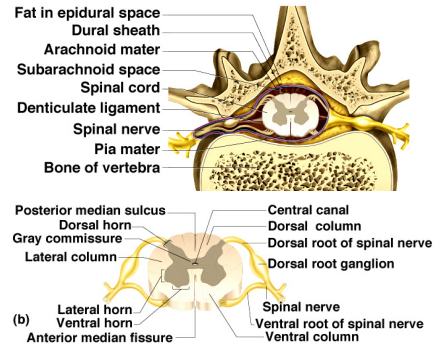
Lumbar Tap



Gross Anatomy of Lower Spinal Cord



Meninges of Vertebra & Spinal Cord

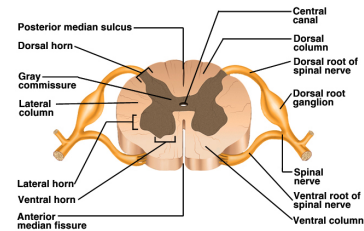


Spina Bifida

- Congenital defect in 1 baby out of 1000
- Failure of vertebral arch to close covering spinal cord
- Mothers can reduce risk by taking folic acid supplement during pregnancy



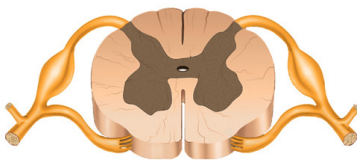
Cross-Sectional Anatomy of the Spinal Cord



- Central area of gray matter shaped like a butterfly and surrounded by white matter in 3 columns

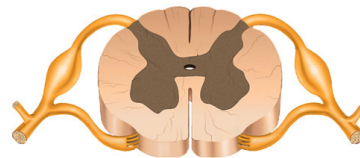
Gray Matter in the Spinal Cord

- Pair of dorsal or posterior horns
- Pair of ventral or anterior horns
- Connected by gray commissure punctured by a central canal continuous above with 4th ventricle



White Matter in the Spinal Cord

- White column = bundles of myelinated axons that carry signals up & down



Spinal Tracts

Ascending tracts: Dorsal column, Gracile fasciculus, Cuneate fasciculus, Dorsal spinocerebellar tract, Ventral spinocerebellar tract, Anterolateral system (containing spinothalamic tract).

Descending tracts: Ventral corticospinal tract, Lateral corticospinal tract, Lateral reticulospinal tract, Medial reticulospinal tract, Lateral tectospinal tract, Vestibulospinal tract, Medial tectospinal tract.

- Ascending & descending tract head up or down while decussation means that the fibers cross sides
- Contralateral means origin and destination are on opposite sides while ipsilateral means on same side

Dorsal Column Ascending Pathway

Spinal cord: Cuneate fasciculus, Gracile fasciculus

Medulla: First-order neuron, Medial lemniscus, Cuneate nucleus

Midbrain: Second-order neuron, Medial lemniscus

Thalamus: Third-order neuron

Somesthetic cortex (postcentral gyrus): Third-order neuron

Spinothalamic Pathway

Spinal cord: First-order neuron, Anterolateral system

Medulla: Second-order neuron

Thalamus: Third-order neuron

Somesthetic cortex (postcentral gyrus): Third-order neuron

Spinocerebellar Pathway

- Proprioceptive signals in limbs and trunk travel up to the cerebellum
- Second order nerves ascend in lateral column

Spinal cord: Dorsal spinocerebellar tract, Ventral spinocerebellar tract, Anterolateral system (containing spinothalamic tract)

Medulla: Lateral tectospinal tract, Medial tectospinal tract, Vestibulospinal tract

Midbrain: Lateral reticulospinal tract, Medial reticulospinal tract

Thalamus: Lateral corticospinal tract, Medial corticospinal tract

Somesthetic cortex (postcentral gyrus): Third-order neuron

Corticospinal Tract

Motor cortex (precentral gyrus): Upper motor neurons

Internal capsule: Upper motor neurons

Midbrain: Cerebral peduncle, Upper motor neurons

Medulla: Decussation in medulla, Medullary pyramid, Upper motor neurons

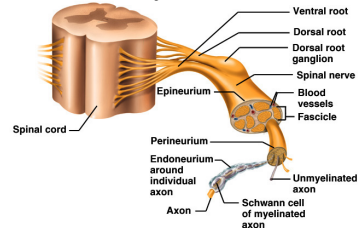
Spinal cord: Lateral corticospinal tract, Ventral corticospinal tract, Lower motor neurons

Descending Motor Tracts

- Tectospinal tract** – reflex movements of head
- Reticulospinal tract** – controls limb movements important to maintain posture
- Vestibulospinal tract** – postural muscle activity in response to inner ear signals

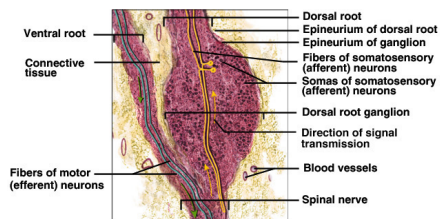


Anatomy of a Nerve



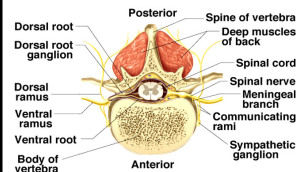
- A nerve is a bundle of nerve fibers (axons)
- Epineurium covers nerves, perineurium surrounds a fascicle & endoneurium separates individual nerve fibers
- Blood vessels penetrate only to the perineurium

Anatomy of Ganglia in the PNS



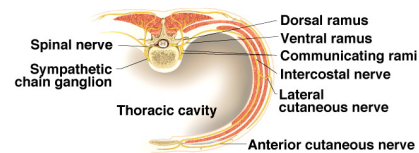
- Cluster of neuron cell bodies in nerve in PNS
- Dorsal root ganglion is sensory cell bodies
 - fibers pass through without synapsing

Branches of a Spinal Nerve



Spinal nerves: 8 cervical, 12 thoracic, 5 lumbar, 5 sacral and 1 coccygeal.

Each has dorsal and ventral ramus.



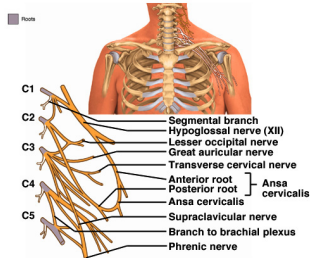
Shingles

- Skin eruptions along path of nerve
- *Varicella-zoster* virus (chicken pox) remains for life in dorsal root ganglia
- Occurs after age 50 if immune system is compromised
- No special treatment

Nerve Plexuses

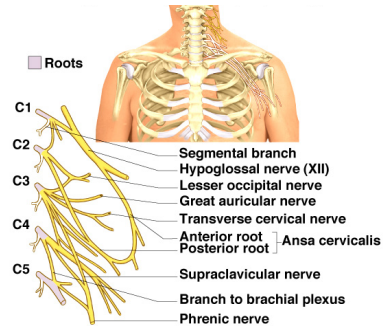
- Ventral rami branch & anastomose repeatedly to form 5 nerve plexuses
 - cervical in the neck, C1 to C5
 - supplies neck and phrenic nerve to the diaphragm
 - brachial in the armpit, C5 to T1
 - supplies upper limb and some of shoulder & neck
 - lumbar in the low back, L1 to L4
 - supplies abdominal wall, anterior thigh & genitalia
 - sacral in the pelvis, L4, L5 & S1 to S4
 - supplies remainder of butt & lower limb
 - coccygeal, S4, S5 and C0

Structure of a Nerve Plexus

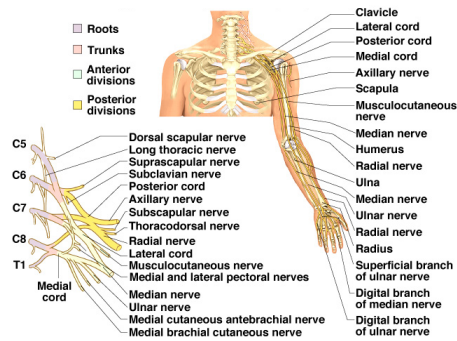


- Notice the branching and merging of nerves in this example of a plexus

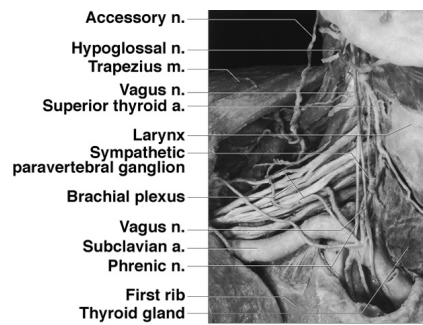
The Cervical Plexus



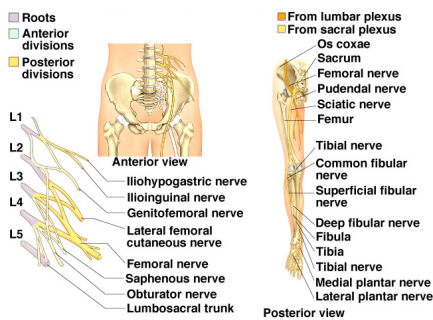
The Brachial Plexus



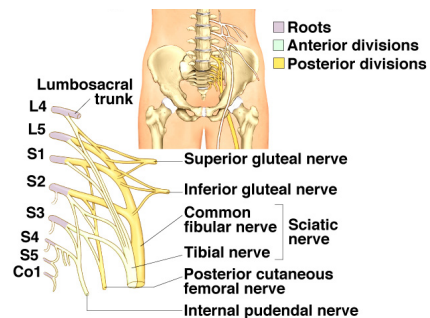
Dissection of the Brachial Plexus



The Lumbar Plexus

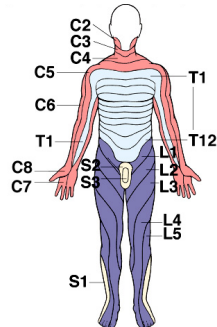


The Sacral and Coccygeal Plexuses



Cutaneous Innervation & Dermatomes

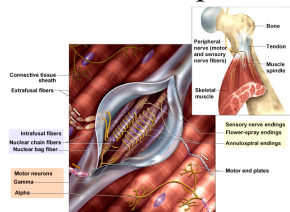
- Each spinal nerve receive sensory input from a specific area of skin called dermatome
- Overlap at edges by 50%
 - a total loss of sensation requires anesthesia of 3 successive spinal nerves



Nature of Somatic Reflexes

- Quick, involuntary, stereotyped reactions of glands or muscle to sensory stimulation
 - automatic responses to sensory input that occur without our intent or often even our awareness
- Functions by means of a somatic reflex arc
 - stimulation of somatic receptors
 - afferent fibers carry signal to dorsal horn of spinal cord
 - interneurons integrate the information
 - efferent fibers carry impulses to skeletal muscles
 - skeletal muscles respond

The Muscle Spindle

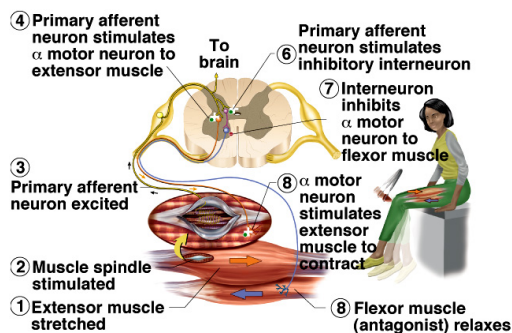


- Sense organs that monitor the length of skeletal muscles (proprioceptors) = stretch receptors
 - respond to onset of stretch or prolonged stretch
- 4 to 10 mm long modified skeletal muscle cells
 - intrafusal fibers that respond to gamma motor neurons & are wrapped with afferent fibers that respond to stretch

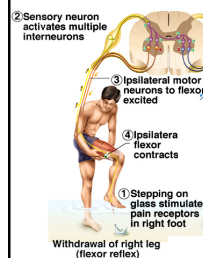
The Stretch (Myotatic) Reflex

- When a muscle is stretched, it contracts & maintains increased tonus (stretch reflex)
 - helps maintain equilibrium & posture
 - head starts to tip forward as you fall asleep
 - muscles contract to raise the head
 - stabilize joints by balancing tension in extensors & flexors smoothing muscle actions
- Very sudden muscle stretch causes tendon reflex
 - knee-jerk (patellar) reflex is monosynaptic reflex
 - testing somatic reflexes helps diagnose many diseases
- Reciprocal inhibition prevents muscles from working against each other

The Patellar Tendon Reflex Arc

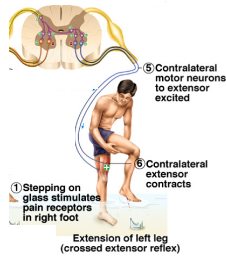


Flexor Withdrawal Reflexes



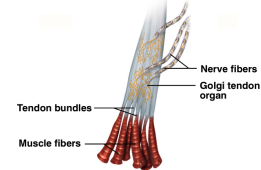
- Flexor(withdrawal) reflex occurs during withdrawal of foot from pain
 - polysynaptic reflex arc
 - neural circuitry in spinal cord controls sequence and duration of muscle contractions

Crossed Extensor Reflexes



- Crossed extensor reflex maintains balance by extending other leg
 - intersegmental reflex extends up and down the spinal cord
 - contralateral reflex arcs explained by pain at one foot causes muscle contraction in other leg

Golgi Tendon Reflex



- Proprioceptors in a tendon near its junction with a muscle -- 1mm long, encapsulated nerve bundle
- Excessive tension on tendon inhibits motor neuron
 - muscle contraction decreased
- Also functions when muscle contracts unevenly

Spinal Cord Trauma

- 10-12,000 people/ year are paralyzed
- 55% occur in traffic accidents
- This damage poses risk of respiratory failure
- Early symptoms are called spinal shock
- Tissue damage at time of injury is followed by post-traumatic infarction