Spinal Cord, Nerves, Spinal Reflexes

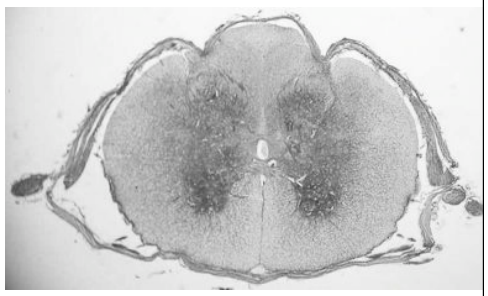
Activities 13-14

Overall Arrangement of Nervous System

- CNS
  - brain and spinal cord
- Spinal Nerves
  - precursors to peripheral nerves
- Plexus (may or may not be involved)
  - nerve root switching (mixing station)
- Peripheral Nerve

Definitions

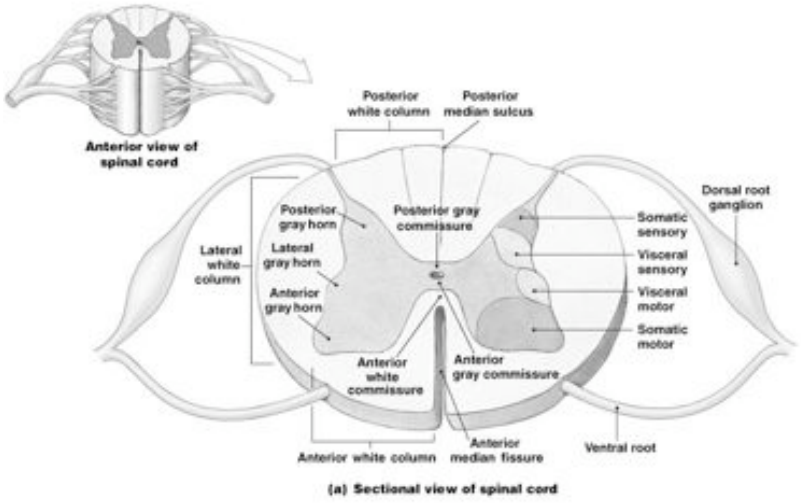
- Gray Matter
  - contains mostly cell bodies
  - areas where neurons may communicate
- White Matter
  - contains mostly axons
  - areas where neural information travels



Definitions

- Nucleus
  - gray matter inside of CNS
- Ganglion
  - gray matter in PNS
- Tract
  - white matter in CNS
  - ascending and descending
- Nerve
  - white matter in PNS

Anatomy of Spinal Cord



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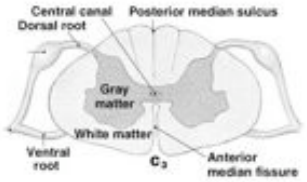
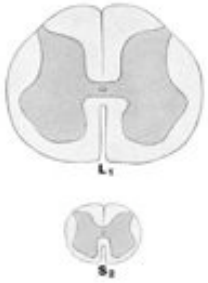
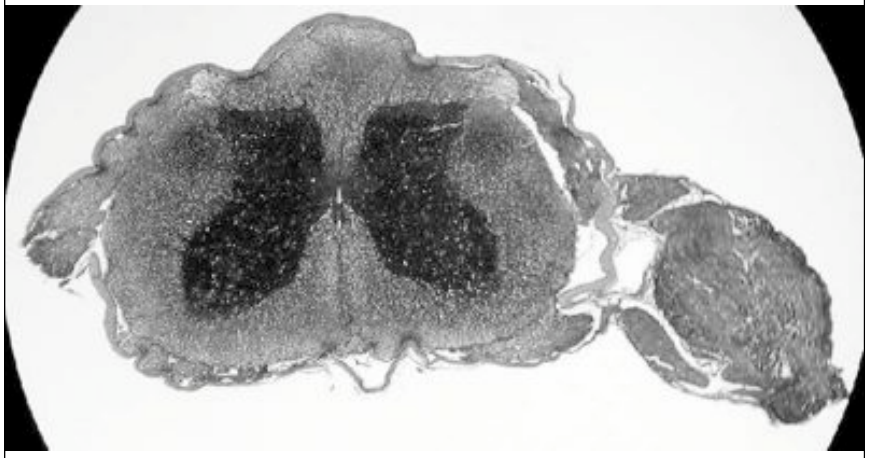


- You can tell which region of the spinal cord you are in by the shape and proportions of the white and gray matter.



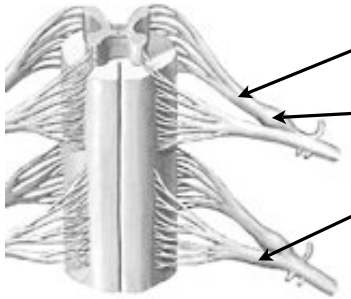
posterior

Anatomy of Spinal Cord



anterior

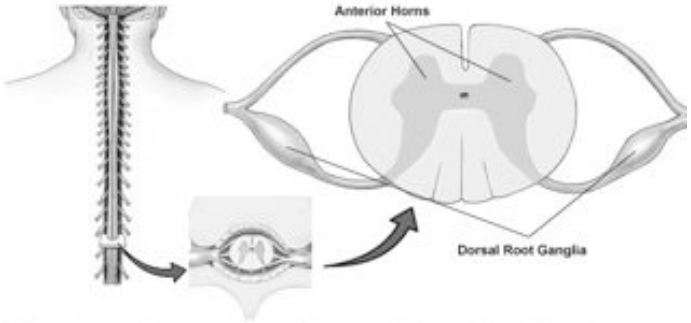
Anatomy of Spinal Cord



- Spinal Roots
  - dorsal root carries sensory (afferent) information
    - unipolar cells
  - dorsal root ganglion
    - place for cell bodies
  - ventral root carries motor (efferent) information to target tissues
    - usually multipolar cells
    - cell bodies are in the spinal cord
- Dorsal and ventral roots combine to make a spinal nerve (mixed)

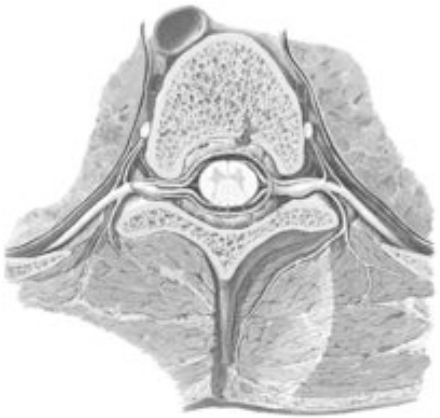
Anatomy of Spinal Cord

Figure F-6: Dorsal Root Ganglion & Anterior Horn

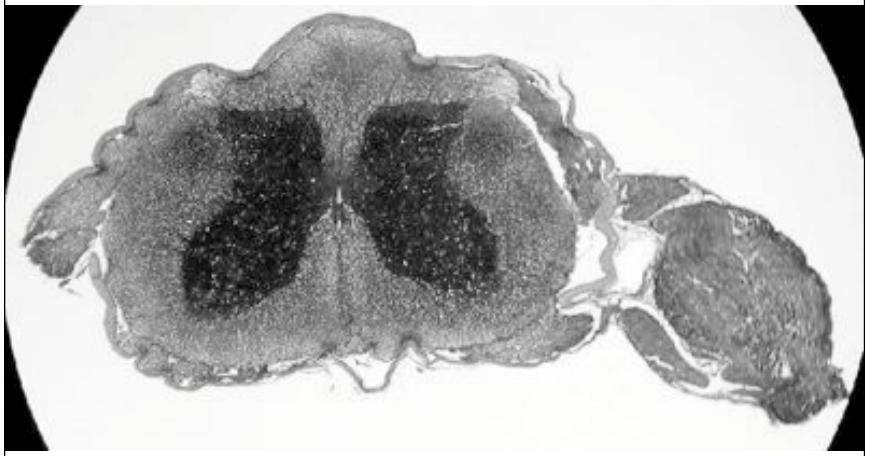


The dorsal root ganglion transmits *sensory* information while the anterior horn directs *motor* neurons.

Anatomy of Spinal Cord



Anatomy of Spinal Cord



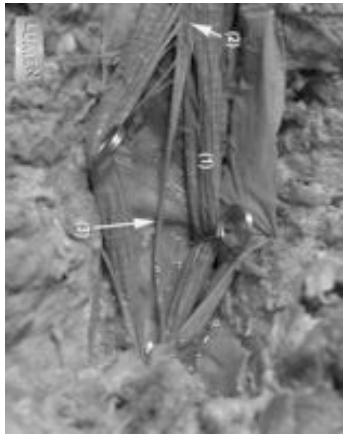
Diseases

- Polio and ALS affect the ventral horns.
  - what overall symptoms would be common in these diseases?

Spinal Canal

- starts at foramen magnum and ends in conus medullaris
- 31 pairs of spinal nerves (nerve roots) come off of the cord
  - exit through intervertebral foramen
- conus medullaris ends at about L1-L2 level.
- nerve roots traveling past the conus make up the cauda equina (horse's tail)

Spinal Canal



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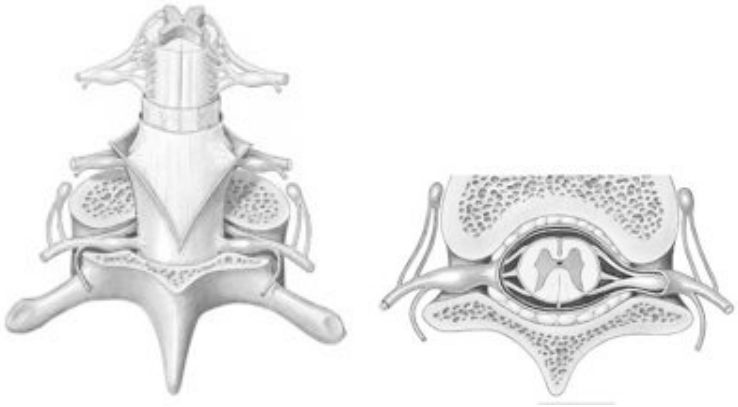
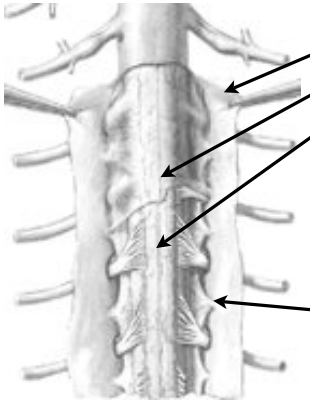
Spinal Canal

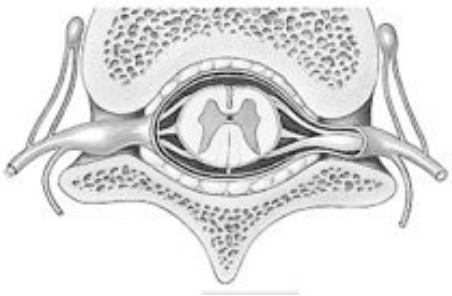


Meninges



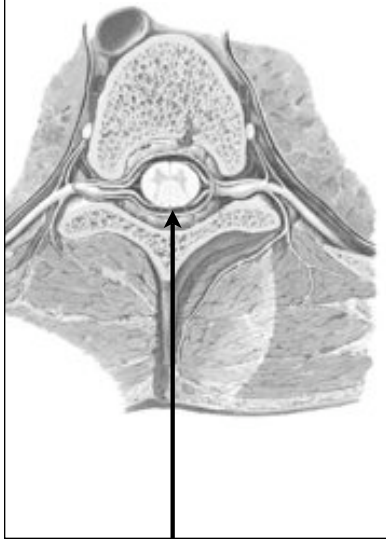
- 3 coverings over the spinal cord
  - Dura Mater
  - Arachnoid Mater
  - Pia Mater
    - blood vessels between arachnoid and pia
    - CSF between arachnoid and pia
- Purpose of meninges
  - protect (cushion)
  - support
    - denticulate ligament
    - filum terminale

Anatomy of Spinal Canal



- Name the three meningeal layers
- Identify the two spaces

Spinal Tap



- Spinal Tap is used when CSF is needed.
  - needle is inserted through the L3-4 interspace, ligamentum flavum, epidural space, dura, arachnoid into subarachnoid space.
  - why at L3-4?
  - Difference between an epidural and a spinal block.
    - which has more risk of headache from loss of CSF?

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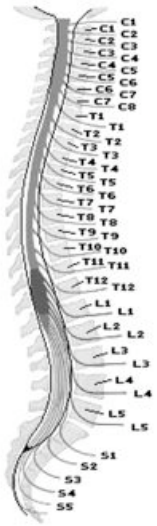


Spinal Nerves

- 31 pairs of spinal nerves each named after the region of the vertebral column that they exit
  - 8 pairs cervical, exit above the vertebral level
  - 12 pairs thoracic
  - 5 pairs lumbar
  - 5 pairs sacral
  - 1 pair coccygeal

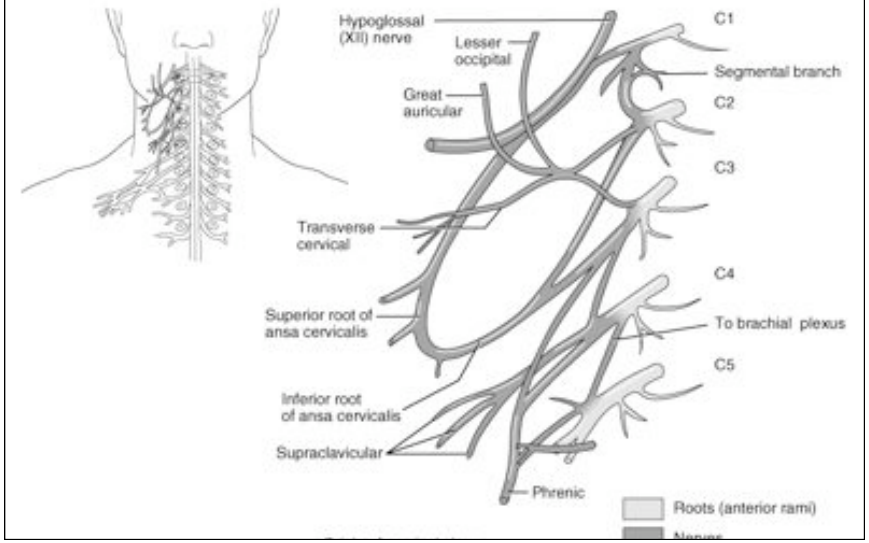
Spinal Nerves

- Spinal Nerves
  - mixed nerves
    - carry both sensory and motor
    - ventral ramus
      - goes on to make up most of the nerves in the body
    - dorsal ramus
      - innervates spinous musculature and skin
    - don't confuse the rami with the roots!

Cervical Plexus

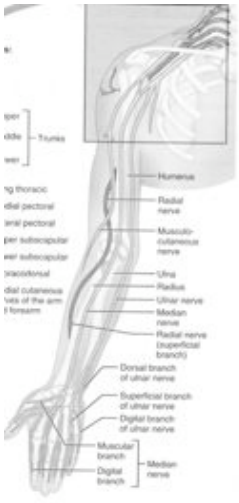
- Plexus is a junction/mixture of spinal nerves.
  - rarely have pure spinal nerves as peripheral nerves
  - exception: intercostal nerves
- Cervical Plexus
  - arise from ventral rami of C1-C5
  - phrenic nerve (C3,4,5 keep diaphragm alive)

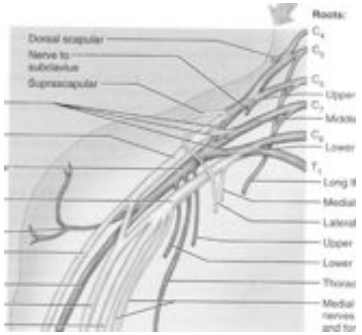
Cervical Plexus



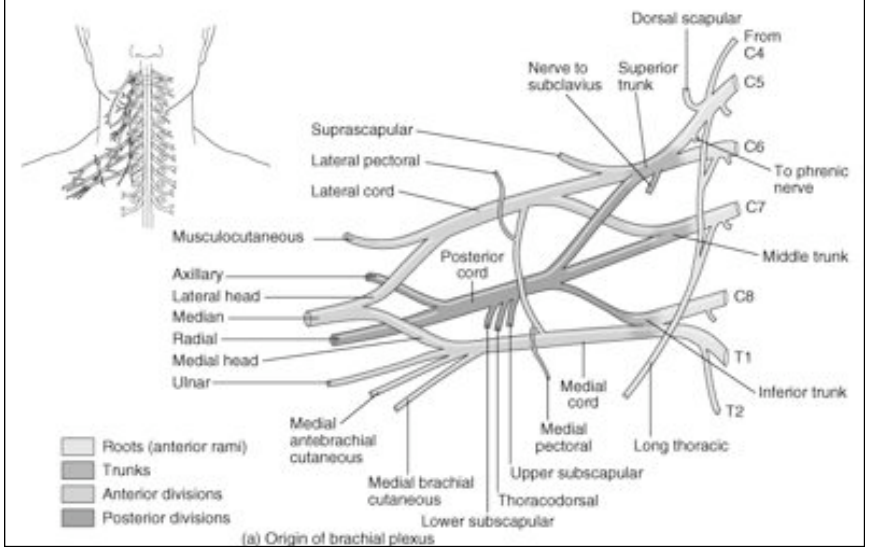
Brachial Plexus

- Brachial Plexus
  - arise from nerve roots of C5-T1





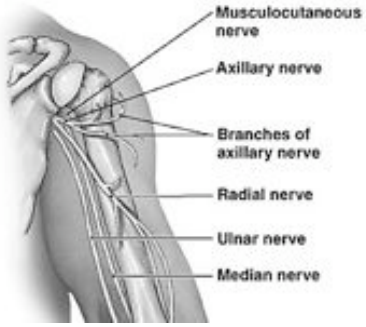
Brachial Plexus

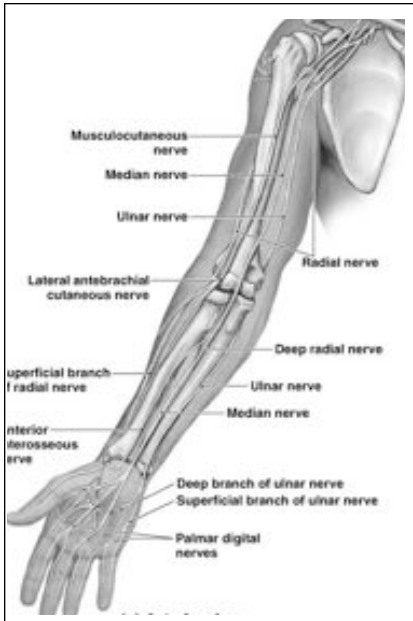


(a) Origin of brachial plexus

Brachial Plexus Nerves

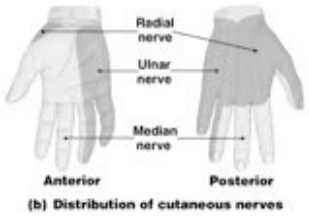
- Axillary
  - Roots: C5-C6
  - Muscles: deltoid, teres minor
  - Sensory: shoulder



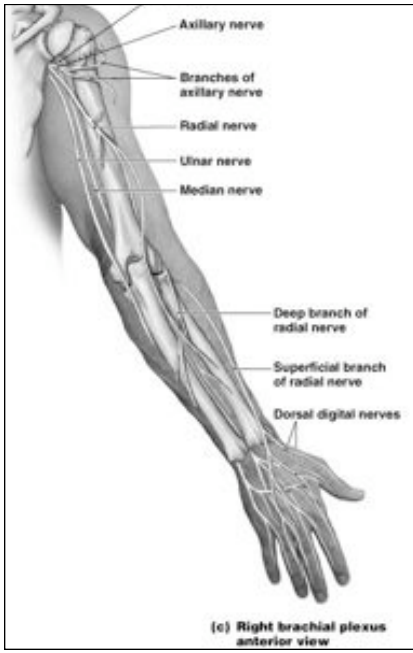


Brachial Plexus Nerves

- Musculocutaneous Nerve
  - Roots: C5-T1
  - Muscles: flexor muscles of arm
  - Sensory: lateral surface of the forearm (via lateral antebrachial cutaneous n.)



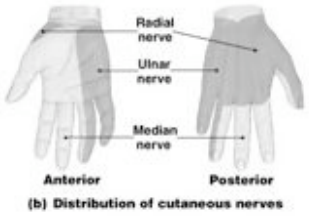
(b) Distribution of cutaneous nerves



(c) Right brachial plexus anterior view

Brachial Plexus Nerves

- Radial
  - Roots: C5-T1
  - Muscles: many in arm and forearm
  - Sensory: posterolateral surface of the arm, forearm and radial half of dorsal surface of hand



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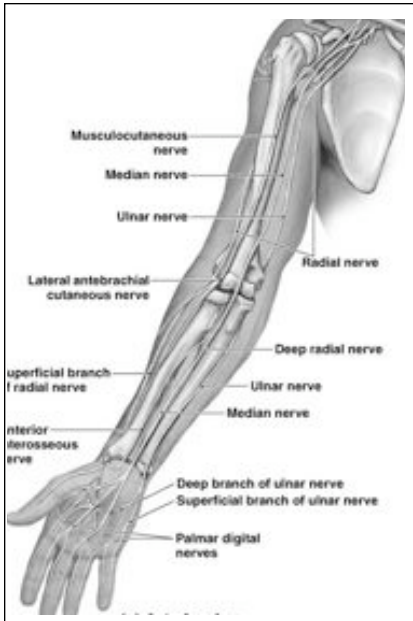

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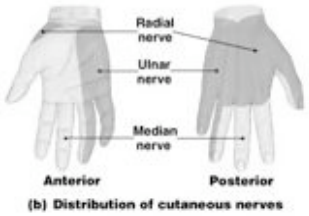
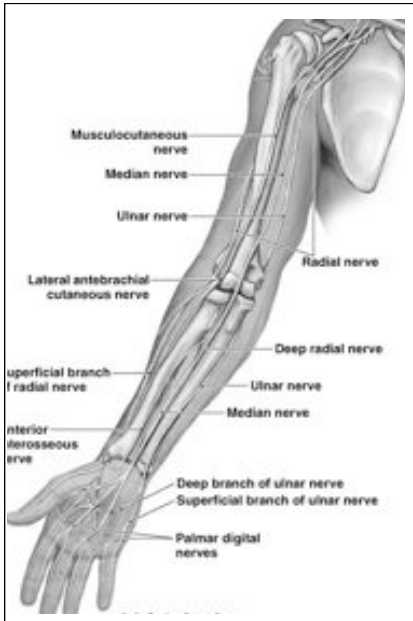
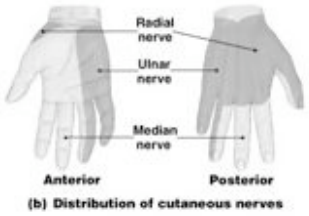


(b) Distribution of cutaneous nerves



Brachial Plexus Nerves

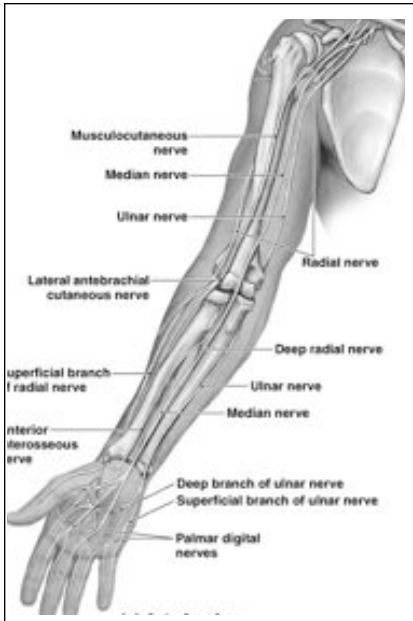
- Median
  - Roots: C6-T1
  - Muscles: flexors of forearm
  - Sensory: see chart
  - Note: carpal tunnel

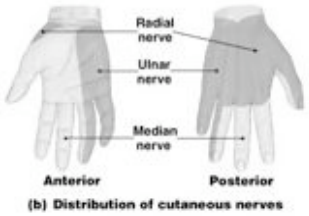


(b) Distribution of cutaneous nerves

Brachial Plexus Nerves

- Ulnar
  - Roots: C8-T1
  - Muscles: hand muscles
  - Sensory: see chart

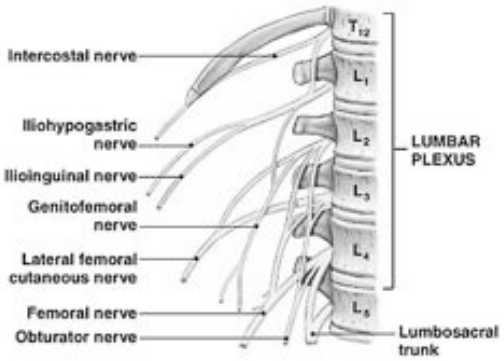




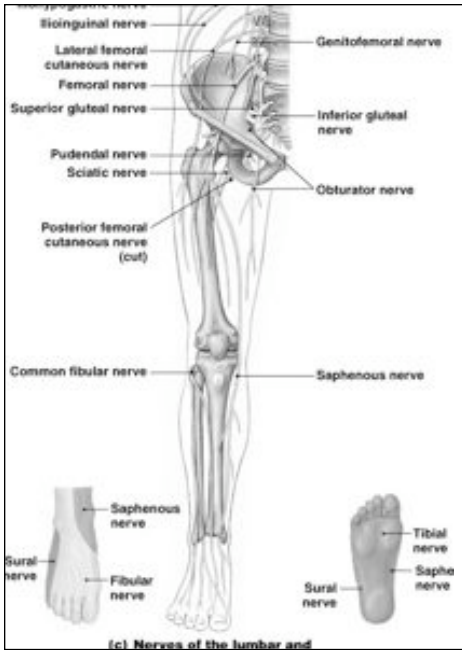
(b) Distribution of cutaneous nerves

Lumbar Plexus

- Lumbar Plexus
  - arise from nerve roots of T12-L4



(a) The lumbar plexus, anterior view

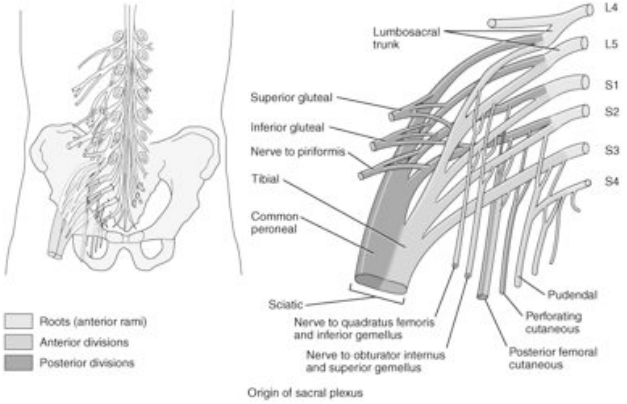


Lumbar Plexus Nerves

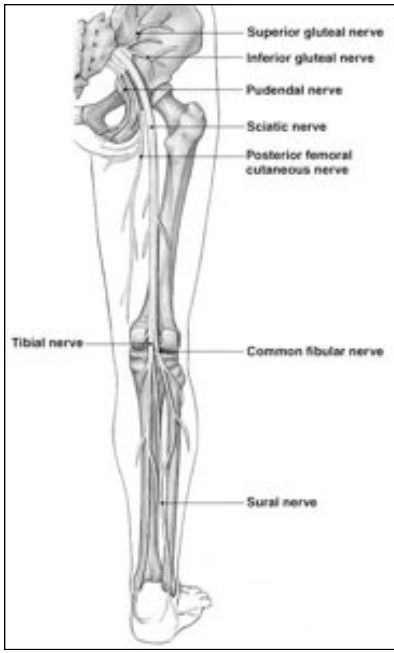
- Femoral N.
  - L2-L4
- Obturator N.
  - L2-L4
- Saphenous N.
  - L2-L4

Sacral Plexus

- Sacral Plexus
  - arise from nerve roots of L4-S4



Origin of sacral plexus



Sacral Plexus Nerves

- Sciatic
  - L4-S3
    - Tibial
    - Fibular
- Pudendal
  - S2-S4

Reflexes

- A reflex is a rapid, predictable response to a stimulus
  - usually a response we don't have time to think about
  - often only involve peripheral nerves and spinal cord
    - can involve higher brain centers too
- Innate Reflexes
  - born with them
    - withdraw from pain, suckling, chewing, tracking
- Aquired Reflexes
  - learned after activities
    - brake reflex
    - any learned muscular activity (sports, music)

Reflexes

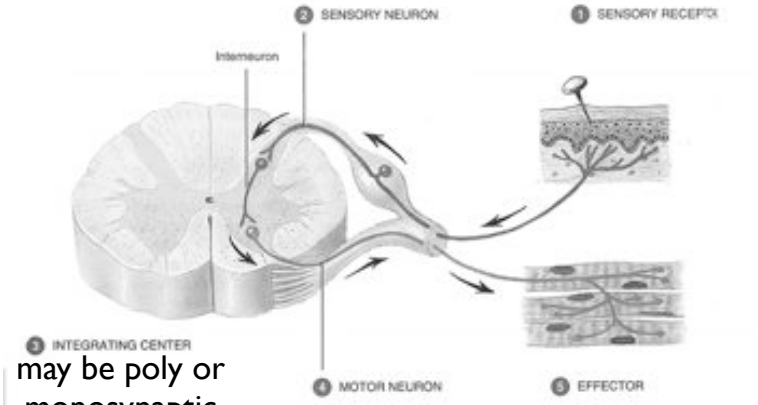
- Two types of reflexes (based on what information processed)
  - Autonomic
    - regulate body functions
      - digestion, BP, sweating
    - usually not aware of actions
  - Somatic
    - helps maintain posture, balance, movement
    - usually aware of the reflex

Reflexes

- Two types of reflexes (based on where information is processed)
  - Spinal
    - integration center is in the spinal cord
  - Cranial
    - integration center is in the brain

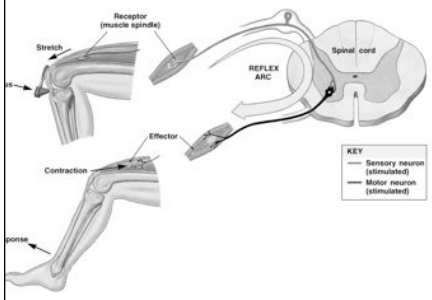
Reflex Arc

The reflex arc has 5 components



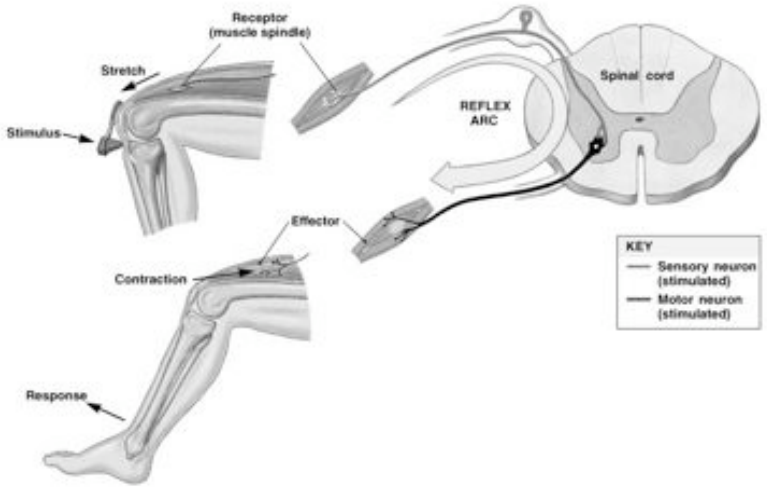
may be poly or monosynaptic

Stretch Reflex

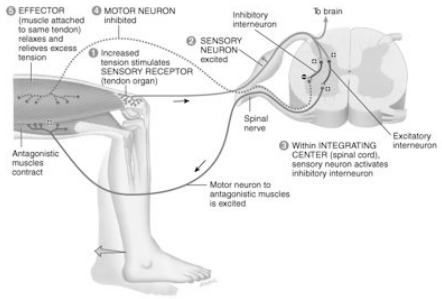


- Used to help posture and prevent sudden collapse of limbs
  - muscle spindle detects muscle stretch
  - sends excitatory afferent signal to spinal cord
  - efferent signal back to same muscle causing it to contract
  - reciprocal innervation

Stretch Reflex

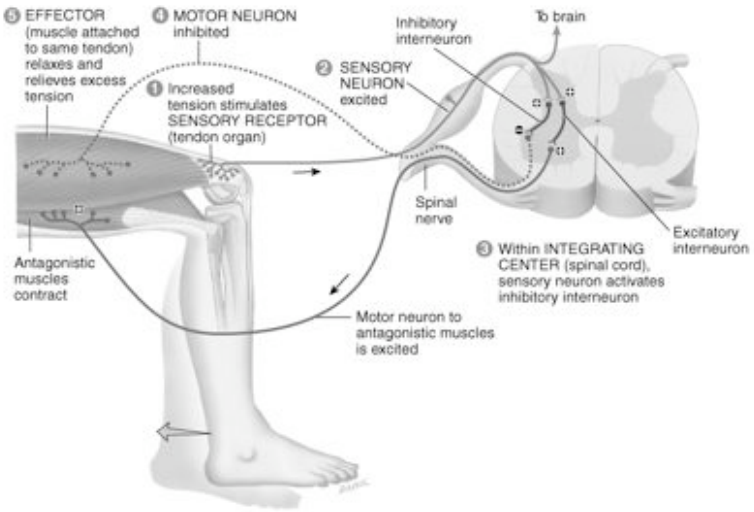


Tendon Reflex

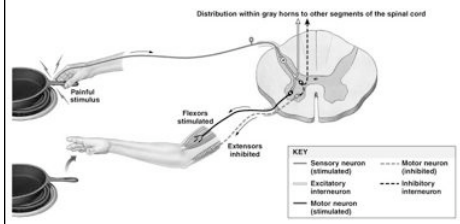


- Prevents overstretching of tendon and muscle
  - golgi tendon organ detects stretch
  - sends inhibitory afferent signal to spinal cord
  - efferent signal back to same muscle causing it to relax
  - reciprocal innervation

Tendon Reflex

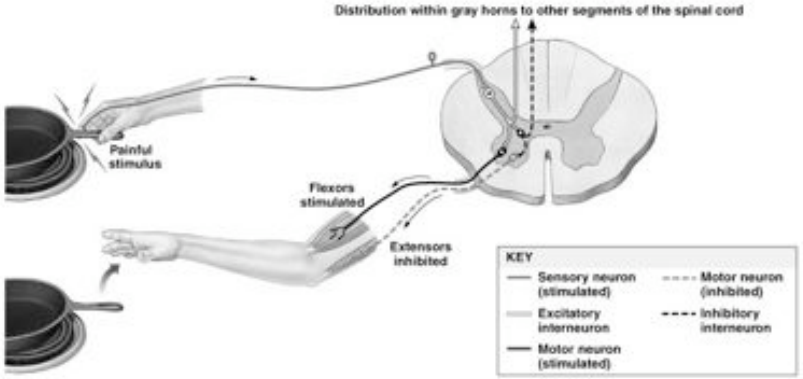


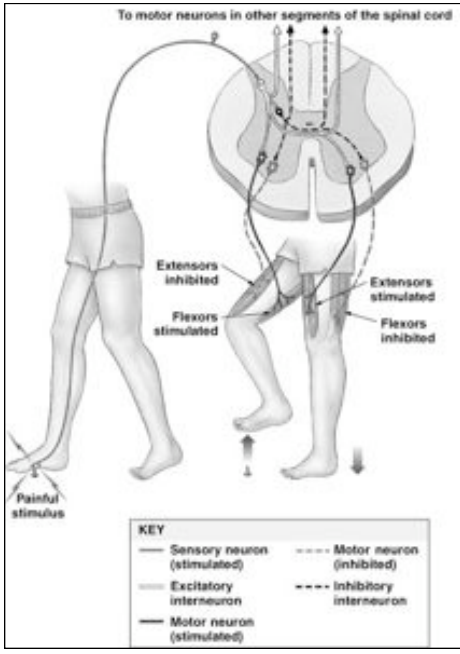
Withdrawal Reflex



- Quick withdrawal of extremity to prevent injury
  - nociceptor detects tissue damage
  - sends excitatory afferent signal to spinal cord
  - efferent signal back to muscle causing it to contract
  - reciprocal innervation

Withdrawal Reflex





Crossed Extensor Reflex

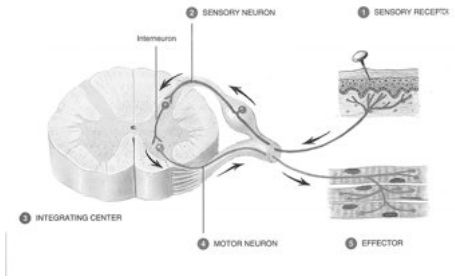
- Its the withdrawal reflex with the bonus of not falling down
  - nociceptor detects tissue damage
  - see diagram
  - reciprocal innervation

Plantar Reflex

- Cutaneous reflex that tests integrity of upper motor neurons of the corticospinal tract
  - tests L4-S2
  - indirectly tests function of primary motor cortex and corticospinal tracts
  - if neural function is normal toes point down
    - toes point up normally up to 1 year old (babinski sign)

Clinical Significance of Reflexes

- An intact reflex requires:
  - functioning sensory receptor
  - functioning afferent neuron
  - intact integrating center
  - functioning efferent neuron
  - functioning muscle



Grading Reflex Response

- Reflexes are graded according to response
  - 0 = no response
  - 1+ = hyporeflexic
  - 2+ = normal
  - 3+ = hyperreflexic
  - 4+ = clonus
- Changing reflexes
  - increases = hyperthyroidism, anxiety, stimulant drugs, spinal cord transection above the level.
  - decreases = hypothyroidism, spinal shock
  - example of upper and lower motor neurons

Lab Reflexes

- Biceps Reflex (stretch)
  - tap on insertion of biceps tendon, tests C5 & C6
- Patellar Tendon Reflex (stretch)
  - tap on patellar tendon, tests L2 - L4
  - test reflexes with and without upper neuron inhibition (grip test)
- Achilles Tendon Reflex (stretch)
  - tap on achilles tendon with foot dorsiflexed, tests S1 & S2