Chapter 13
Spinal Nerves, Ganglia, and Nerve Plexus
Spinal Nerves

- Posterior root
- Posterior ramus
- Posterior root ganglion
- Anterior ramus
- Anterior root
- Vertebral body
- Spinal cord
- Transverse process of vertebra
- Deep muscles of back
- Spinal nerve
- Meningeal branch
- Communicating rami
- Sympathetic ganglion
- Spinous process of vertebra
General Anatomy of Nerves and Ganglia

- Spinal cord communicates with the rest of the body by way of spinal nerves

- nerve = a cordlike organ composed of numerous nerve fibers (axons) bound together by connective tissue
  - mixed nerves contain both afferent (sensory) and efferent (motor) fibers
  - composed of thousands of fibers carrying currents in opposite directions
Anatomy of a Nerve

- Rootlets
- Posterior root
- Anterior root
- Spinal nerve
- Posterior root ganglion

- Fascicle
- Epineurium
- Perineurium
- Endoneurium
- Unmyelinated nerve fibers
- Myelinated nerve fibers
- Nerve fiber
- Blood vessels

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General Anatomy of Nerves and Ganglia

- nerves of peripheral nervous system are ensheathed in Schwann cells
  - forms neurilemma and often a myelin sheath around the axon
  - external to neurilemma, each fiber is surrounded by basal lamina and then a thin sleeve of loose connective tissue – endoneurium
  - fascicles – nerve fibers gathered in bundles
  - perineurium – wraps fascicles // composed of up to 20 layers of overlapping, squamous, epithelium-like cells
  - epineurium – bundles numerous fascicles that constitutes whole nerve // composed of dense irregular connective tissue // protects nerve from stretching and injury
- blood vessels penetrate connective tissue coverings // nerves have high metabolic rate and need plentiful blood supply
Classification of Nerve Fibers

- **sensory (afferent) nerves**
  - carry signals from sensory receptors to the CNS

- **motor (efferent) nerves**
  - carry signals from CNS to muscles and glands

- **mixed nerves**
  - consists of both afferent and efferent fibers
  - conduct signals in two directions

- both sensory and motor fibers can also be described as:
  - **somatic** or **visceral**
  - **general** or **special**
Anatomy of Ganglia in the PNS

• **ganglion** - cluster of neurosomas outside the CNS // enveloped in an endoneurium continuous with that of the nerve

• among neurosomas are bundles of nerve fibers leading into and out of the ganglion // posterior root ganglion associated with spinal nerves
Spinal Nerves

• 31 pairs of spinal nerves (mixed nerves)
  
  – 8 cervical nerves (C1 – C8) C1 between skull and atlas // others exiting at intervertebral foramen
  
  – 12 thoracic nerves (T1 – T12)
  
  – 5 lumbar nerves (L1 – L5)
  
  – 5 sacral nerves (S1 – S5)
  
  – 1 coccygeal nerve (Co)
Spinal Nerves

- proximal branches forming spinal nerves /// each spinal nerve has two points of attachment to the spinal cord
  - posterior (dorsal) root
    - sensory input to spinal cord
    - posterior (dorsal) root ganglion – contains the somas of sensory neurons carrying signals to the spinal cord
    - six to eight rootlets that emerge from the posterior horn of cord
Spinal Nerves

- anterior (ventral) root
  - motor output // exit out of spinal cord
  - six to eight rootlets leave spinal cord and converge to form anterior root
  - posterior & anterior roots merge to form spinal nerve proper that enters intervertebral foramen
- cauda equina
  - formed from roots that arise from L2 to Co
  - occupy lumbar cisterna
Spinal Nerves

- distal branches of spinal nerves /// distal to vertebral foramen
- the nerve divides into three branches:
  - anterior ramus – innervates the anterior and lateral skin and muscles of the trunk /// gives rise to nerves of the limbs
  - posterior ramus – innervates the muscles and joints in that region of the spine and the skin of the back
  - meningeal branch – re-enters the vertebral canal and innervates the meninges, vertebrae and spinal ligaments
Spinal Nerves and Plexuses

- Cervical nerves (8 pairs)
- Cervical enlargement
- Cervical plexus (C1–C5)
- Brachial plexus (C5–T1)
- Vertebra T1
- Thoracic nerves (12 pairs)
- Lumbar enlargement
- Lumbar plexus (L1–L4)
- Vertebra L1
- Lumbar nerves (5 pairs)
- L1
- L2
- L3
- L4
- Medullary cone
- L5
- Sacral nerves (5 pairs)
- Sacral plexus (L4–S4)
- S1
- S2
- S3
- S4
- S5
- Coccygeal nerves (1 pair)
- Coccygeal plexus (S4–Co1)
- Coccygeal nerves
- Sciatic nerve
- Cauda equina
- Intercostal (thoracic) nerves (T1–T12)
Anterior Rami Form Nerve Plexuses

(a) Anterolateral view
(b) Cross section
Mnemonic for subunits of the brachial plexus:
Risk Takers Don't Cautiously Behave.
Roots, Trunks, Divisions, Cords, Branches
(b) Distribution of nerves from brachial plexus
(b) Distribution of nerves from the sacral and coccygeal plexuses
(b) Distribution of nerves from lumbar plexus
Lumbar plexus projected to surface

(a) Origin of lumbar plexus
- Roots
- Anterior division
- Posterior division

From T12

Ilioinguinal
Genitofemoral
Lateral cutaneous nerve of thigh
Femoral
Accessory obturator (present in only about 10% of population)
Obturator
Sacral and coccygeal plexuses projected to surface

(a) Origin of sacral and coccygeal plexuses

- L4 contribution to femoral nerve
- Lumbosacral trunk
- Superior gluteal
- Inferior gluteal
- Nerve to piriformis
- Tibial
- Common fibular
- Sciatic
- Nerve to quadratus femoris and inferior gemellus
- Nerve to obturator internus and superior gemellus
- Pudendal
- Perforating cutaneous posterior cutaneous nerve of thigh

- Roots
- Anterior division
- Posterior division

- L4
- L5
- S1
- S2
- S3
- S4
- S5
- Coccygeal plexus
- Anococcygeal nerve
Erb-Duchenne palsy (waiter's tip)

Median nerve palsy

Wrist drop

Ulnar nerve palsy

Winging of right scapula

(c) Injuries to the brachial plexus
Spinal Nerve Injuries

- radial nerve injury // passes through axilla
  - crutch paralysis
  - wrist drop

- sciatic nerve injury
  - sciatica – sharp pain that travels from gluteal region along the posterior side of the thigh and leg to ankle
  - ninety percent of cases result from herniated intervertebral disc or osteoporosis of lower spine
  - Sometimes caused by men “sitting” on their wallets
Dissection of Spinal Nerve

- Posterior median sulcus
- Gracile fasciculus
- Cuneate fasciculus
- Lateral column
- Segment C5
- Cross section
- Arachnoid mater
- Dura mater
- Neural arch of vertebra C3 (cut)
- Spinal nerve C4
- Vertebral artery
- Spinal nerve C5:
  - Rootlets
  - Posterior root
  - Posterior root ganglion
  - Anterior root