Spinal Cord, Spinal Nerves, and Somatic Reflexes

- spinal cord
- spinal nerves
- somatic reflexes

Functions of the Spinal Cord

- conduction: bundles of fibers passing information up and down spinal cord, connecting different levels of the trunk with each other and with the brain
- locomotion: walking involves repetitive, coordinated actions of several muscle groups
- reflexes: central pattern generators are pools of neurons providing control of flexors and extensors that cause alternating movements of the lower limbs
- withdrawal of hand from pain: involves brain, spinal cord, and peripheral nerves

Damage to Spinal Cord

- accidents damage the spinal cord of thousands of people every year
  - paraplegia: paralysis of lower limbs
  - quadriplegia: paralysis of all four limbs
  - respiratory paralysis, loss of sensation or motor control
  - disorders of bladder, bowel, and sexual function
- damage to spinal cord from strokes or other brain injuries
  - hemiplegia: paralysis of one side of the body only

The Spinal Cord & Spinal Nerves

- Together with brain forms the CNS
- Functions
  - spinal cord reflexes
  - integration (summation of inhibitory and excitatory) nerve impulses
  - highway for upward and downward travel of sensory and motor information

Spinal Cord Protection

Protection: vertebral column, meninges, cerebrospinal fluid, and vertebral ligaments.
External Anatomy of Spinal Cord
- Flattened cylinder
- 16-18 inches long & 3/4 inch diameter
- In adult ends at L2
- Cervical enlargement
  - upper limbs
- Lumbar enlargement
  - lower limbs

Inferior End of Spinal Cord
- Conus medullaris
  - cone-shaped end of spinal cord
- Filum terminale
  - extension of pia mater
  - Anchors SC to the coccyx

Spinal Cord & Spinal Nerves
- Spinal nerves begin as roots
- Dorsal or posterior root is incoming sensory fibers
  - dorsal root ganglion (swelling) = cell bodies of sensory nerves
- Ventral or anterior root = outgoing motor fibers

Gray Matter of the Spinal Cord
- Gray matter is shaped like the letter H or a butterfly
  - contains neuron cell bodies, unmyelinated axons & dendrites
  - paired dorsal and ventral gray horns
- Central canal continuous with 4th ventricle of brain
Tracts of the Spinal Cord
- Function of tracts
  - highway for sensory & motor information
  - sensory tracts ascend
  - motor tracts descend
- Many tracts decussate
  - contralateral (origin/destination differ)
  - ipsilateral (origin/dest. Same side)
- Naming of tracts
  - indicates position & direction of signal
  - example = anterior spinothalamic tract
- impulses travel from spinal cord towards brain (thalamus)

Function of Spinal Tracts
- Spinothalamic tract
  - pain, temperature, deep pressure & crude touch
- Gracile fasciculus
  - proprioception, discriminative touch, two-point discrimination, pressure and vibration
- corticospinal & corticobulbar tracts
  - precise, voluntary movements
- Rubrospinal & vestibulospinal
  - programming automatic movements, posture & muscle tone, equilibrium & coordination of visual reflexes
Nerves & Connective Tissue Coverings

- Endoneurium = wrap each nerve fiber
- Perineurium = surrounds group of nerve fibers forming a fascicle
- Epineurium = covers entire nerve

Spinal Nerves

- 31 Pairs of spinal nerves
- All are mixed nerves!
- Named & numbered by cord level of their origin
  - 8 pairs of cervical nerves (C1 to C8)
  - 12 pairs of thoracic nerves (T1 to T12)
  - 5 pairs of lumbar nerves (L1 to L5)
  - 5 pairs of sacral nerves (S1 to S5)
  - 1 pair of coccygeal nerves

Branching of Spinal Nerve

- Spinal nerves formed from d & v roots
- Spinal nerves branch into d & v rami
  - dorsal rami supply skin & muscles of back

Ventral rami form plexus: supply anterior trunk & limbs
meningeal branches supply meninges, vertebrae & BV

Rami of Spinal Nerves

A Nerve Plexus

- Joining of ventral rami of spinal nerves to form nerve networks (plexuses)
- Found in neck, arm, low back & sacral regions
- T7 to T12 supply abdominal wall as well
Cervical Plexus
- Ventral rami of spinal nerves (C1 to C5)
- Supplies parts of head, neck, & shoulders
- Phrenic nerve (C3-C5) supplies diaphragm
- Damage to cord above C3 causes respiratory arrest

Phrenic Nerve
- Supplies diaphragm
- Damage to cord above C3 causes respiratory arrest

Brachial Plexus
- Ventral rami from C5 to T1
- Supplies shoulder & upper limb

Branches off Brachial Plexus
- Notice: Femoral and Obturator nerves
- Found anterior and medial to hip joint

Lumbar Plexus
- Ventral rami of L1 to L4
- Supplies abdominal wall, external genitals & parts of thigh
- Femoral nerve injury: inability to extend leg & loss of sensation in thigh

Branches of Lumbar Plexus
- Notice: Femoral and Obturator nerves
- Found anterior and medial to hip joint
Sacral Plexus
- Ventral rami of L4-L5 & S1-S4
- Anterior to the sacrum
- Supplies buttocks, perineum & part of lower limb
- Sciatic nerve = L4 to S3 supplies post thigh & all below knee

Branches of Sacral Plexus
- Note: Sciatic nerve origins

Sciatic Nerve Branches
- Common Peroneal nerve and Tibial nerve behind the knee
- Sciatic Nerve - may be sign of herniated disc

Dermatomes:
- Dermatome:
  - area of skin that sends sensory info to one spinal nerve
  - overlap up to 50%
  - sensory anesthesia requires 3 spinal nerves to be blocked
- Skin on face supplied by Cranial Nerve V

Spinal Reflexes
- Quick stereotyped, involuntary response of glands/muscles to stimuli
- Integration center for spinal reflexes is gray matter of spinal cord
- Examples
  - somatic reflexes result in skeletal muscle contraction
  - autonomic (visceral) reflexes involve smooth & cardiac muscle and glands.
    - heart rate, respiration, digestion, urination, & more
Muscle Spindle

Somatic reflex employs a Reflex Arc

- Specific nerve impulse pathway
- 5 components of reflex arc
  1. receptor
  2. sensory neuron
  3. integrating center
  4. motor neuron
  5. effector

The Flexor (Withdrawal) Reflex
The Crossed extension Reflex

The Tendon Reflex

- tendon organs – proprioceptors in a tendon near its junction with a muscle
- tendon reflex – in response to excessive tension on the tendon
  - inhibits muscle from contracting strongly
  - moderates muscle contraction