Central Nervous System: Part 2

1. Meninges
2. CSF
3. Spinal Cord and Spinal Nerves

Explain spinal cord anatomy, including gray and white matter and meninges (give the general functions of this organ).

Discuss the structure and functions of the spinal nerves and plexuses.

Describe the structural components of reflexes.
1. Cranial Meninges

Three layers:

1. **Dura mater** - strong, "tough mother"
   a. falx cerebri
   b. falx cerebelli
   c. tentorium cerebelli

2. **Arachnoid** - spidery, holds blood vessels

3. **Pia mater** - "delicate mother"

Note: Subdural hematoma
The meninges
2. CSF: Cerebrospinal Fluid

- Formation in ventricles by specialized ependymal cells of **choroid plexus** (~500 mL/day; total volume ~ 150 mL)

- **Functions**
  - transport medium (nutrients, waste)
  - shock absorption
  - buoyancy (floats the brain)

- CSF circulation: Ventricles → central canal → subarachnoid space

- An important diagnostic tool.
Hydrocephalus?
Arachnoid granulations: This is where the CSF produced in the choroid plexuses of the ventricles and which has circulated into the subarachnoid space is reabsorbed.
Meningitis: inflammation of meninges/CSF

- **Bacterial**
  - Relatively rare
  - Life threatening
  - Antibiotics

- **Fungal**

- **Viral**—most common
  - Younger
  - Self-resolving
Blood Brain Barrier (BBB)

- Tight Junctions in capillary endothelium prevent passive diffusion into the brain. Lots of Active Transport, especially of H₂O soluble compounds (think glucose).
- Fat soluble compounds readily pass the BBB
  - E.g. steroid hormones, ADEK
- Major role of astrocytes
- **3 areas in brain don’t have BBB**
  - portion of hypothalamus
  - pineal gland (in diencephalon)
  - choroid plexus
3. Spinal cord:

- Resides inside vertebral canal
  - Extends to L1/ L2
- 31 segments, each associated with a pair of dorsal root ganglia
- Two enlargements
  - Cervical and Lumbar
- Conus medullaris
- Cauda Equina
- Filum Terminale

Fig. 13-29
Gray matter expanded to incorporate more sensory input from limbs and more cell bodies for motor control of limbs
Lumbar Enlargement

See fig 14-1
Spinal Meninges

Three membranes surround all of CNS

1) **Dura mater** - "tough mother", strong. Note the Epidural Space.

2) **Arachnoid** - spidery looking, carries blood vessels, etc. Note the Subarachnoid space which contains CSF

3) **Pia mater** - "delicate mother", adheres tightly to surface of spinal cord
Transverse Section

Fig 13.30 Compare the spinal roots with the model of the vertebral column in the lab. Note that the dura covers both the dorsal and ventral roots.
Organization of Spinal Cord

**Gray matter - interior horns**
- posterior - somatic and visceral sensory nuclei
- anterior (and lateral) gray horns – somatic and visceral motor control
- gray commissures - axons carrying information from side to side

**White matter - tracts or columns**
- posterior white column -
- anterior white column
- lateral white column
- anterior white commissure

*functions*
- ascending tracts - sensory toward brain
- descending tracts - motor from brain
Sectional anatomy of spinal cord

Outer white part; inner gray butterfly
Lumbar Puncture
(= Spinal Tap)

For clinical examination of CSF or administration of radiopaque dyes, drugs and anesthetics

However: mostly “epidurals” for anesthetics
Organization of Spinal Nerves:

1. **Root** – inside vertebral canal
   a. dorsal sensory root with a ganglion
   b. ventral motor root

2. **Mixed spinal nerve**

3. **Rami**
   a. dorsal - mixed to skin and muscles of back
   b. ventral - mixed “spinal nerve” to ventrolateral body surfaces and limbs
   c. *white ramus communicans* motor ANS
   d. *gray ramus communicans* motor ANS
Reflexes

Fast, preprogrammed, inborn, automatic responses

Occur in the CNS at the spinal cord or brainstem levels (cranial nerves)

May be either monosynaptic or polysynaptic

All require
a. stimulus at receptor
b. sensory information relay
c. processing at CNS level
d. activation of motor response
e. response of peripheral effector
From interoceptors of back

From exteroceptors, proprioceptors of body wall, limbs

Dorsal root ganglion

Dorsal root

Somatic sensory

Visceral sensory

Rami communicantes

Ventral root

(b) Sensory fibers

From interoceptors of visceral organs

Somatic sensations

Visceral sensations
Postganglionic fibers to smooth muscles, glands, etc., of back

To skeletal muscles of back

Dorsal root ganglion

Dorsal root

Visceral motor

Ventral ramus

Spinal nerve

Dorsal ramus

Ventral root

Sympathetic ganglion

Sympathetic nerve

Rami communicantes

Gray ramus (postganglionic)

White ramus (preganglionic)

Postganglionic fibers to smooth muscles, glands, etc., of body wall, limbs

To skeletal muscles of body wall, limbs

Somatic motor commands

Visceral motor commands

Postganglionic fibers to smooth muscles, glands, visceral organs in thoracic cavity

Preganglionic fibers to sympathetic ganglia innervating abdominopelvic viscera

(a) Motor fibers
Ascending and Descending Tracts

- Somatosensory cortex
- Axons of third-order neurons
- Thalamus
- Cerebrum
- Medial lemniscus tract (axons of second-order neurons)
- Nucleus gracilis
- Nucleus cuneatus
- Medulla oblongata
- Fasciculus gracilis (axon of first-order sensory neuron)
- Joint stretch receptor (proprioceptor)
- Pain receptors
- Cervical spinal cord
- Spinothalamic tract (axons of second-order neurons)
- Temperature receptors
- Lumbar spinal cord
- Dorsal column pathway
- Spinothalamic pathway
- Axon of first-order neuron
- Muscle spindle (proprioceptor)

- Pyramidal cells
- Primary motor area of cerebral cortex
- Internal capsule
- Cerebrum
- Cerebral peduncle
- Medulla oblongata
- Ventral corticospinal tract
- Pyramids
- Decussation of pyramid
- Lateral corticospinal tract
- Medulla oblongata
- Ventral corticospinal tract
- Cervical spinal cord
- (a) Pyramidal (lateral and ventral corticospinal) pathway
- (b) Rubrospinal pathway
- Pyramids
- Decussation of pyramid
- Medulla oblongata
- Ventral corticospinal tract
- Cervical spinal cord
- (a) Pyramidal (lateral and ventral corticospinal) pathway
- (b) Rubrospinal pathway

Copyright © 2008 Pearson Education, Inc., publishing as Benjamin Cummings
Dermatomes

Sensory innervations by specific spinal nerves ⇒ Each pair of spinal nerves monitors specific region of body surface.