Homework

- PreLab 3
- HW 3-4: Spinal Nerve Plexus Organization
The Nervous System

SPINAL CORD
The Spinal Cord

- Continuation of CNS inferior to foramen magnum
  - Simpler
  - Conducts impulses to and from brain
    - Two way conduction pathway
  - Reflex actions
The Spinal Cord

- Passes through vertebral canal
  - Foramen magnum $\rightarrow$ L2
  - Conus medullaris
  - Filum terminale
  - Cauda equina

Spinal Canal
(a) The spinal cord and its nerve roots, with the bony vertebral arches removed. The dura mater and arachnoid mater are cut open and reflected laterally.
The Spinal Cord

- **Spinal nerves**
  - 31 pairs

- **Cervical and lumbar enlargements**
  - Nerves serving the upper & lower limbs emerge here
(a) The spinal cord and its nerve roots, with the bony vertebral arches removed. The dura mater and arachnoid mater are cut open and reflected laterally.
The Spinal Cord

- Protection
  - Bone
  - Meninges
  - CSF
- Spinal tap-inferior to L2 vertebra
Figure 12.30

- Ligamentum flavum
- Lumbar puncture needle entering subarachnoid space
- Supra-spinous ligament
- Filum terminale
- Cauda equina in subarachnoid space
- Dura mater
- Arachnoid matter
- Intervertebral disc

T₁₂
L₅
The Spinal Cord

- Cross section
  - Central gray matter
  - Cortex of white matter
(a) Cross section of spinal cord and vertebra

- Epidural space (contains fat)
- Subdural space
- Subarachnoid space (contains CSF)
- Pia mater
- Arachnoid mater
- Dura mater
- Bone of vertebra
- Dorsal root ganglion
- Body of vertebra
- Spinal meninges

Figure 12.31a
(b) The spinal cord and its meningeal coverings
The Spinal Cord

- **Gray matter**
  - Site of association neurons & motor neuron cell body synapses
  - Regions
    - Dorsal (posterior) horns
    - Ventral (anterior) horns
    - Lateral horns (only in thoracic and lumbar regions)
The Spinal Cord

- **White matter**
  - Myelinated ascending (sensory) & descending (motor) tracts
  - Tracts located in 3 white columns (funiculi) on each side
    1. Dorsal (posterior),
    2. Lateral
    3. Ventral (anterior)
Complete CNS 23, #4

(b) The spinal cord and its meningeal coverings
The Spinal Cord

- **Spinal tracts**
  - Multineural pathways
  - Most decussate (cross over)
  - Most exhibit somatotopy
  - Pathways are paired symmetrically
Pyramidal (lateral and ventral corticospinal) pathways

(a)
The Spinal Cord

- **Naming of tracts**
  - Many are named for origin and termination
  - Example
    - Anterior (ventral) spinothalamic tract
The Spinal Cord

- **Ascending Pathways**
  - Consists of two or three neurons
    - First order
    - Second order
    - Third order
The Spinal Cord

- **Ascending Pathways**
  - First-order neuron
    - Receptor to spinal cord
    - Synapses with second-order neuron
  - Examples
    - Posterior (dorsal) column
      - Receptor to medulla
    - Spinothalamic tract
      - Receptor to spinal cord
The Spinal Cord

- **Ascending Pathways**
  - Second-order neuron
    - Interneuron
    - Synapse with third-order neuron
  - Examples
    - Posterior (dorsal) column
      - Medulla to thalamus (decussates in medulla)
    - Spinothalamic tract
      - Spinal cord to thalamus (decussates in spinal cord)
The Spinal Cord

- **Ascending Pathways**
  - Third-order neuron
    - Interneuron
  - Examples
    - Posterior (dorsal) column
      - Thalamus to cortex
    - Spinothalamic tract
      - Thalamus to cortex
The Spinal Cord

- **Ascending pathways**
  - Two pathways transmit somatosensory information to the sensory cortex via the thalamus
    1. Posterior (dorsal) column
    2. Spinothalamic pathways
Ascending tracts

- Fasciculus gracilis
- Fasciculus cuneatus
- Dorsal white column
- Dorsal spinocerebellar tract
- Ventral spinocerebellar tract
- Lateral spinothalamic tract
- Ventral (anterior) spinothalamic tract

Descending tracts

- Ventral white commissure
- Lateral reticulospinal tract
- Lateral corticospinal tract
- Rubrospinal tract
- Medial reticulospinal tract
- Ventral corticospinal tract
- Vestibulospinal tract
- Tectospinal tract
Figure 12.34b (2 of 2)

- Lateral spinothalamic tract (axons of second-order neurons)
- Pain receptors
- Axons of first-order neurons
- Temperature receptors
- Medulla oblongata
- Cervical spinal cord
- Lumbar spinal cord

(b) Spinothalamic pathway
Figure 12.34b

Primary somatosensory cortex
Axons of third-order neurons
Thalamus

Cerebrum

Midbrain

Cerebellum

Pons

(b) Spinothalamic pathway
Figure 12.34a (2 of 2)

- Medulla oblongata
- Fasciculus cuneatus (axon of first-order sensory neuron)
- Fasciculus gracilis (axon of first-order sensory neuron)
- Axon of first-order neuron
- Muscle spindle (proprioceptor)
- Joint stretch receptor (proprioceptor)
- Cervical spinal cord
- Medial lemniscus (tract) (axons of second-order neurons)
- Nucleus gracilis
- Nucleus cuneatus
- Dorsal spino-cerebellar tract (axons of second-order neurons)
- Lumbar spinal cord
- Touch receptor

(a) Spinocerebellar pathway
(b) Dorsal (posterior) column
Primary somatosensory cortex
Axons of third-order neurons
Thalamus

Cerebrum
Midbrain
Cerebellum
Pons

(a) Spinocerebellar pathway  Dorsal (posterior) column
The Spinal Cord

- **Descending pathways & tracts**
  - Deliver efferent impulses from the brain to the spinal cord
    1. Direct pathways = pyramidal tracts
    2. Indirect pathways (extrapyramidal) = all others
The Spinal Cord

- **Pyramidal Tracts**
  - From primary motor cortex to cord
  - Involve two neurons:
    1. Upper motor neurons (1\textsuperscript{st} order)
       - Cortex to cord (decussate in pyramids or cord)
    2. Lower motor neurons (2\textsuperscript{nd} order)
       - Spinal cord to muscle
       - Innervate skeletal muscles (voluntary)
Pyramidal cells (upper motor neurons)

Primary motor cortex

Internal capsule

Cerebral peduncle

Midbrain

Cerebellum

Pons

(a) Pyramidal (lateral and ventral corticospinal) pathways
(a) **Pyramidal (lateral and ventral corticospinal) pathways**

- **Ventral corticospinal tract**
- **Pyramids**
- **Decussation of pyramids**
- **Lateral corticospinal tract**
- **Skeletal muscle**
- **Somatic motor neurons (lower motor neurons)**

**Medulla oblongata**

**Cervical spinal cord**

**Lumbar spinal cord**
The Spinal Cord

- Expyramidal (indirect) tracts
  - Various CNS regions (avoiding pyramids) to cord
  - Impulses regarding unconscious motor control
  - Posture and balance
  - Involve two neurons:
    1. Upper motor neurons (1\textsuperscript{st} order)
       - Subcortex or pons (decussate) to cord
    2. Lower motor neurons (2\textsuperscript{nd} order)
       - Spinal cord to muscle
       - Innervate skeletal muscles (involuntary)
An extrapyramidal pathway

- Cerebrum
- Midbrain
- Cerebellum
- Pons
- Red nucleus

(b) Rubrospinal tract
Rubrospinal tract

Medulla oblongata

Cervical spinal cord

(b) Rubrospinal tract
The Spinal Cord

- **Motor neuron damage**
  - Damage to LMN
    - Flaccid paralysis
  - Damage to UMN
    - Spastic paralysis