**Title and Focus of Activity:** Neurologic pathways laboratory activity

*Linking foundational and clinical sciences*

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**Course Information:**

Neuroscience I; 5 units; First year, Second semester

**Learning Activity Description:**

Context/Purpose: The activity is meant to reinforce the location of the anatomical pathways most typically assessed in a neurologic exam: 1) the dorsal column medical lemniscus pathway which carries information regarding discriminative touch, proprioception, kinesthesia, and vibration; 2) the anterolateral system (AKA spinothalamic pathway) which carries the sensations of itch, tickle, pain, temperature, and crude touch; and the descending motor pathway which allows for isolated, volitional movement and involves the 3) lateral corticospinal tract and the 4) lower motor neuron. Knowing the location of the neurons involved in these pathways provides the foundational knowledge inherent to understanding neurologic diagnosis and expectant symptoms resulting from supratentorial, posterior fossa, spinal cord, or peripheral level nervous system damage.

Instructions to Students:

On the cross-section of the nervous system found on page 209 in Neuroanatomy in Clinical Context, 9e. An Atlas of Structures, Sections, Systems, and Syndromes by DE Haines (Wolters Kluwer, 2015), draw the pathways indicated in the case scenario. Label the structures as indicated below. Complete the problem-solving activity that follows.

Case scenario:

Marvin stepped on a tack with his LEFT foot. Draw the afferent pathway most likely to be activated by this stimulus beginning with a receptor and ending in the cerebral cortex.

Marvin sat down and he felt for the tack with his LEFT hand. Draw the afferent pathway (beginning with a receptor and ending in the cerebral cortex) most active in his left hand to allow him to precisely feel for the tack in his foot.

Since Marvin is right-handed, he removed the tack with his RIGHT hand. Draw the pathway of the two efferent neurons that were active to allow him to voluntarily and in an isolated, controlled manner use his hand to complete this activity.

For each pathway (when/if applicable), label:

1. The origin of the pathway
2. The termination of the pathway
3. The receptor
4. The sensory neuron fiber type
5. The Upper motor neuron
6. The Lower motor neuron
7. Where synapses occur (be specific)
8. Where axons cross midline (be specific)
9. The specific name of the pathway in which axons are traveling (if there is one).

Problem-solving:

The following week, Marvin was throwing javelins with his sister. She accidentally threw one at him while his back was turned. It cut through the RIGHT half of his spinal cord at C5. What functions/abilities will Marvin lose BELOW C5 and on WHICH SIDES(S) of his body will he lose those functions/abilities? [Hint: use your drawing to problem solve which pathways are affected. The injury may affect (a) pathway(s) on the cut side which were not necessarily drawn in your picture but exist on that side of the spinal cord nonetheless.]

Time for student to complete the activity:

Preparation for activity outside of/before class: Up to 2 hours; Class time completion of the activity: Up to 2 hours

Readings/other preparatory materials:

H Blumenfeld. Neuroanatomy through Clinical Cases. Sunderland: Sinauer Associates, Inc. 2010.

Preparatory reading: Pages 224-237, 276-282.

Reference pages to review for the clinical problem during the activity: 241-249.

DE Haines. Neuroanatomy in Clinical Context, 9e. An Atlas of Structures, Sections, Systems, and Syndromes. Philadelphia: Wolters Kluwer. 2015.

Preparatory reading: 192-193, 196-197, 210-211

The blank template from page 209 or 225 will be needed for the drawing.

Reference pages to review during the activity include 108-109, 190-199, 210-213

Learning Objectives:

* 1. On a cross-section of the human nervous system, the student will be able to draw and label the
		1. parts of the neurologic pathway that carries pain and temperature.
		2. parts of the neurologic pathway that carries proprioception/vibration/discriminative touch.
		3. parts of the motor pathway responsible for fine, volitional motor control.
	2. When given a neurologic problem involving the disruption of the above pathways, the student will determine the symptoms expected due to pathway disruption.

Methods of evaluation of student learning:

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| **Structure** | **Labeled?** | **Points possible** |
| Origin of the dorsal column medical lemniscus pathway | Left hand | (1) |
| Origin of the anterolateral system pathway | Left foot | (1) |
| Origin of the lateral corticospinal tract | Left precentral gyrus | (1) |
| Origin of the alpha motor neuron | Right ventral horn | (1) |
| Termination of the dorsal column medical lemniscus | Right post-central gyrus | (1) |
| Termination of the anterolateral system | Right post-central gyrus | (1) |
| Termination of the lateral corticospinal tract | Right ventral horn | (1) |
| Termination of the alpha motor neuron | Right hand muscle | (1) |
| Receptor of the dorsal column medical lemniscus pathway | Meissner’s corpuscle, Merkel’s receptor, pacinian corpuscle, ruffini ending, or hair receptor | (1) |
| Receptor of the anterolateral system  | Bare (free) nerve ending | (1) |
| Sensory neuron fiber type of the dorsal column medical lemniscus pathway | A-ᵦ (A beta) | (1) |
| Sensory neuron fiber type of the anterolateral system  | A-∂ (A delta) or C | (1) |
| Upper motor neuron (lateral corticospinal tract neuron) | (correct neuron must be labelled) | (1) |
| Lower motor neuron (alpha motor neuron) | (correct neuron must be labelled) | (1) |
| 1st order neuron – 2nd order neuron synapse for the dorsal column medial lemniscus pathway | Nucleus cuneatus | (1) |
| 2nd order neuron – 3rd order neuron synapse for the dorsal column medial lemniscus pathway | Ventral Posterior Lateral Nucleus of the Thalamus | (1) |
| 1st order neuron – 2nd order neuron synapse for the anterolateral system | Dorsal horn | (1) |
| 2nd order neuron – 3rd order neuron synapse for the anterolateral system | Ventral Posterior Lateral Nucleus of the Thalamus | (1) |
| Upper motor neuron onto the lower motor neuron | Ventral horn | (1) |
| Dorsal column medial lemniscus pathway crosses midline | Internal arcuate fibers | (1) |
| Anterolateral system crosses midline | Anterior white commissure | (1) |
| Lateral corticospinal tract crosses midline | Pyramidal decussation | (1) |
| The axonal pathway of the first order neuron of the dorsal column medial lemniscus pathway in the spinal cord. | Dorsal column or fasciculus cuneatus | (1) |
| The axonal pathway of the second order neuron of the dorsal column medial lemniscus pathway in the brainstem. | Medial lemniscus | (1) |
| Anywhere along the axonal pathway of the anterolateral system | Anterolateral system | (1) |
| The axonal pathway of upper motor neuron before it crosses (above the bottom of the brainstem) | Corticospinal tract | (1) |
| The axonal pathway of the upper motor neuron after it crosses (anywhere in the spinal cord) | Lateral corticospinal tract | (1) |
|  |  |  |
| **Structure** | **Drawn correctly?** |  |
| 1st order neuron dorsal column medial lemniscus pathway | (Should begin in the left hand, contain a dorsal root ganglion, enter via the dorsal horn in the cervical enlargement, directly move into the dorsal column (fasciculus cuneatus) and end in the nucleus cuneatus all on the left side of the nervous system.) | (2) |
| 2nd order neuron dorsal column medial lemniscus pathway | (Should begin in the left nucleus cuneatus, cross midline at that level, ascend in the medial lemniscus, and end in the thalamus.) | (2) |
| 3rd order neuron dorsal column medial lemniscus pathway | (Should begin in the thalamus, exit into the posterior limb of the internal capsule and end in the supero-lateral part of the post-central gyrus.)  | (2) |
| 1st order neuron anterolateral system | (Should begin in the left foot, contain a dorsal root ganglion, enter the lumbosacral enlargement of the spinal cord and end in the dorsal horn.) | (2) |
| 2nd order neuron anterolateral system | (Should begin in the left dorsal horn, cross midline in the anterior white commissure and then ascend through the anterolateral column/system through the spinal cord and brainstem, ending in the thalamus.) | (2) |
| 3rd order neuron anterolateral system | (Should begin in the thalamus, exit into the posterior limb of the internal capsule and end in the medial part of the post-central gyrus.) | (2) |
| Lateral corticospinal tract neuron | (Should begin in the supero-lateral part of the pre-central gyrus, run through the posterior limb of the internal capsule and lateral aspect of the brainstem, cross midline at the very bottom of the brainstem and continue to descend to the lateral aspect of the cervical spinal cord, ending in the ventral horn of the cervical spinal cord.) | (2) |
| Alpha motor neuron | (Should begin in the ventral horn of the right side of the spinal cord in the cervical enlargement, exit through the ventral surface of the spinal cord where the ventral root would be, and run in a peripheral nerve, ending in a muscle in the right hand.) | (2) |
|  |  |  |
| **Problem-solving:****Symptoms** | **Location** |  |
| Lost vibration, proprioception, kinesthesia, discriminative touch  | Right side, C5 and below | (3) |
| Loss of fine, volitional motor control; spasticity, increased reflexes, up-going Babinski | Right side, C5 and below | (3) |
| Loss of pain, temperature, itch, tickle | Left side, C5 and below | (3) |
| Total |  /52 |