CEREBELLUM

Objectives:

1. What are the main manifestations of cerebellar disease or disease of input or output pathways?
2. Explain why the statement, "all proprioception is in the dorsal columns" is incorrect.
3. Two terms are similar but the pathology is different. Explain the difference between sensory ataxia and cerebellar ataxia. In which situation would you have a positive Romberg test.

Overview:
The Cerebellum is one of three major systems for motor control.
1. Corticospinal / Corticobulbar System = "Pyramidal Tract"
2. Cerebellum
3. Basal Ganglia

1. The cerebellum is not necessary for perception.
2. The cerebellum is not necessary for movement.
3. Cerebellar destruction results in no sensory impairment.
4. Cerebellar destruction results in no loss of muscle strength.
5. Cerebellum does not end on motor neurons or project to spinal cord.
6. Cerebellar destruction does disrupt coordination involved with balance, eye movements, muscle tone (both alpha and gamma), and limb control.
7. Consider the cerebellum a comparator of:
   a. Intention (cortical command)
   b. Performance (spinal cord feedback)
8. Consider the cerebellum a comparator of experience that can influence the two major descending systems:
   a. Motor cortex descending motor systems = corticospinal tract
   b. Brainstem descending motor systems (vestibulospinal and reticulospinal tracts)
10. Advises the cortex when movement can "start".
11. The cerebellum selects and coordinates timing, duration, and amplitude. Helps learn new motor skills or modify old ones.
From Neurologic exam website.
I. EXTERNAL FEATURES
A. Located in Posterior Cranial Fossa
   1. Below tentorium
   2. Above IV ventricle
   3. Tonsil on inferior surface is above the foramen magnum

C. Three Peduncles Attach Cerebellum to Brain Stem. See diagram bottom p 4
   1. **Inferior CP** mainly **input** paths = ICP
      a. Spinocerebellar tracts from *ipsilateral* spinal cord. Information from
         Golgi tendon organs, muscle spindles, cutaneous receptors, joint capsules,
         and ligaments. **Unconscious proprioception**.
      b. Vestibular information from VIII **n.** and vestibular nuclei
         (*ipsilateral*).
   2. **Middle CP** mainly **input** = MCP
      a. Pontine nuclei receive corticopontine fibers from *all areas* of the cerebral
         cortex of same side.
      b. **Pontine nuclei** project to the cerebellum of the *opposite* side
      c. Therefore the Right motor cortex works with the left cerebellum.
   3. **Superior CP** main **output** path = SCP
      Majority of peduncle is composed of axons leaving the cerebellum and
      going to: **Thalamus** (ventral lateral nucleus)

From The Digital Anatomist
Interactive Brain Syllabus. John Sundsten and Kate Mulligan, Univ.Washington
School of Medicine. 1998 ©
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II. Three major anatomical regions each with overlapping inputs and different outputs. Therefore, lesions in each region result in a different constellation of symptoms or deficits. These are summarized below.

<table>
<thead>
<tr>
<th>REGIONS*</th>
<th>FUNCTIONS</th>
<th>DYSFUNCTION</th>
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<tbody>
<tr>
<td>1. Axial and proximal Posture for equilibrium</td>
<td>Disequilibrium when sitting = titubation</td>
<td>Truncal ataxia,</td>
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<td>Vestibular connections = (Flocculonodular lobe)</td>
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<tr>
<td>Spinal cord connections (Anterior lobe, vermis)</td>
<td>Posture, especially support for gait and locomotion. Tone. Lower Limb muscle control</td>
<td>Ataxia of gait (trunk and leg muscle) Ataxia = uncoordinated movements not due to loss of strength, sensation or tone: Dysemetria, Dyssynergia</td>
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<tr>
<td>Cerebral Hemisphere= programming and initiating movements (Lateral hemisphere) Posterior Lobe</td>
<td>Participates with premotor cortex in</td>
<td>Ataxia of extremities: upper more than lower</td>
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<td>Phasic triggering of programs for speech Learning and storage of Skilled movements</td>
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Principal Cerebellar Inputs

Left Cerebral Cortex

Corticobulbar Fibers
Corticospinal Fibers

Corticopontine fibers in cerebral peduncle

Modified from Haines, 1997 (simplified)
III. SUMMARY OF PRINCIPAL CEREBELLAR INPUTS

A. VESTIBULAR
1. Primary sensory neuron = vestibular ganglion cell
2. Terminates in the vestibular nuclei or go straight to the cerebellum to cerebellum
3. Terminate in the region called the **Floculonodular lobe**.

B. SPINAL CORD
1. Primary sensory neurons for legs carry information from muscle spindles, Golgi tendon Organs, joint capsules
2. Synapse on second order neurons in cord
3. Second order neurons form the **Dorsal Spinocerebellar Tract** and ascend on the ipsilateral side to the cerebellum. They enter the cerebellum through the inferior cerebellar peduncle (ICP) and terminate in the **anterior lobe, vermis**
4. Note that the spinal cord works with the **cerebellum of the same side**.

C. CEREBRAL CORTEX (VIA THE PONTINE NUCLEI)
1. Originate in cells in all areas of the cerebral cortex and descend in the internal capsule (on either side of the corticospinal tract in the cerebral peduncle).
2. Axons terminate on cells in the pontine nuclei
3. Pontine cells send their axons **across** the midline and enter the opposite middle cerebellar peduncle (MCP) especially the lateral part of the hemispheres.
4. Note that the cerebral cortex works with the cerebellum of the **opposite side**.

IV. BASIC PLAN OF CEREBELLAR CORTEX — CEREBELLAR HISTOLOGY
Refer to textbook if you are really interested!
V. Cerebellar Output to the Premotor Cortex

Decussation of SCP

Thalamocortical Radiations

V. L. Thal.