Lecture 25 -- Cerebellum -- Martin

Lecture Plan
1) Cerebellar clinical signs
2) functional anatomy (mediolateral zones)
3) cerebellar functions

Cerebellar clinical signs (PNS: p. 849-850; Fig. 42-16)
1) hypometria and delayed movement onset
2) ataxia
3) impairments in rapid alternating movements

Functional anatomy of the cerebellum

Motor hierarchy
• influences motor behavior not by driving motoneurons directly, but rather by its influence on the motor pathways
• Cerebellum-neither high nor low, but all levels

Anatomy of the cerebellum (fig. 42-1, 2, 3)
Cortex—folia, many many neurons
- Anterior lobe (limbs and trunk)
- Posterior lobe (limbs and trunk)
- Flocculonodular lobe

3 pairs of deep nuclei (fastigial, interposed, dentate)
Peduncles—Inputs and outputs—superior, middle, and inferior

Cerebellar inputs (Fig. 42-4-6)
- Climbing fibers, from inferior olivary nucleus
- Mossy fibers, from various sources (spinal cord, vestibular nuclei, pontine nuclei, etc.)

Input-output organization
- Inputs directed both to deep nuclei and cortex
- Cortical output from Purkinje cells only; INHIBITORY
- Purkinje cells project to deep nuclei (and vestibular nuclei)
- Deep nuclei (EXCITATORY) project to motor systems

Medio-lateral cerebellar zones and their connections
1. Spinocerebellum (p. 841-844)
   - Vermis and fastigial nucleus
   - Intermediate hemisphere and interposed nuclei
2. Cerebro-cerebellum (p. 845-847)
   - Lateral hemisphere and dentate nucleus
3. Vestibulocerebellum (pg. 841)
   - Flocculonodular lobe and vestibular nuclei

Cerebellar functions
1) Anticipatory control (pg. 843-844; Figure 42-13)
2) Motor learning and adaptation (p. 847-849)
   - Defects in adapting movements—controlling movements in a flexible way to better suit the task
3) Role of cerebellum in motor cognitive functions and emotions
   - Complex motor strategies
Active tactile explorations
Cerebellar cognitive affective disorder

Overall Conclusions
• Unlike pyramidal lesions, which produce weakness/paralysis, cerebellar lesions produce disorders of coordination, learning, and motor cognition
• Role in automating movements, adapting movements to task demands
• Purely mental processes underlying movement control and possibly independent
• Cognition and emotions??
• No single function: mostly motor, but functions may apply to many types of behavior

Cerebellar Cortex Circuitry Addendum

2 principal excitatory inputs

Climbing fibers
Mossy fibers

Cerebellar cortex excitatory circuits

Inferior olivary nucleus $\rightarrow$ Climbing fiber $\rightarrow$ Purkinje cells

various nuclei $\rightarrow$ Mossy fibers $\rightarrow$ Granule cells (Parallel fibers) $\rightarrow$ Purkinje cells

Key Points:

Cerebellar circuitry—cortical and deep nuclei—same for different anatomical divisions

Functional distinctions based on different inputs and outputs rather than different circuitry

Purkinje cell is the output neuron of the cerebellar cortex; and is inhibitory

One cerebellar excitatory neuron (granule cell), rest are inhibitory

Neurons of the cerebellar cortex:

Projection (inhibitory): Purkinje projects to deep nuclei
Excitatory interneuron: Granule synapse on Purkinje neuron
Inhibitory interneurons: Basket, Golgi, Stellate synapse on Purkinje neurons

Relevant reading: ch. 42 in “Principles”