

S34. CEREBELLUM

2017



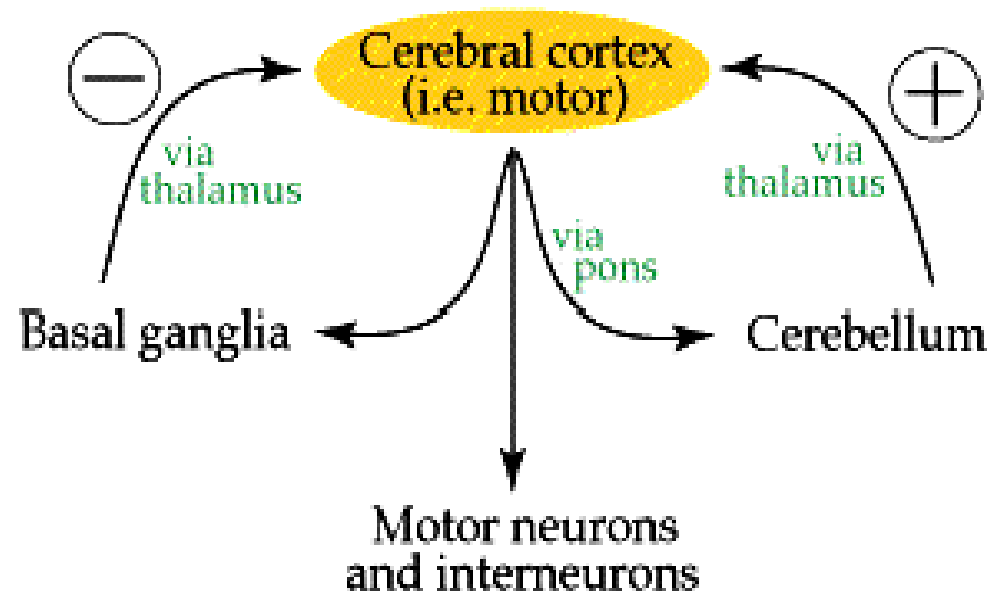
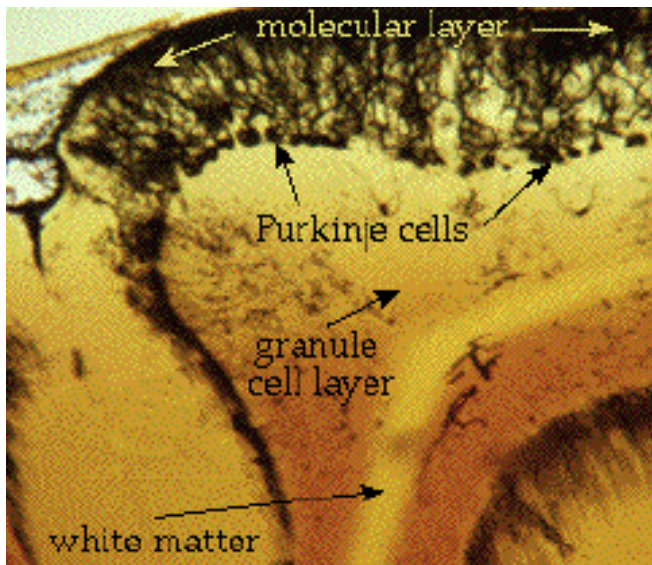
Joanne Wojcieszek, MD

SLO 49

Describe the functional anatomy of the cerebellum and neurologic signs/symptoms, pathophysiology, neuroimaging, medical treatment, and neurosurgical procedures for cerebellar disorders

The Treasure at the Bottom of the Brain

Henrietta C. Leiner and Alan L. Leiner



Cerebellum: *midsagittal view*

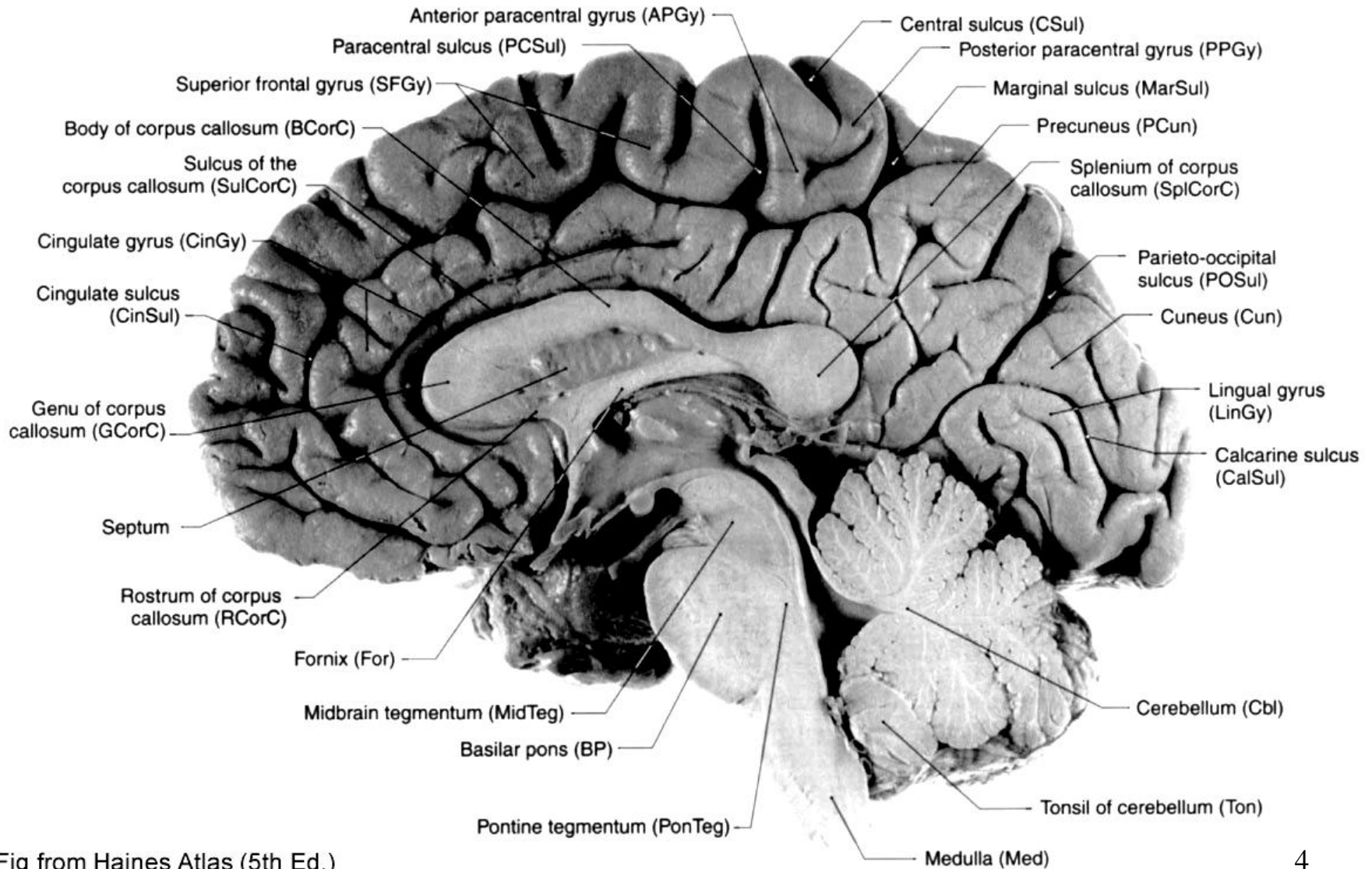
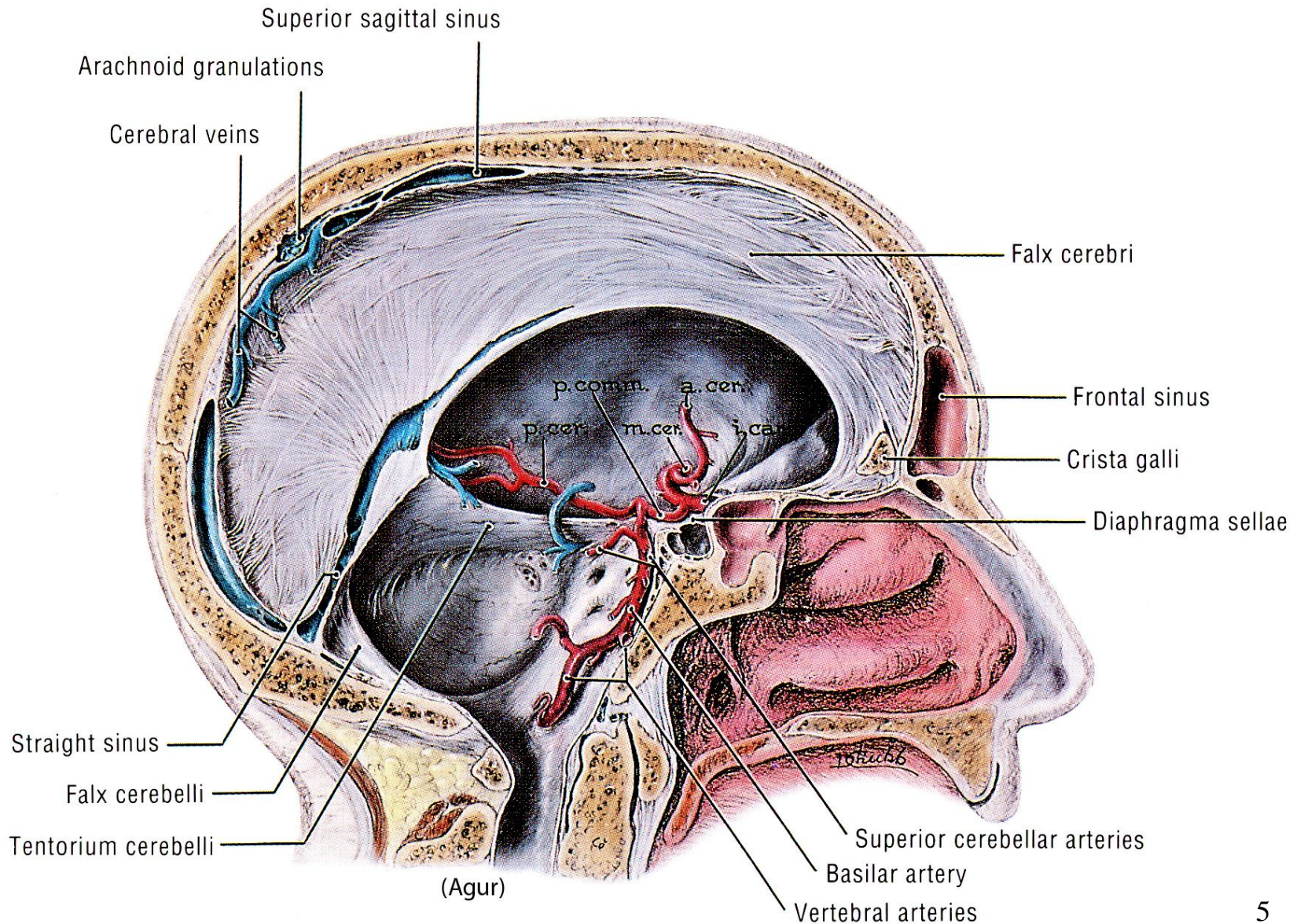


Fig from Haines Atlas (5th Ed.)

Cerebellar Tentorium



Cerebellar Function

cerebellum is important for:

- coordination of voluntary movements**
 - Cortico-ponto cerebellar fibers**

- control of posture and equilibrium**
 - Connection with vestibular system**



Cerebellar Dysfunction

What are the symptoms ?

Clumsiness, imbalance, slurred speech and dizziness

SIGNS

Ataxia

Dysarthria

Nystagmus

Intention tremor

Dysmetria

Inability to tandem

Dysdiadochokinesis

Hypotonia (not very important)

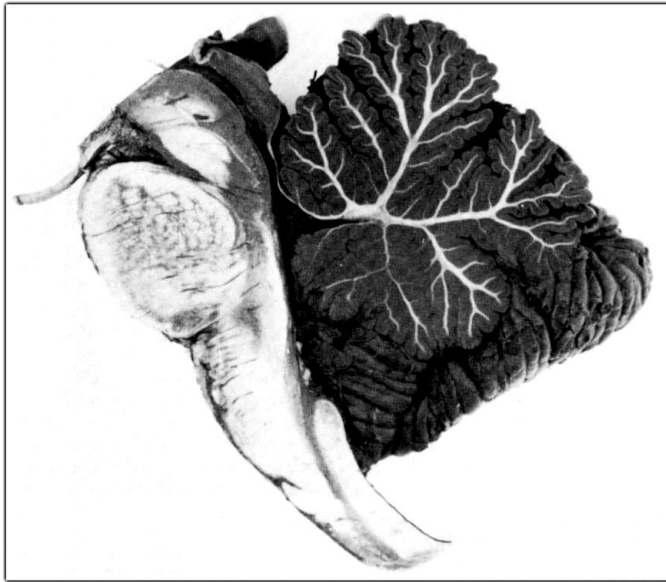
**What animal reminds us
of the external surface
of the cerebellum?**



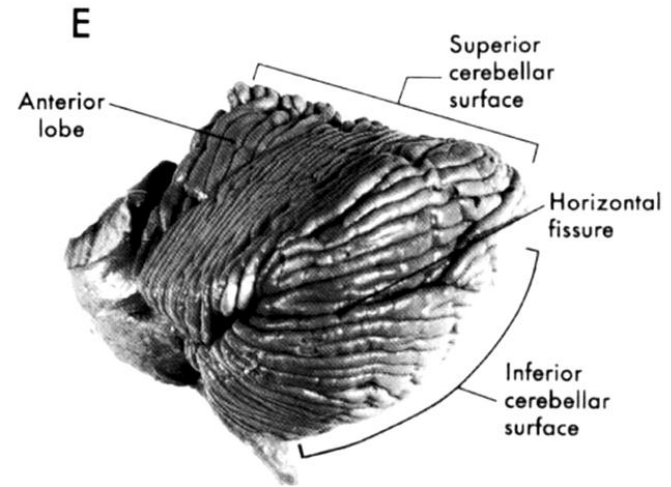
Cerebellar Signs

- ❑ Cerebellar dysfunction is **ipsilateral**
- ❑ A lesion in the **left** cerebellum causes **left** body incoordination

Cerebellar Surface: *parts*



Cerebellar surface in the median plane. The cut surface has been stained by a method that differentiates gray matter (*dark*) and white matter (*light*). ($\times 1\frac{1}{2}$)



A

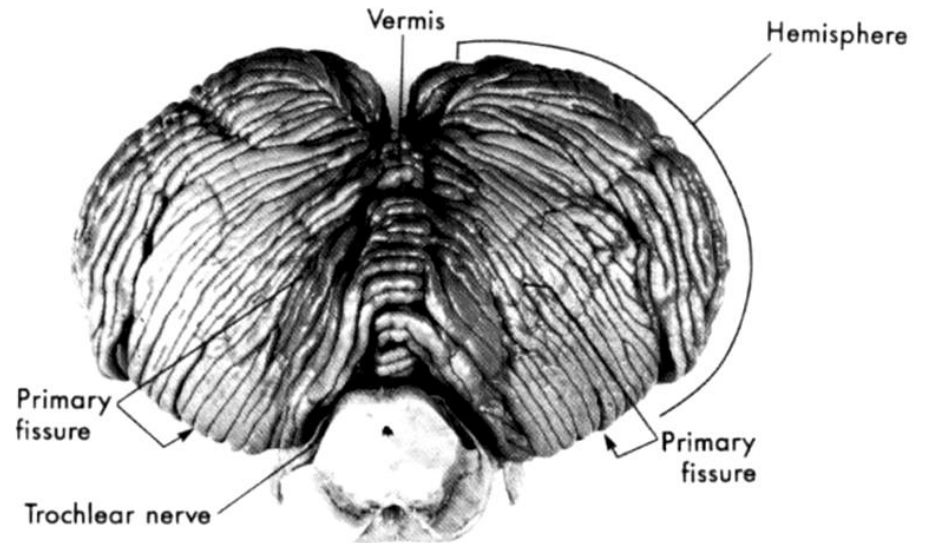
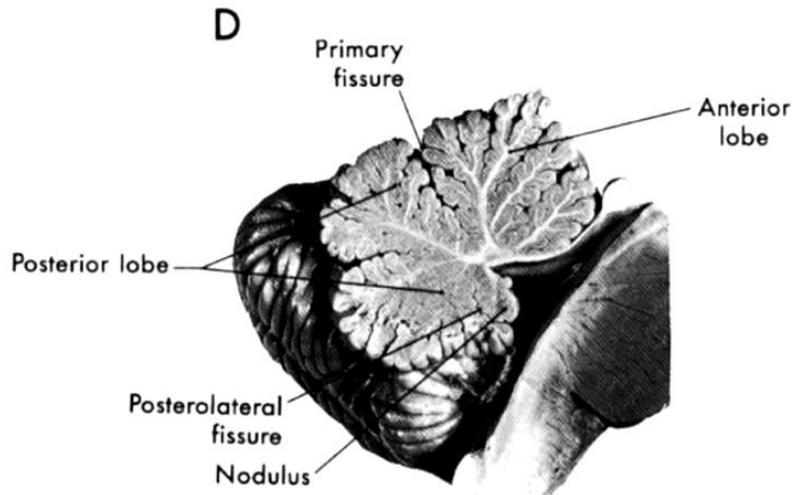
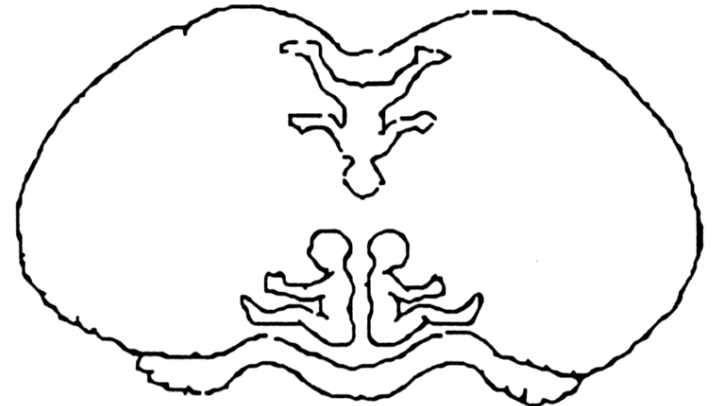


Fig from Haines

Cerebellar Vermis and Hemisphere

- ❑ We can divide the cerebellum into 2 parts:
 - midline vermis
 - 2 large lateral hemispheres



- ❑ Lesions in the midline cause gait ataxia ****
- ❑ Hemispheric insults cause incoordination of the limbs ipsilateral to the lesion (limb ataxia)***

Cerebellar Peduncles

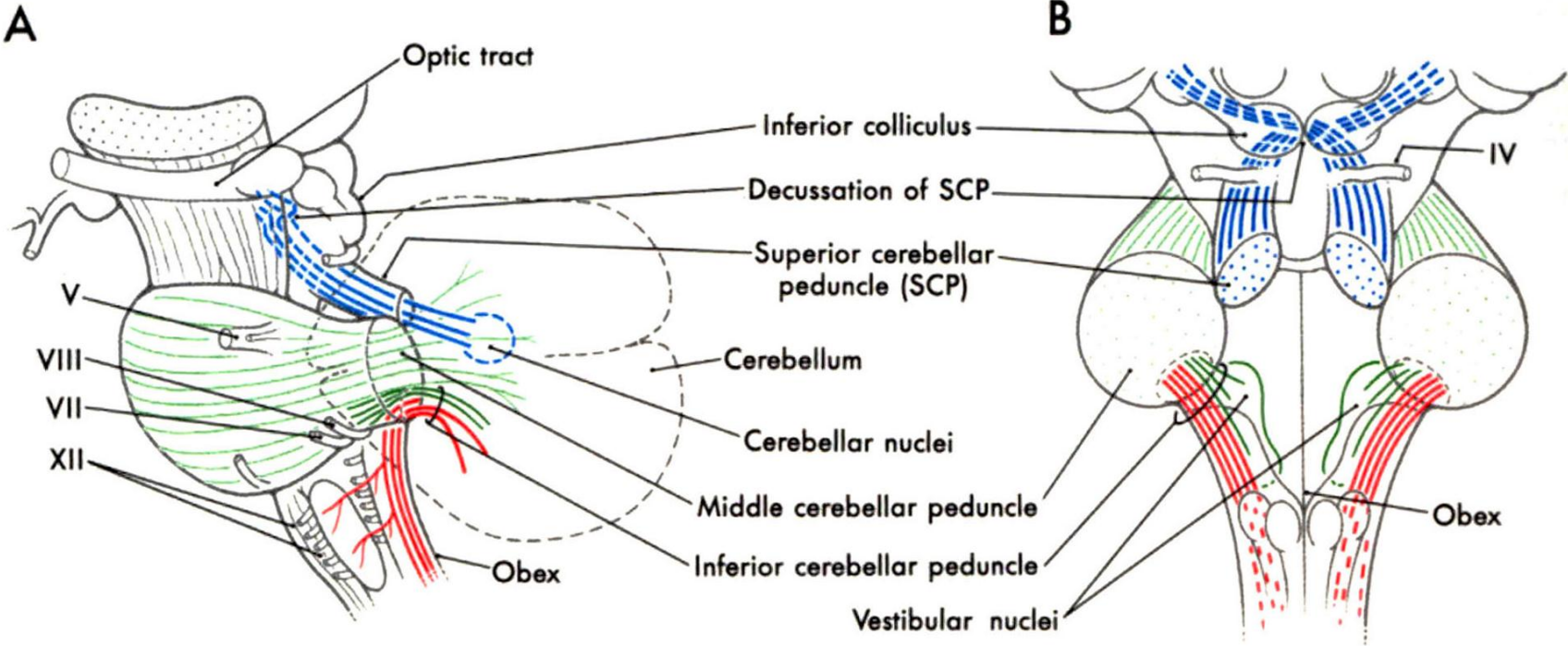
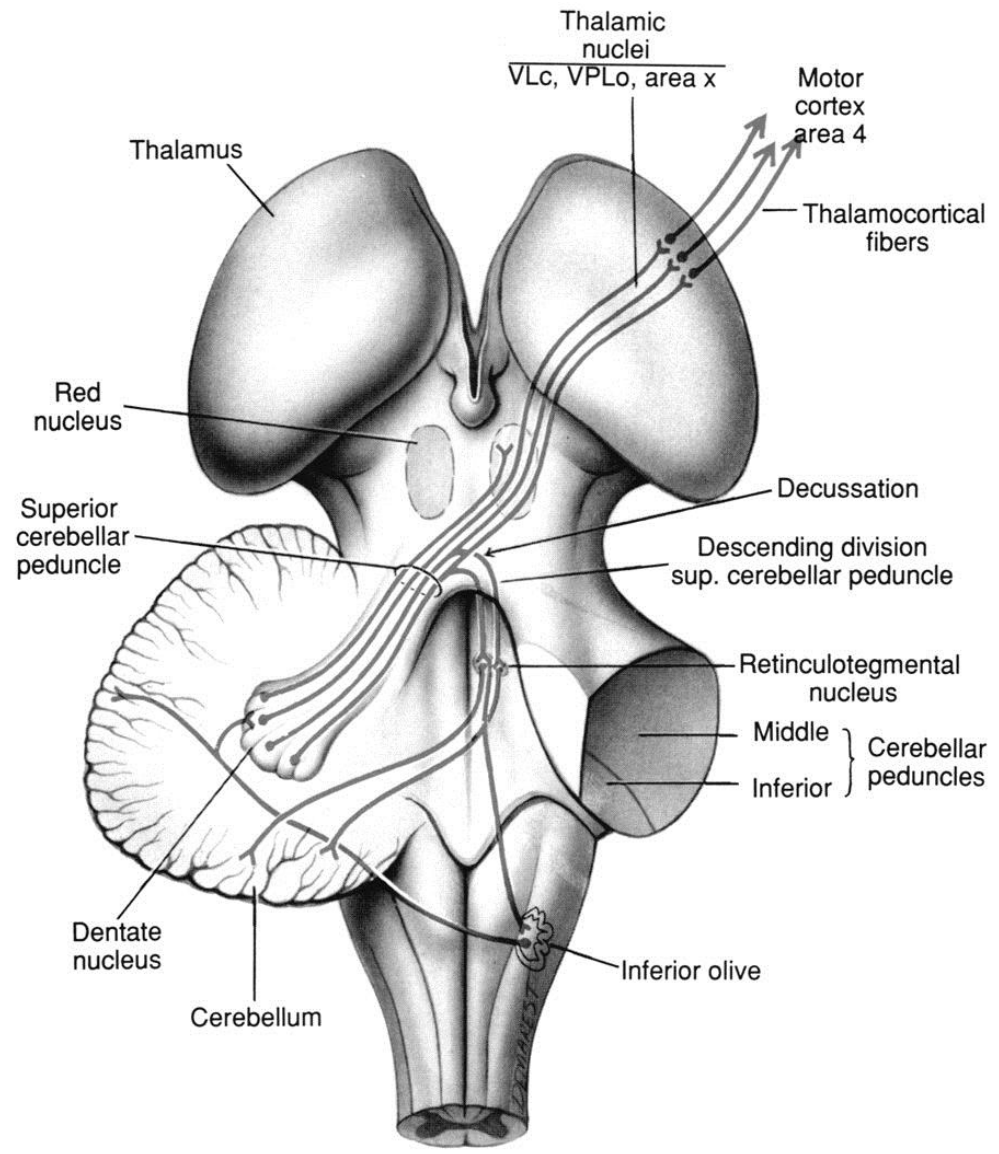


Fig from Haines

Superior Cerebellar Peduncle (1)

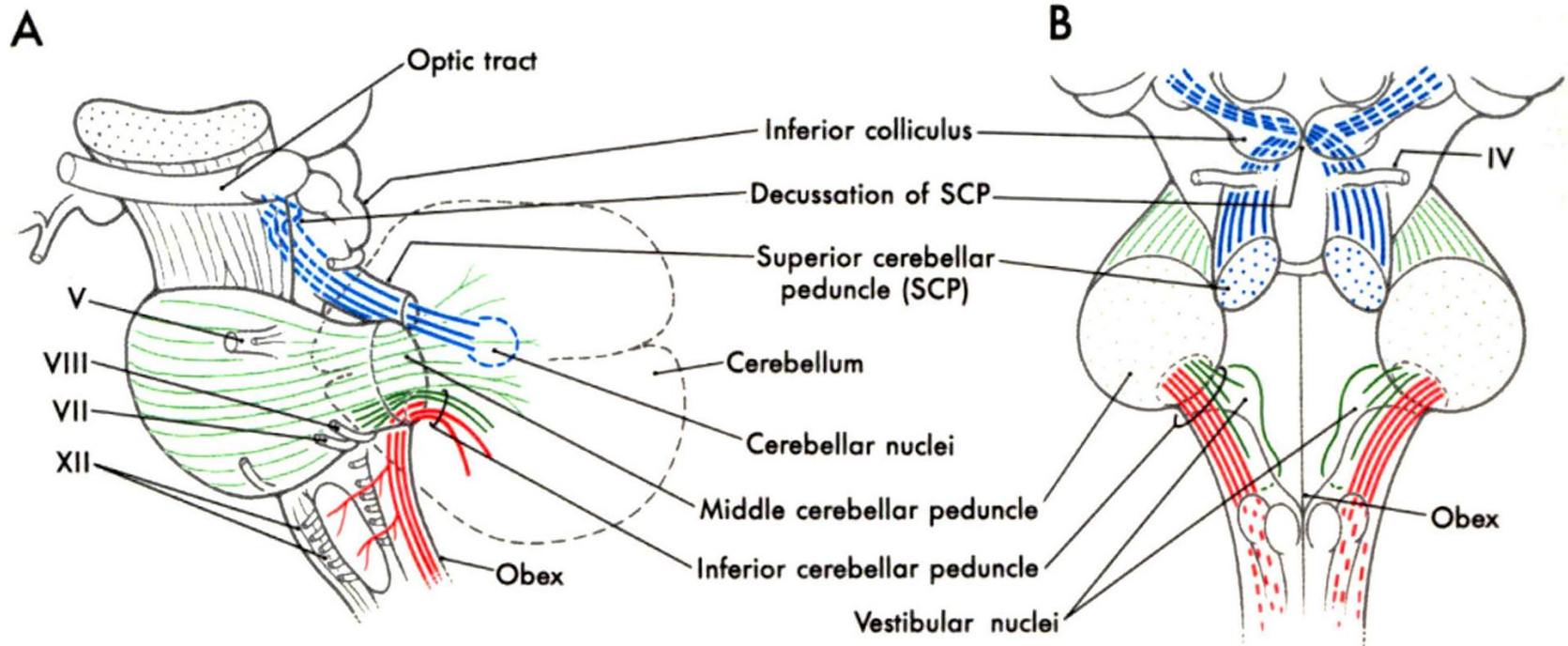
- ❑ The superior cerebellar peduncle (*brachium conjunctivum*) is the major efferent pathway from the cerebellum
- ❑ Efferent fibers from deep cerebellar nuclei on their way to the thalamus and brainstem
- ❑ Fibers exit superior cerebellar peduncle then enter the midbrain
- ❑ Cross and form the decussation of the superior cerebellar peduncle → thalamus → motor cortex

Superior Cerebellar Peduncle (1)



Middle Cerebellar Peduncle (2)

- ❑ The middle cerebellar peduncle (*brachium pontis*)
- ❑ This bundle contains primarily cortical afferents on their way into the cerebellum from the contralateral pons



Corticospinal & Corticobulbar Tracts

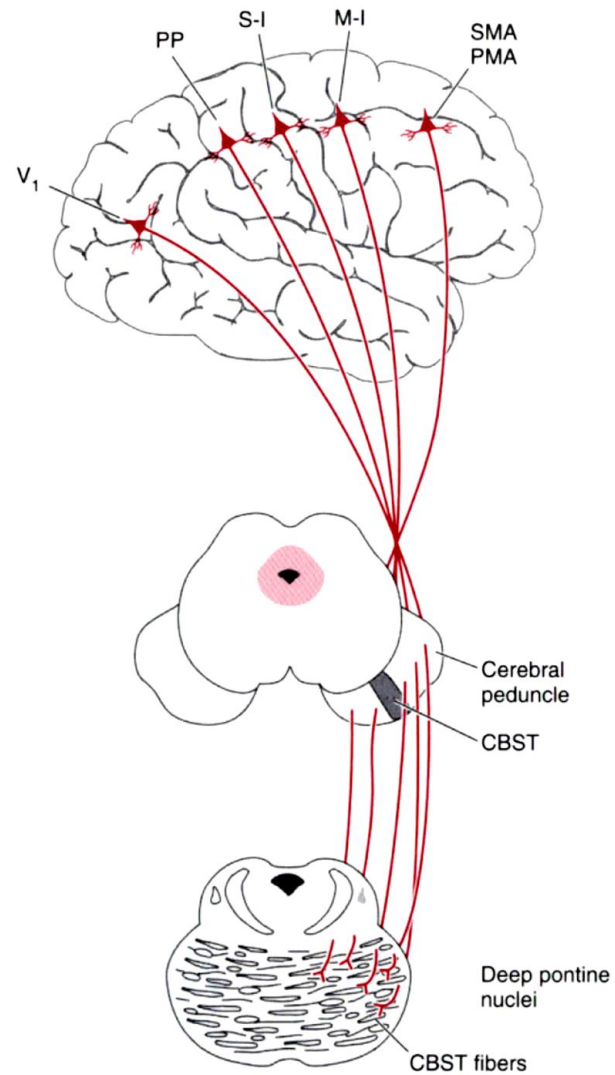
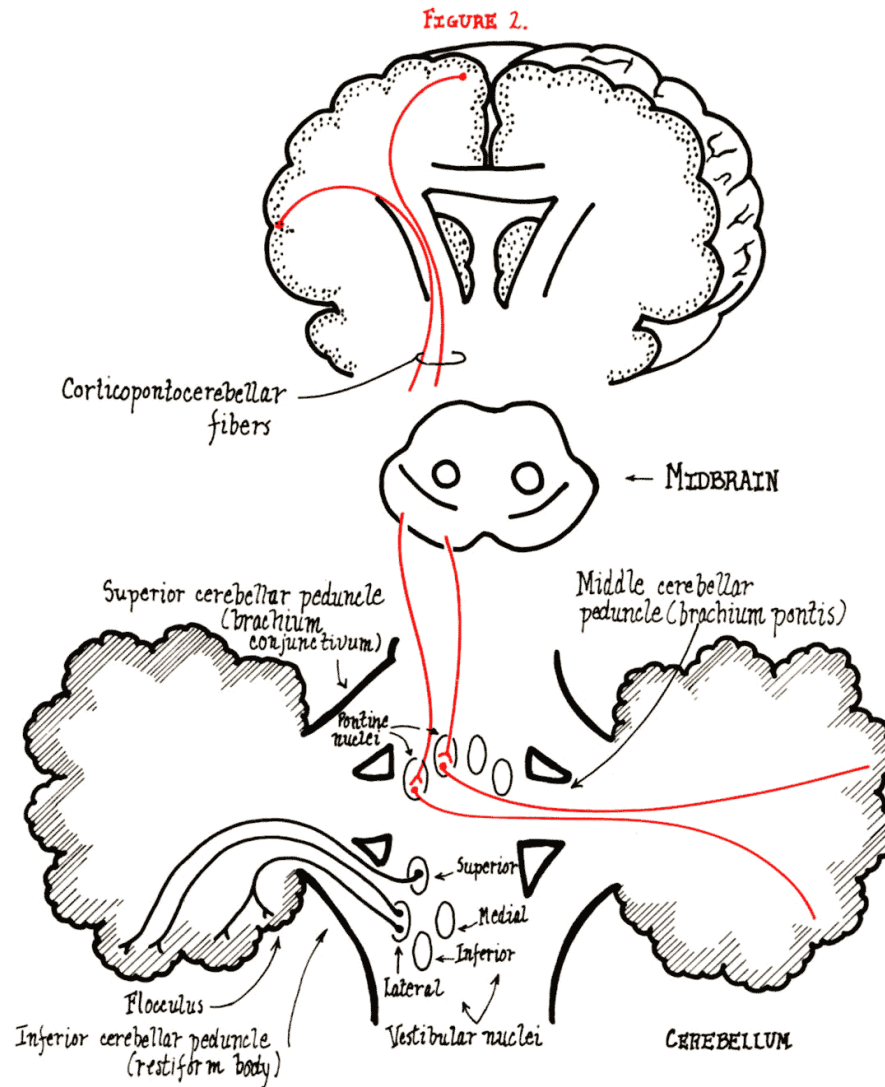


Fig from Kingsley

Cortico-ponto-cerebellar Pathway



Inferior Cerebellar Peduncle (3)

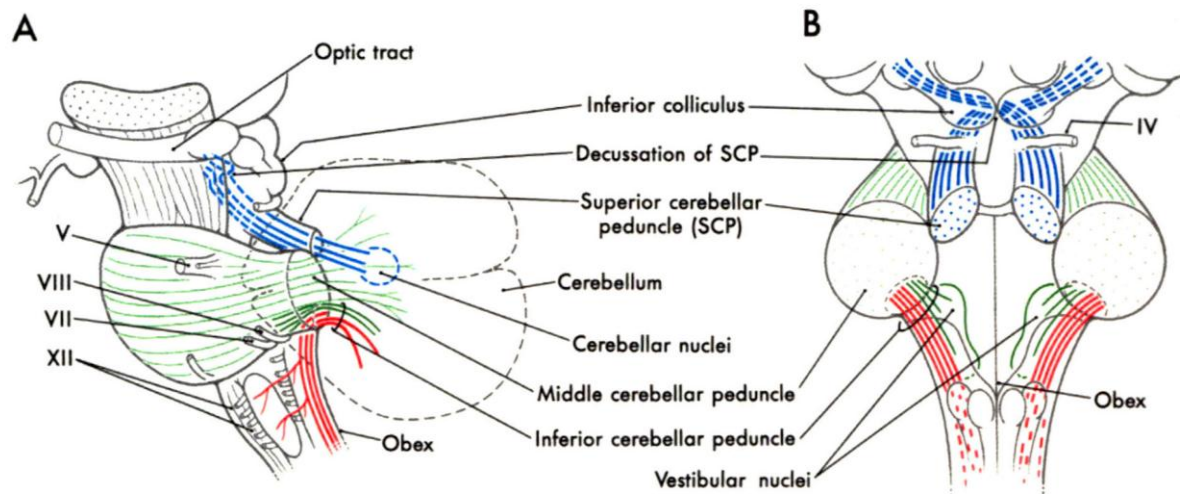
The inferior cerebellar peduncle is composed of 2 bundles:

❑ The *restiform body*

- contains afferent fibers from the spinal cord and medulla on their way into the cerebellum.

❑ The *juxtarestiform body*

- transmits information (afferent and efferent) between the flocculonodular lobe / fastigial nucleus and the vestibular system.



Flocculonodular lobe

- ❑ Oldest part of the cerebellum
- ❑ Coordinates balance and eye movements
- ❑ Input and output via inferior cerebellar peduncle
- ❑ Connects with vestibular nuclei

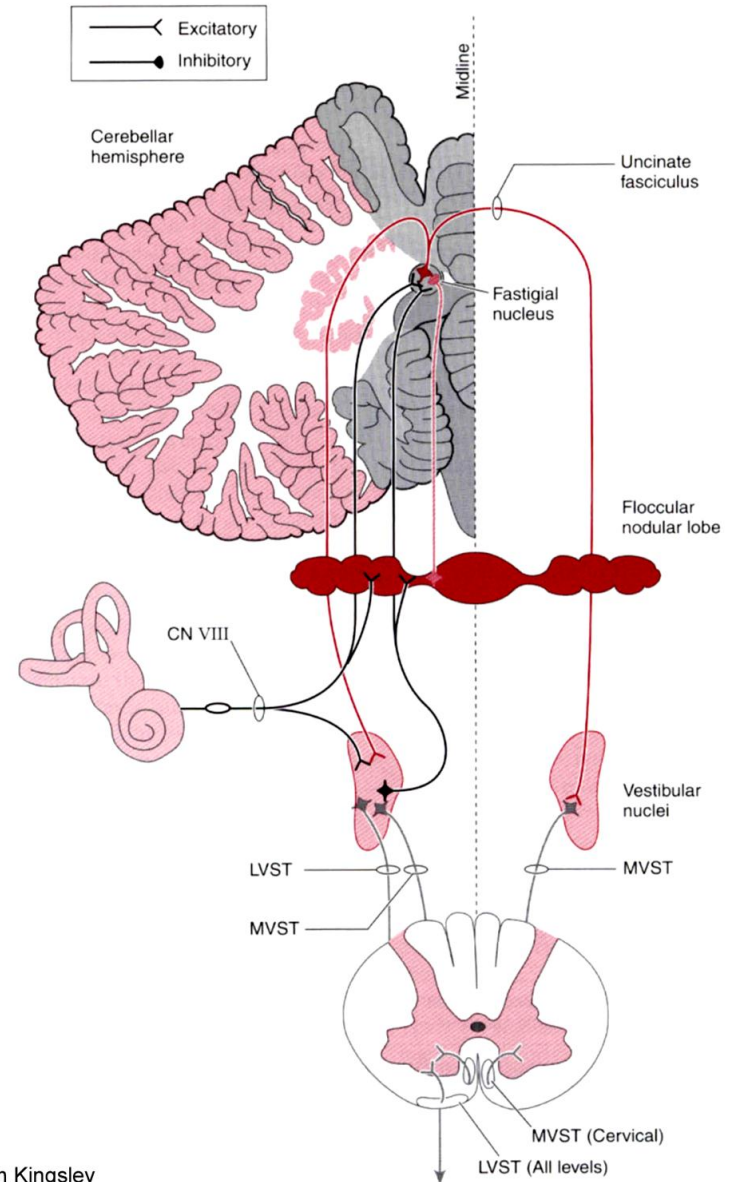


Fig from Kingsley

Cerebellar Inputs from Vestibular System

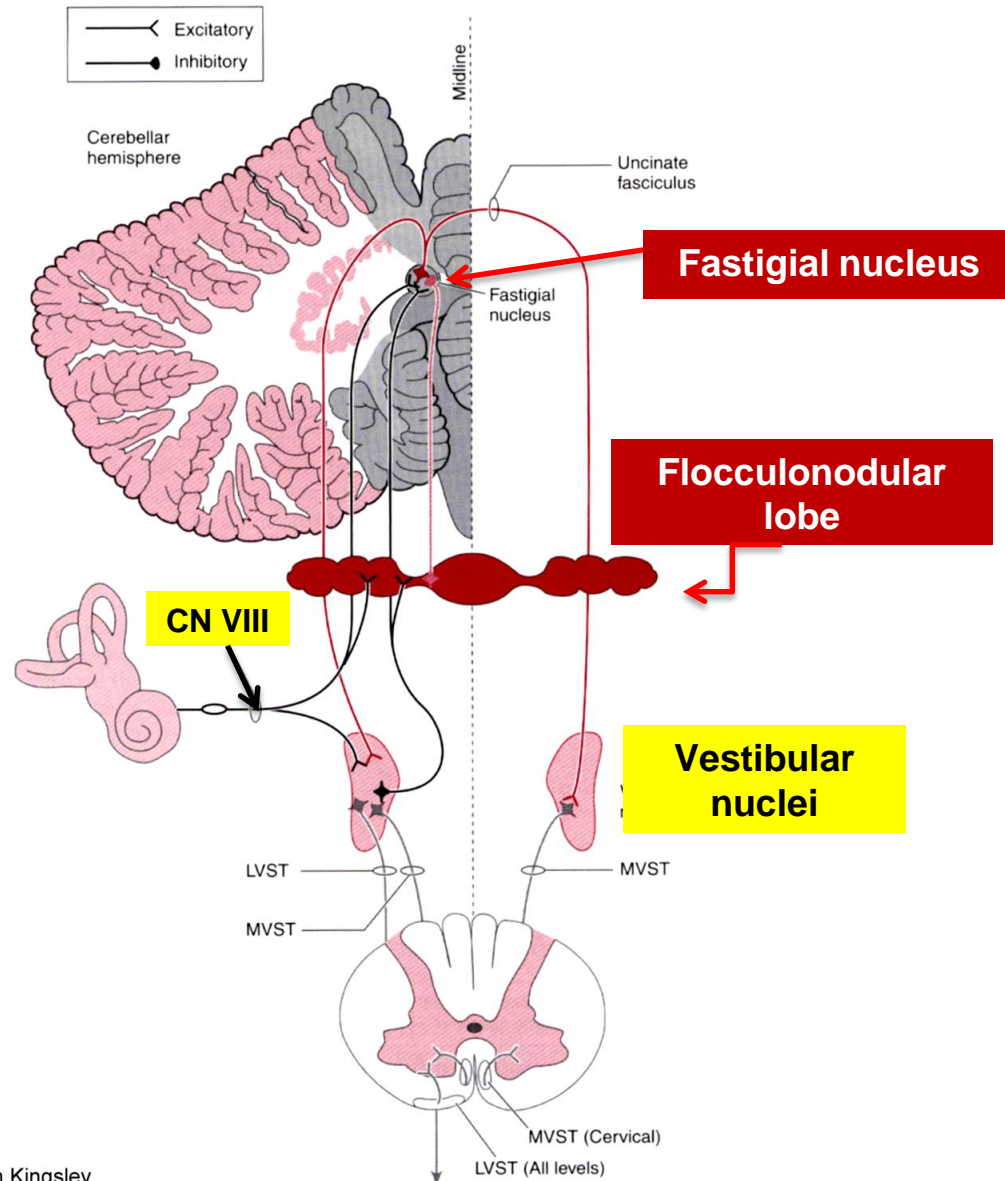
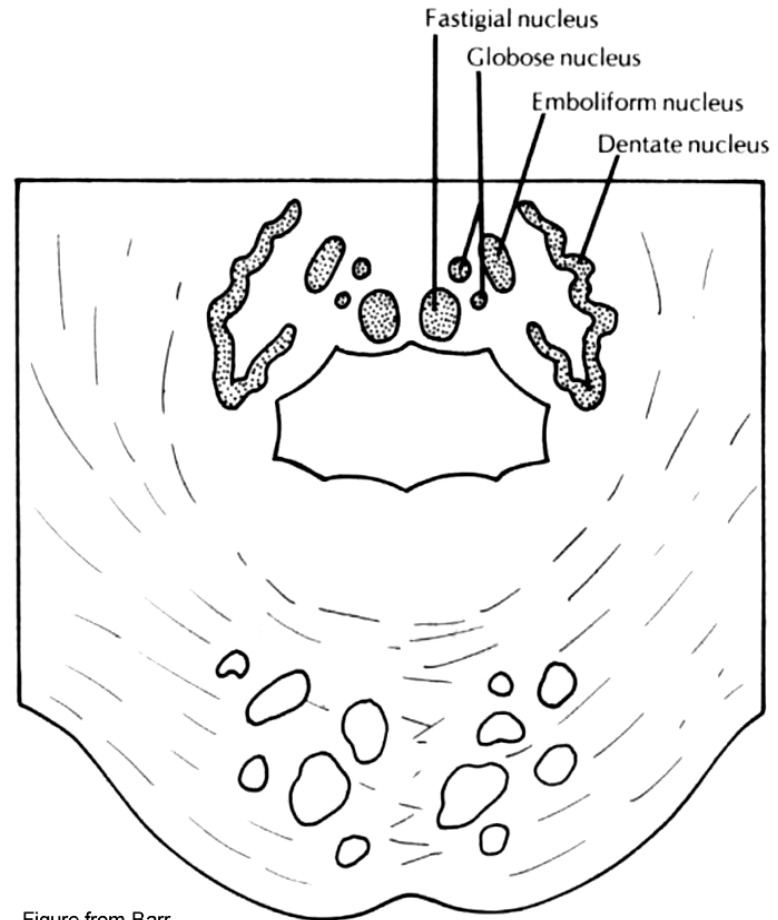


Fig from Kingsley

Deep Cerebellar Nuclei

- ❑ 4 pairs of cerebellar nuclei embedded in the white matter core of the cerebellum
- ❑ As you travel from one side of the cerebellum to the other:
 - dentate--emboliform--globose--fastigial-----
fastigial-- globose-
emboliform- - -dentate
 - memory-tip : **Flunked his GED**, going medial to lateral



Cerebellar Nuclei

Dentate nucleus is largest

Interposed nucleus:

Fastigial nucleus

Globose nucleus

Emboliform nucleus

Dentate nucleus

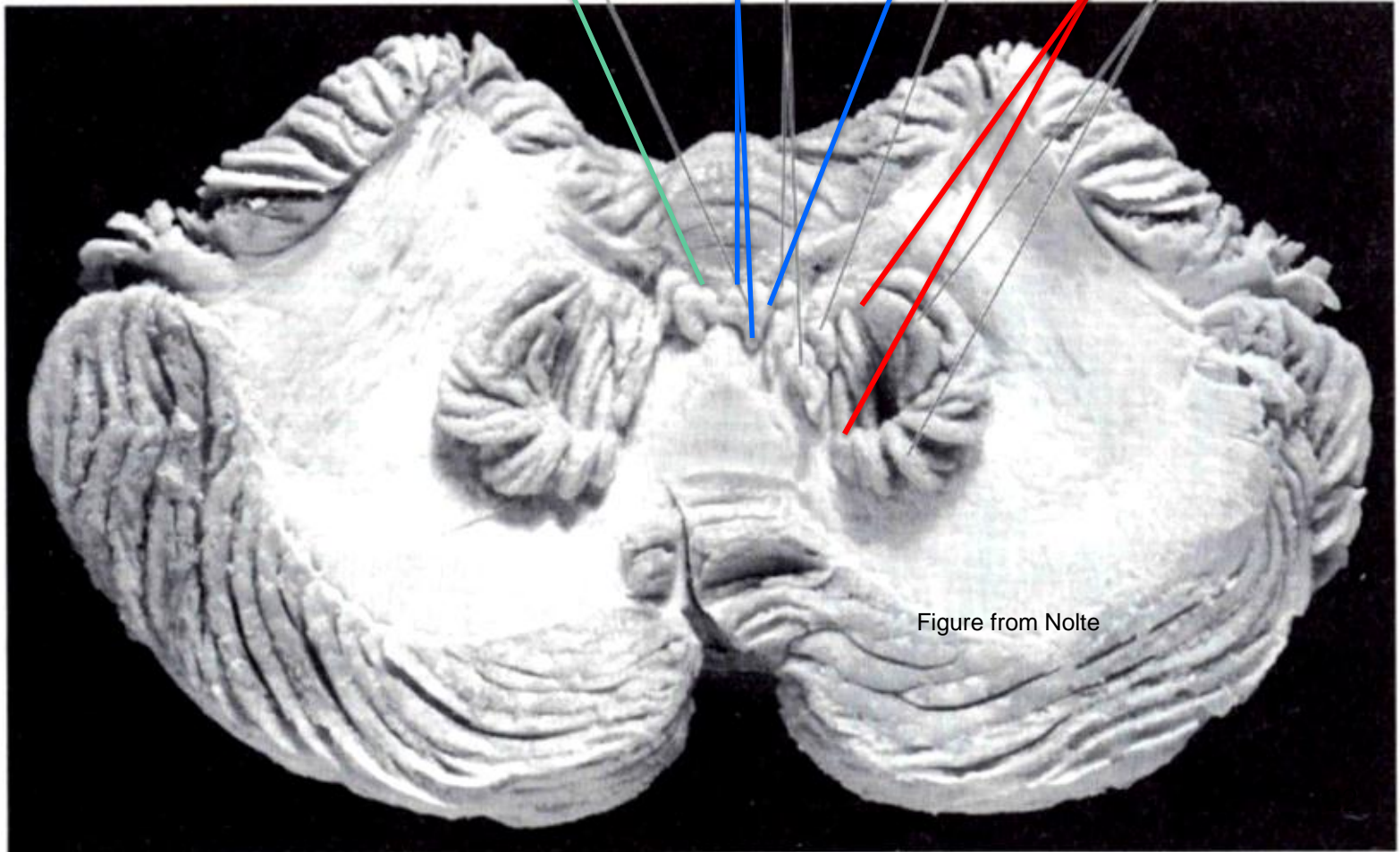
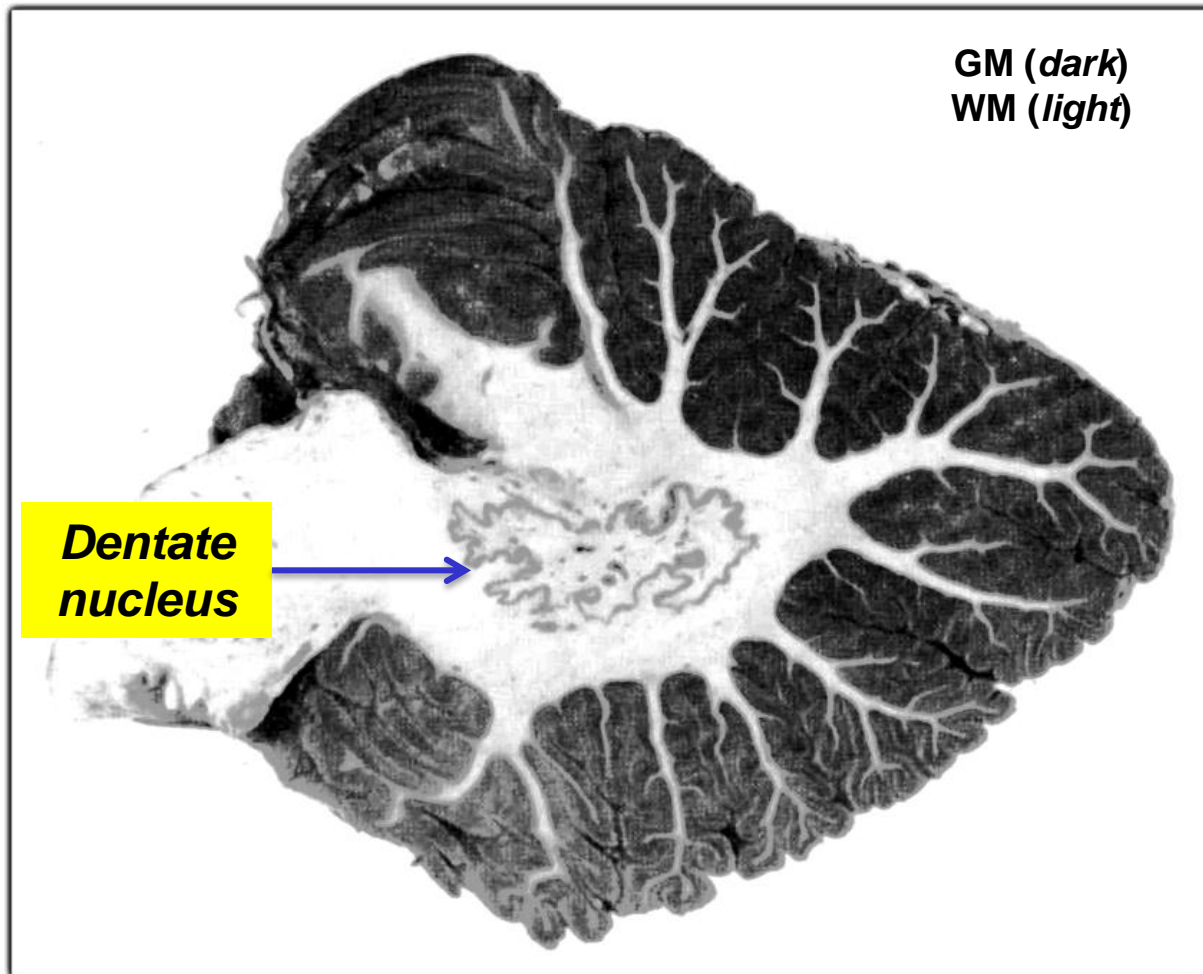


Figure from Nolte

Cerebellar Nuclei



Cerebellar surface in a sagittal plane through a hemisphere, stained to differentiate gray matter (*dark*) and white matter (*light*). The dentate nucleus is shown embedded in the medullary center of the white matter. ($\times 1\frac{1}{2}$)

Cerebellar Projections Functional Subdivisions

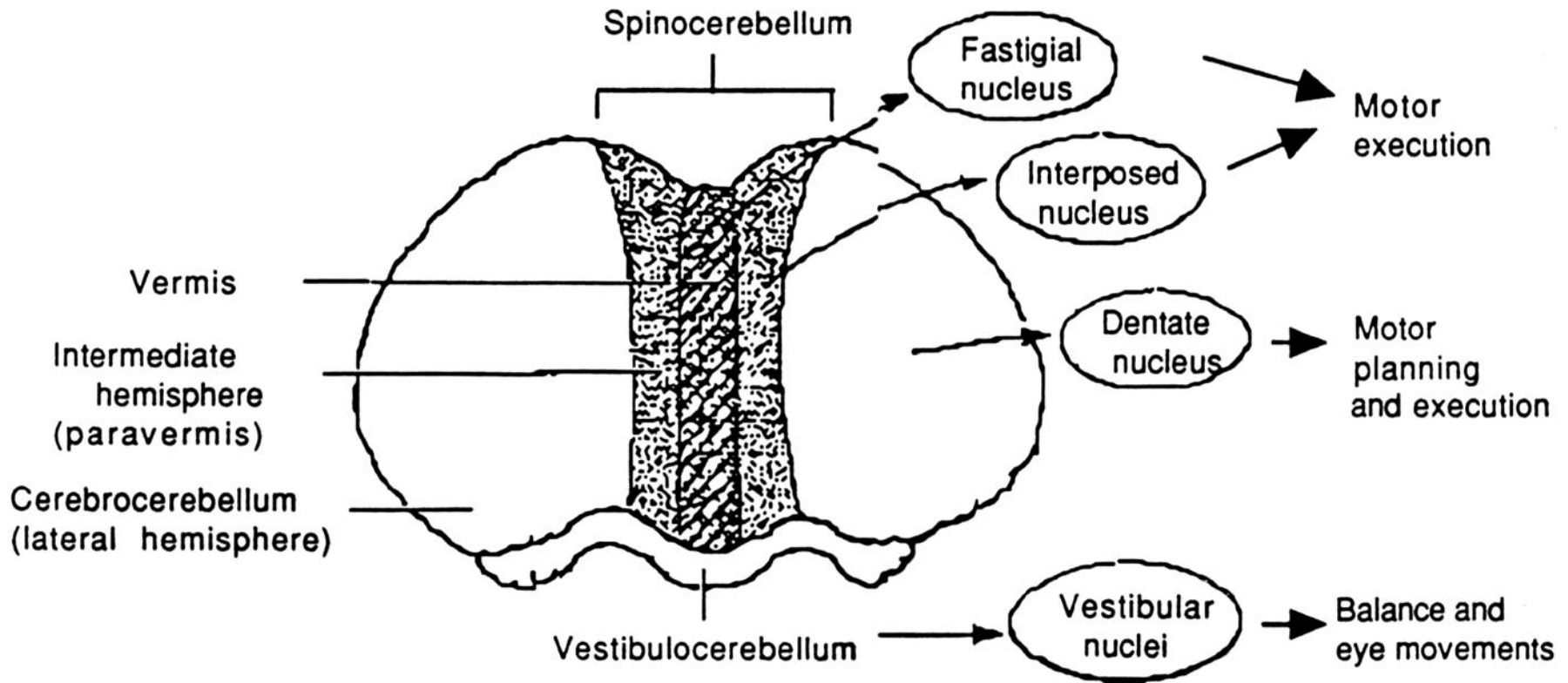


Figure 6. The cerebellar projections and functional subdivisions.

Cerebellar Input into the Motor Circuit

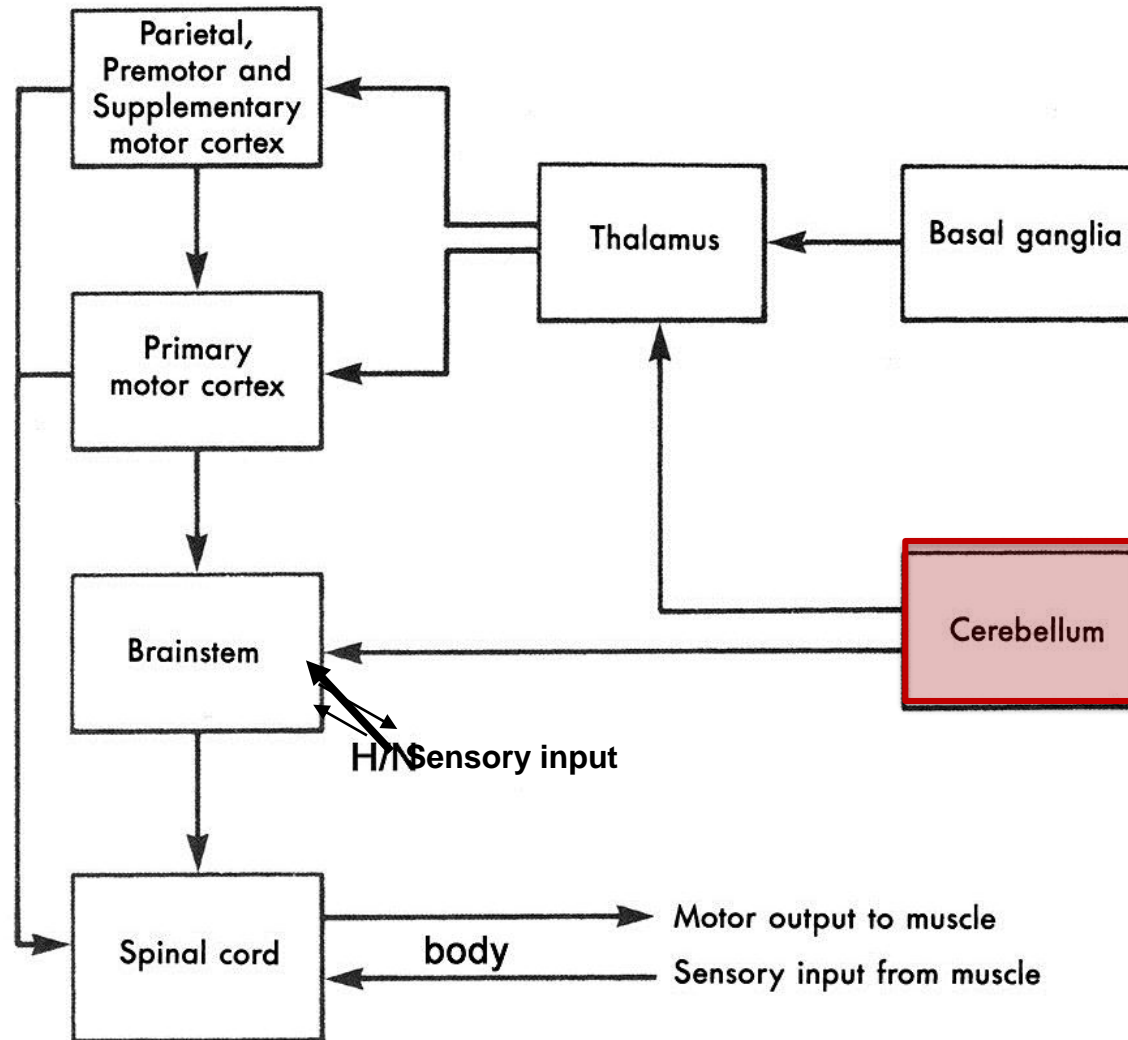


Figure from Haines

Cerebellar Cortex

3-layers



Figure from Barr

Molecular layer

Purkinje cell layer

Granule cell layer

White matter
of folium

Transverse section of cerebellar folia showing the three layers of cortex and the white matter of the folia. (Stained with cresyl violet, $\times 35$)

Cerebellar Cortex: *cell types, circuit, afferents*

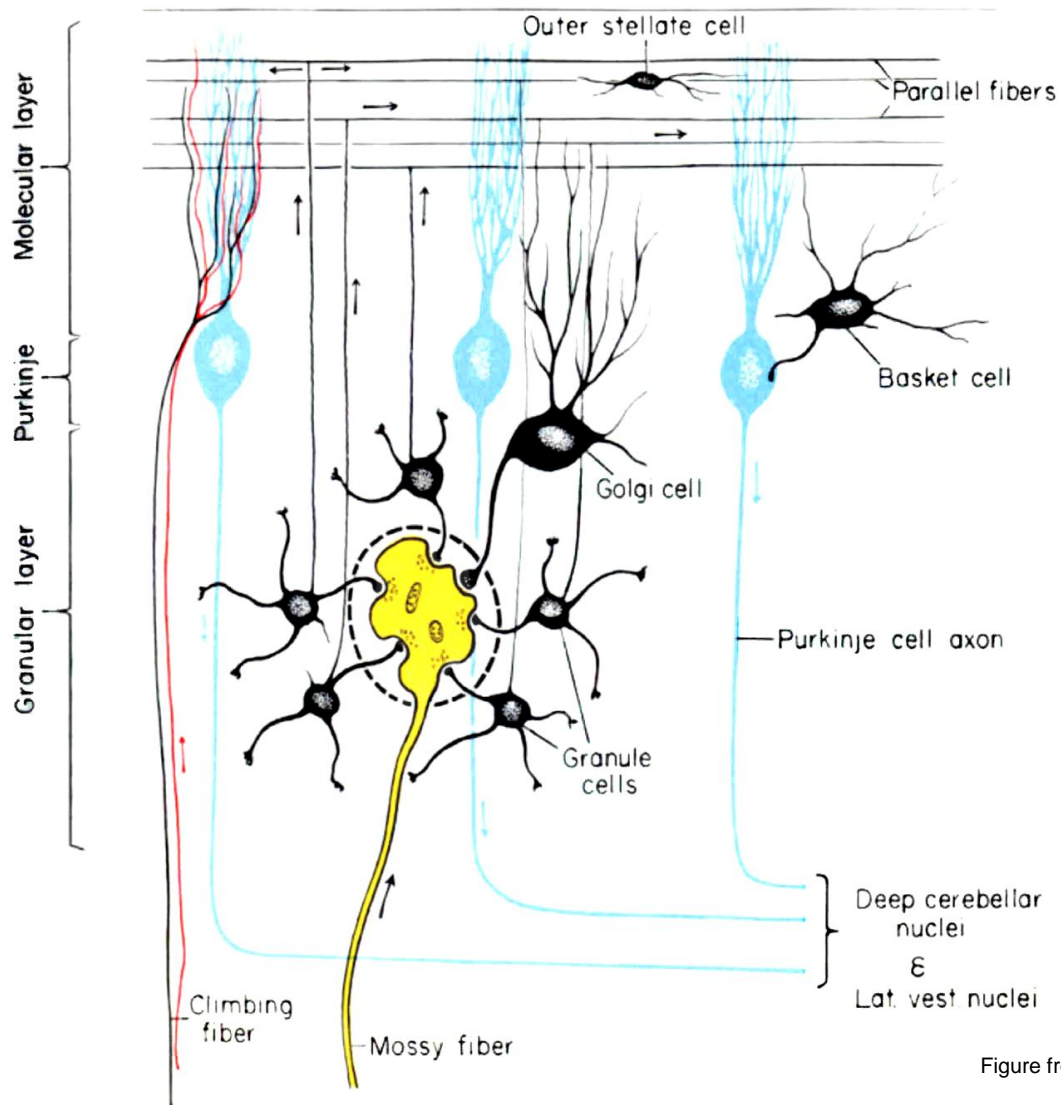
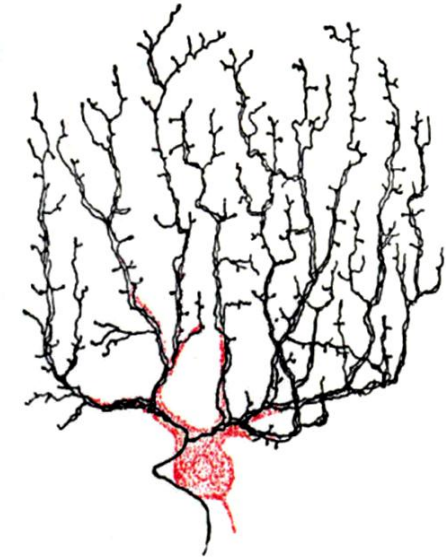


Figure from Carpenter

Cerebellar Cortex: *Purkinje Cells*

Purkinje cells:

- ❑ Dendrites extend up into the molecular layer
- ❑ Purkinje axons are the *only* fibers that leave the cerebellar cortex
- ❑ Purkinje axons *mainly* project to the deep cerebellar nuclei
- ❑ Purkinje cells are **inhibitory** and release **GABA**

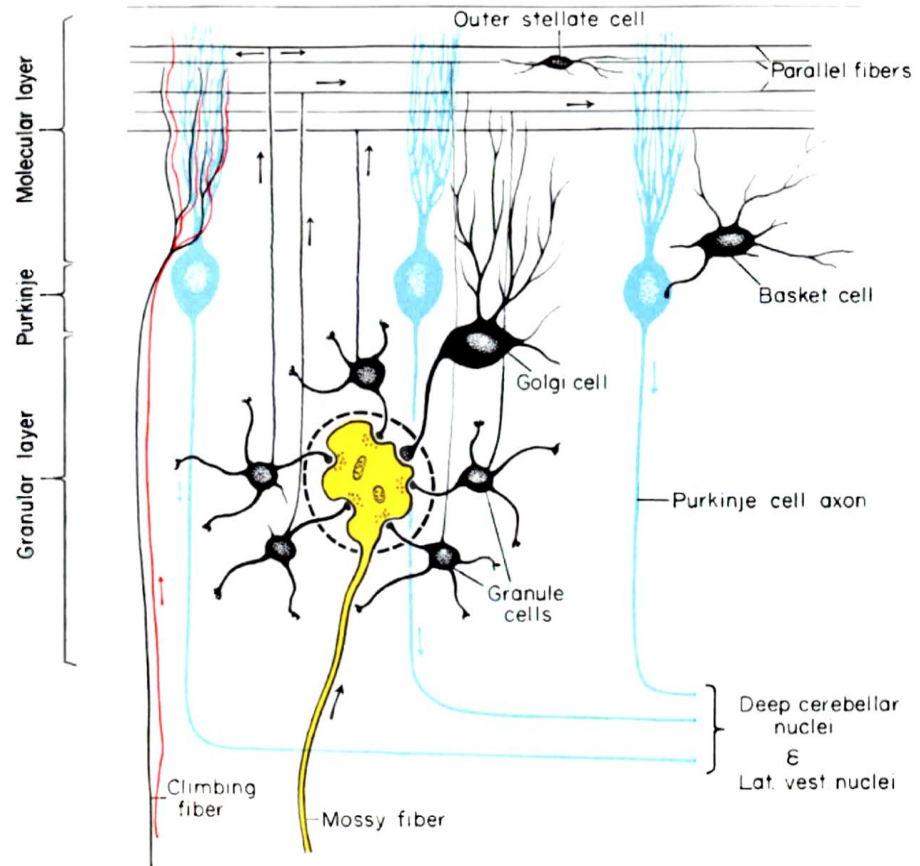


A drawing of a Golgi-stained climbing fiber, demonstrating the origin of its name as it climbs up the dendritic tree of a Purkinje cell (shown in color). (Modified from Ramón y Cajal S: *Histologie du système nerveux de l'homme et des vertébrés*, Paris, 1909, 1911, Maloine.)

Cerebellar Cortex: *Granule Cells*

Granule cells:

- ❑ Located in granule cell layer
- ❑ One granule cell connects with hundreds of Purkinje cells via parallel fibers
- ❑ The *only* excitatory neuron in the cerebellar cortex*****



Trivia: the most numerous neuron type in the brain

Cerebellar Cortex: *Afferents*

What fibers are coming into the cerebellum?

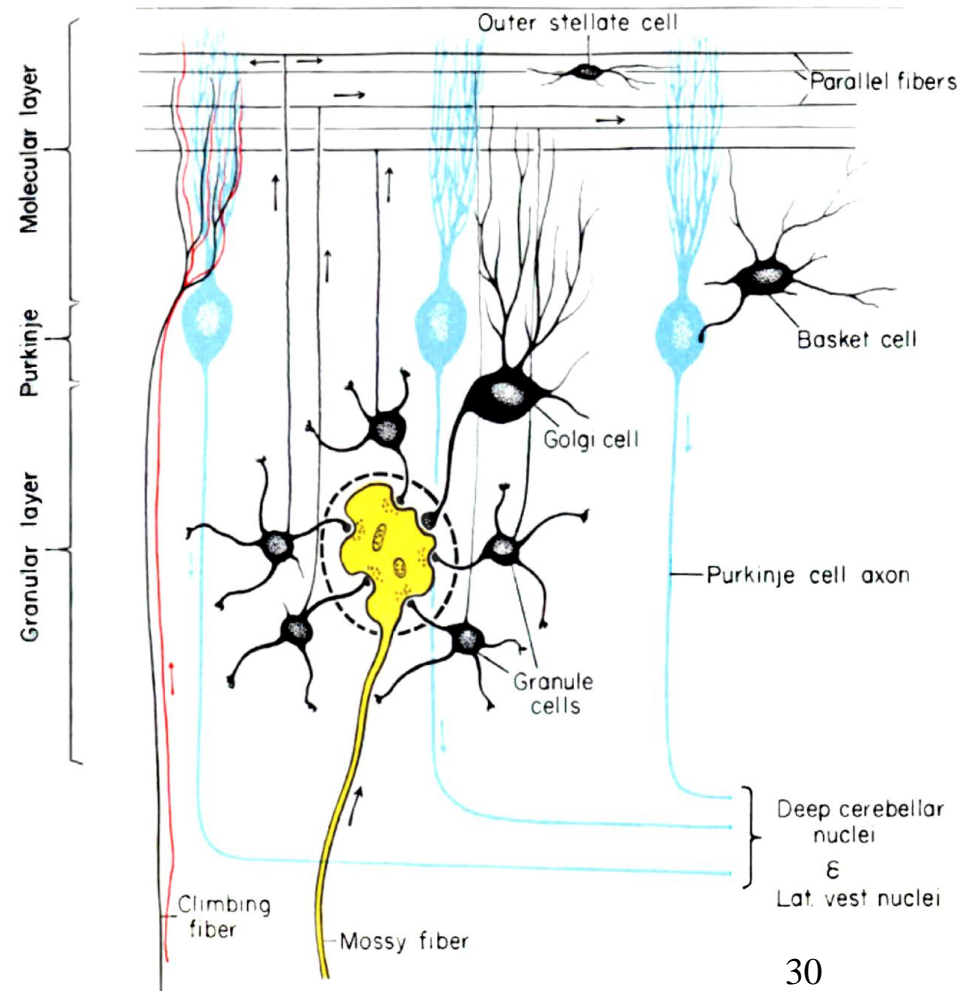
Afferent Connections:

□ Mossy Fibers

carry sensory info from spinal cord and brainstem

□ Climbing Fibers

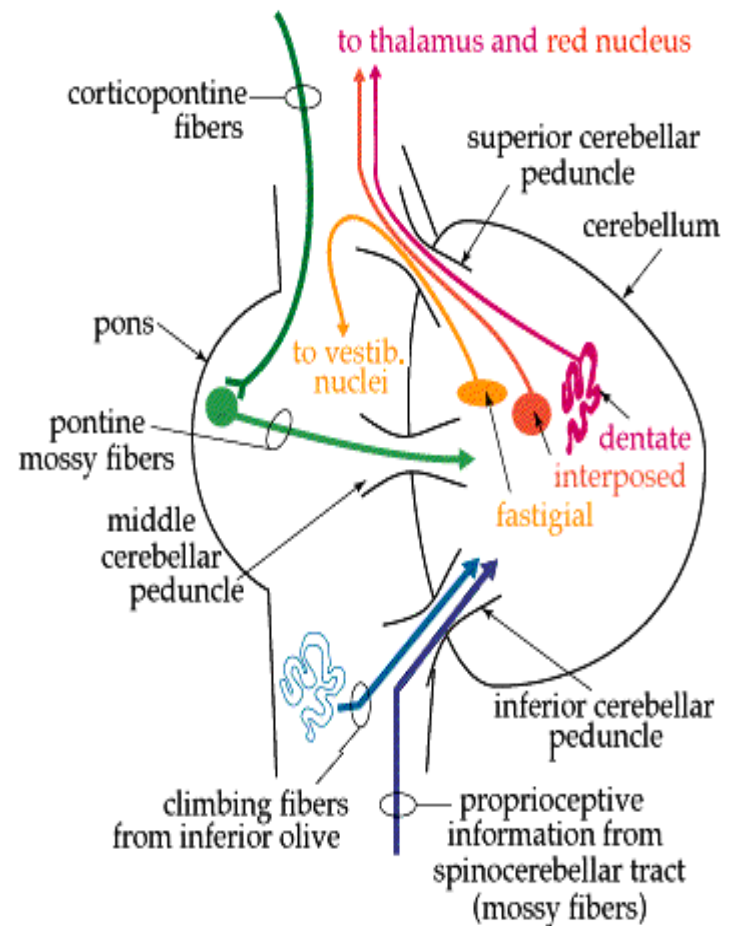
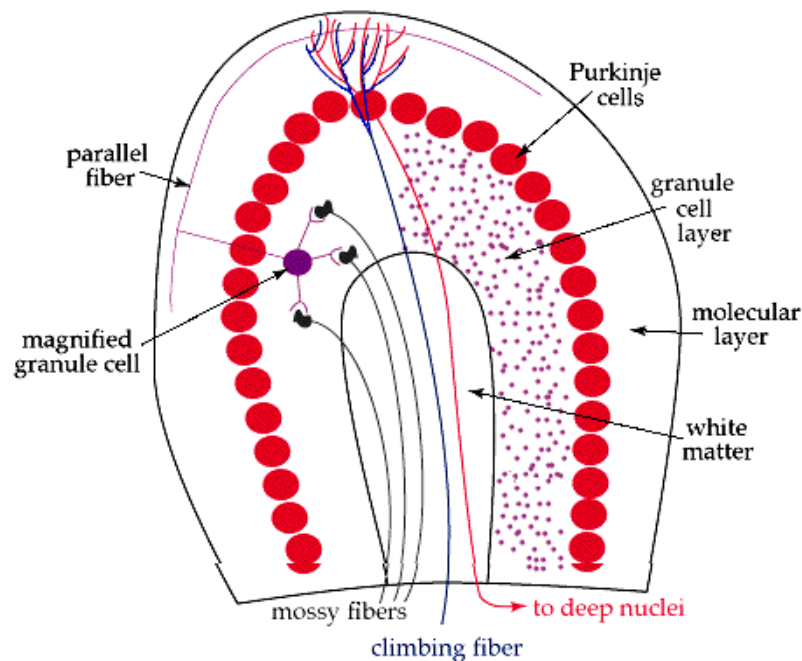
□ Arise from the inferior olive



Cerebellar Cortex: *Afferents*

Climbing fibers:

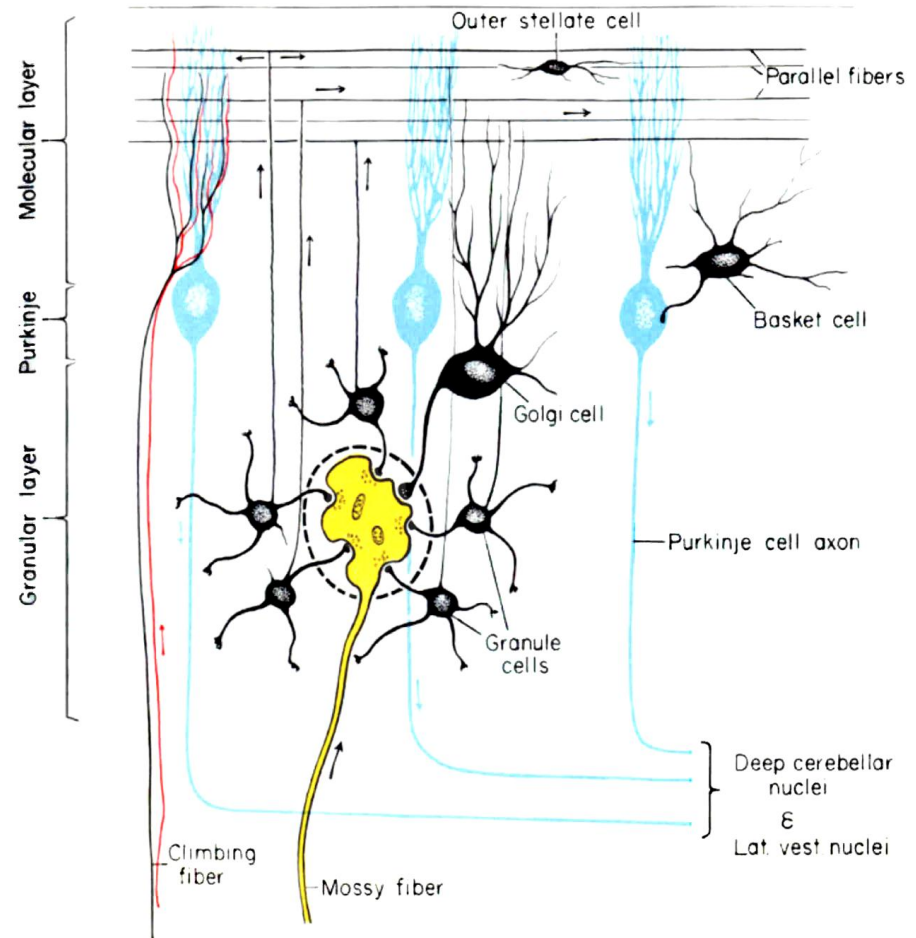
- ❑ Arise from the inferior olive
- ❑ Project to cerebellum via the inferior cerebellar peduncle



Cerebellar Cortex: *Afferents*

Climbing fibers:

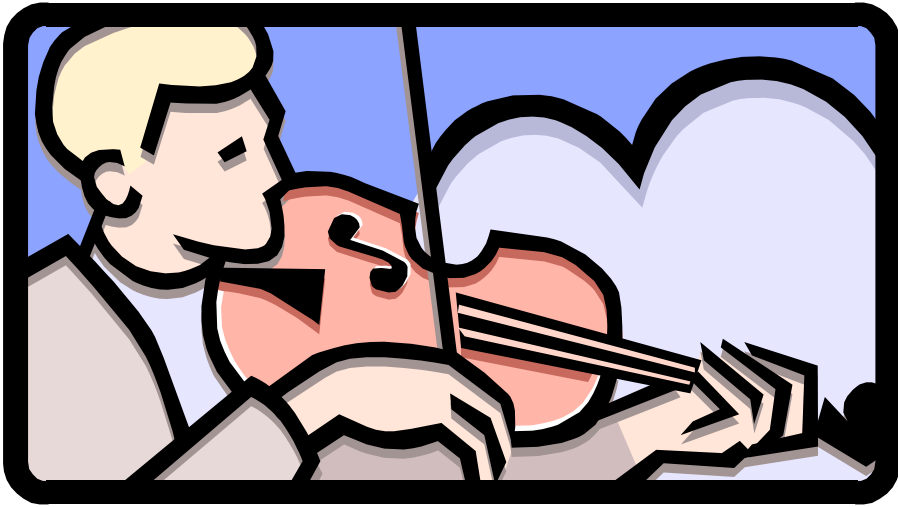
- ❑ Wind around the dendrite of the Purkinje cell like a vine growing on a tree.
- ❑ Unlike mossy fibers, climbing fibers synapse directly on Purkinje cells



Inferior Olive

- ❑ The inferior olivary nuclei are the source of all **climbing fibers** travelling into the cerebellum
- ❑ Axons exit the left inferior olive, cross over and enter the right cerebellum via the inferior cerebellar peduncle
- ❑ Inferior olive is an important relay station--all motor and sensory systems project here
- ❑ Motor cortex input to olivary nucleus--Important in complex motor learning**

Closeness



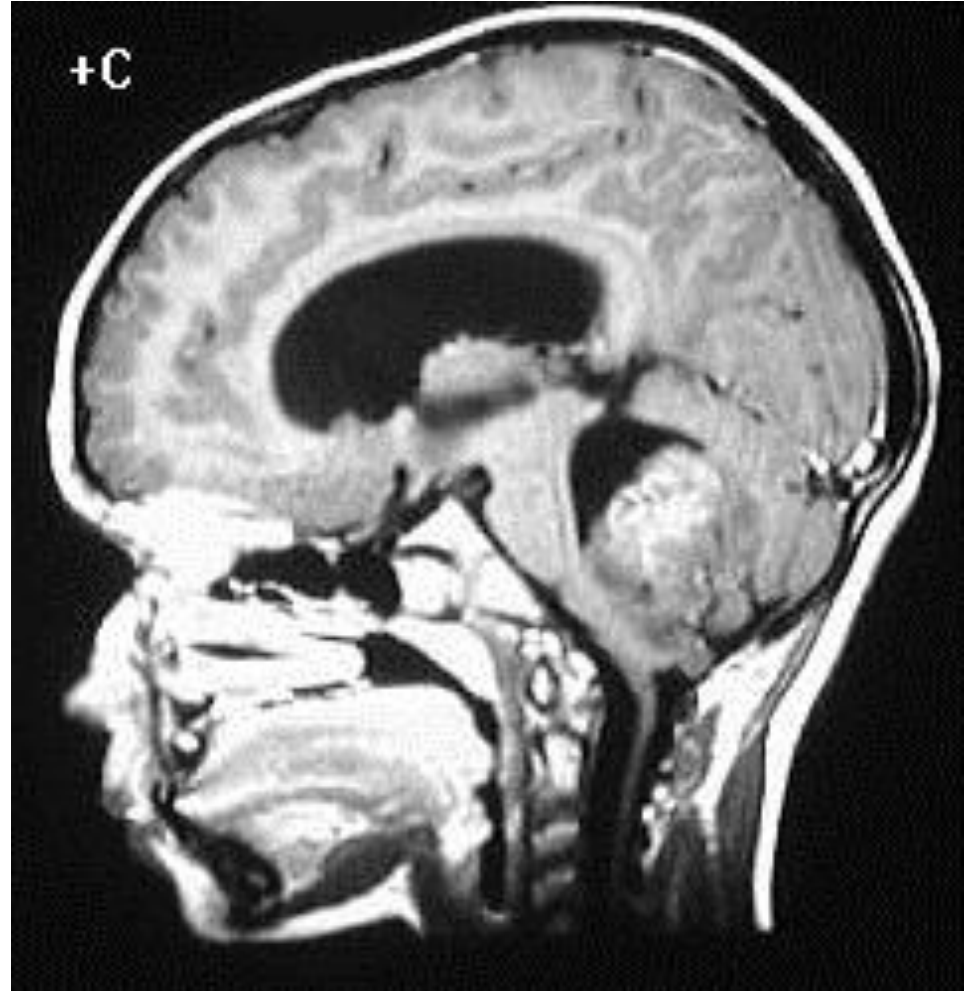
- ***Mossy fibers are intimate with granule cells---***
- ***Climbing fibers are intimate with Purkinje cells***

Causes of Cerebellar Dysfunction

- ❖ **Stroke**
- ❖ **Multiple sclerosis (MCP)**
- ❖ **Tumor (MEDULLOBLASTOMA)**
- ❖ **Trauma**
- ❖ **Degenerative diseases (SCA 1-17)**
- ❖ **Paraneoplastic**
- ❖ **Viral**
- ❖ **Post viral (post VZV cerebellitis)**
- ❖ **Medications: phenytoin**

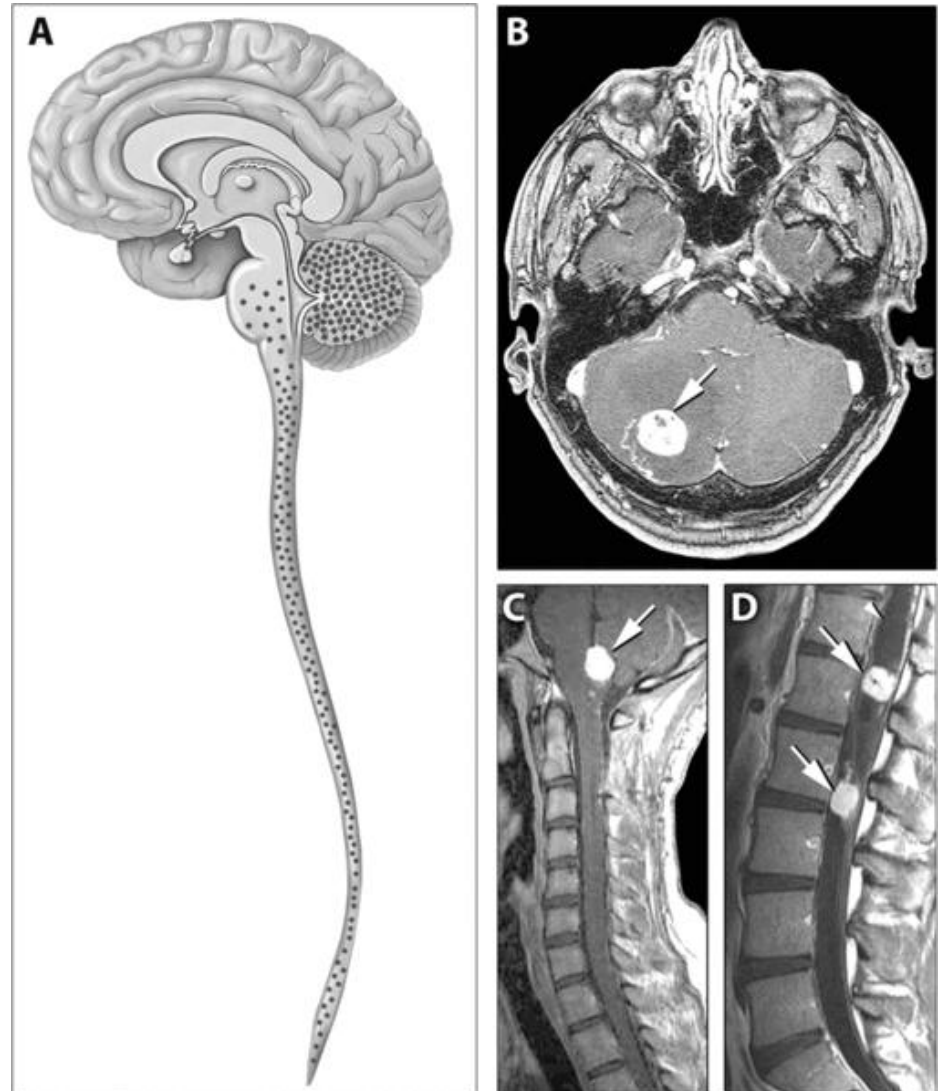
Medulloblastoma

Children >> Adult



Von Hippel-Lindau (VHL)

- Cerebellar and spinal cord hemangioma
- Renal carcinoma
- Pheochromocytoma
- VHL results from a mutation in the von Hippel-Lindau tumor suppressor gene on chromosome 3p25.3



Blood Supply to Cerebellum

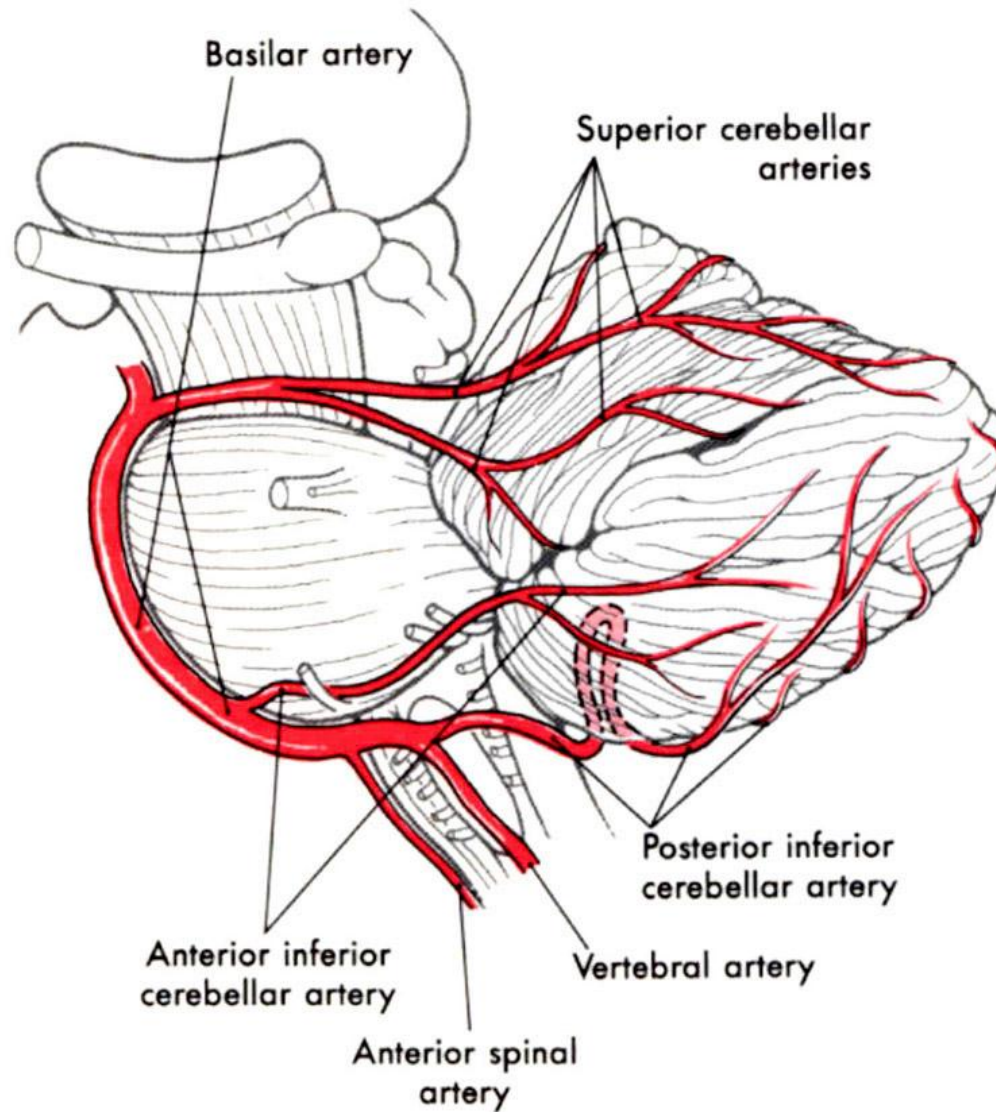


Fig from Haines

Wallenberg Syndrome****

Lateral Medullary Syndrome

- ❑ **PICA infarct**
- ❑ **Ischemic infarction: lateral medulla**
- ❑ **Right face and left body pain & temperature loss**
- ❑ **Right limb ataxia**
- ❑ **Right Horner's syndrome**
- ❑ **Dysphagia, droopy right palate**

Degeneration of the Anterior Vermis

Chronic Alcohol Abuse

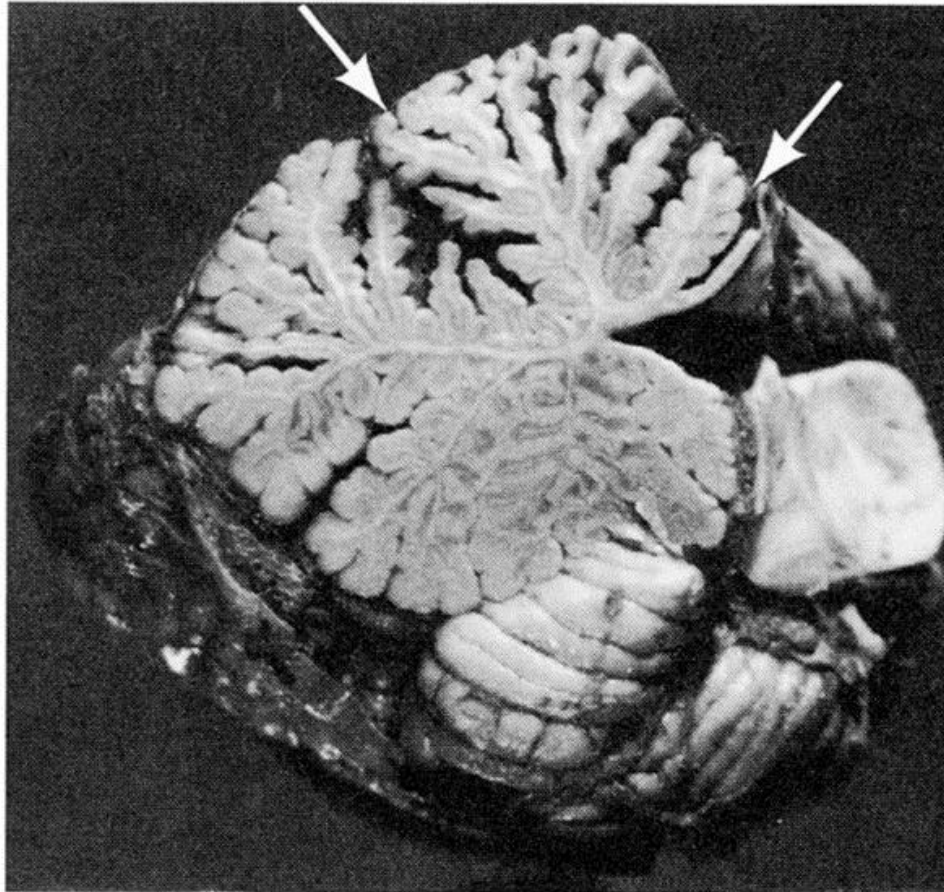
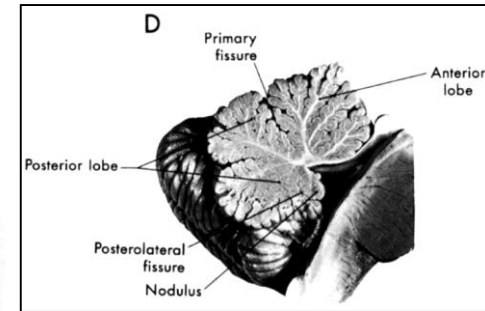


Figure 19.13 from Puvres



**Slowly Progressive Cerebellar
Ataxia and Cervical Dystonia:
Clinical Presentation of a New
Form of Spinocerebellar Ataxia?**

Clinical Features of a Large Australian Pedigree With Episodic Ataxia Type 1

**Pure Cerebello-Olivary
Degeneration of Marie, Foix,
and Alajouanine Presenting With
Progressive Cerebellar Ataxia,
Cognitive Decline, and Chorea**

Creutzfeldt-Jakob Disease (CJD)

