

Cerebellum

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University of Minnesota

Course News

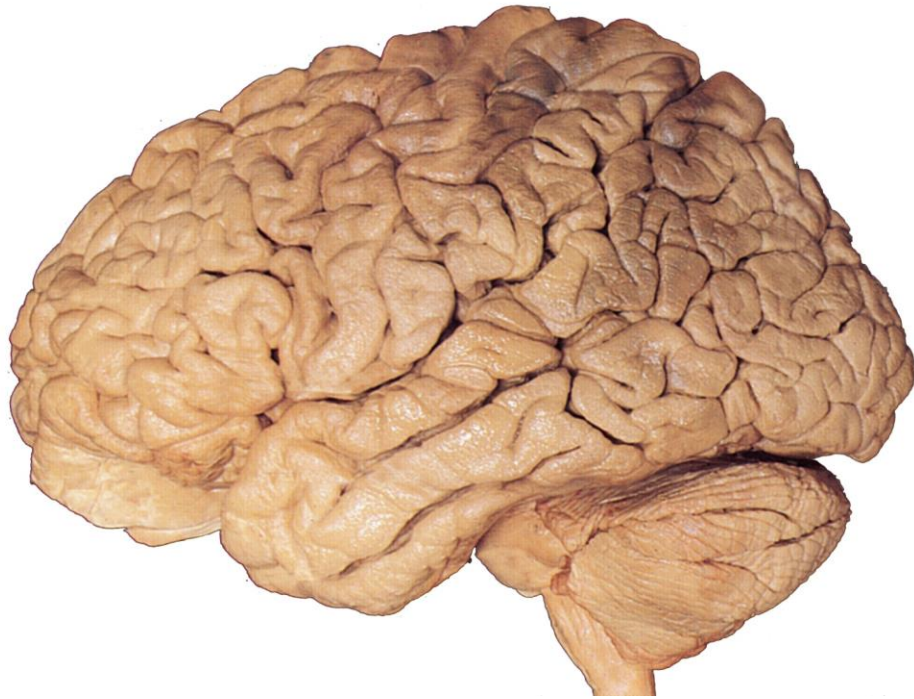
Friday's lecture is by
the other Dr. McLoon!

Please attend the lecture live if you can!

Anatomy of the Cerebellum

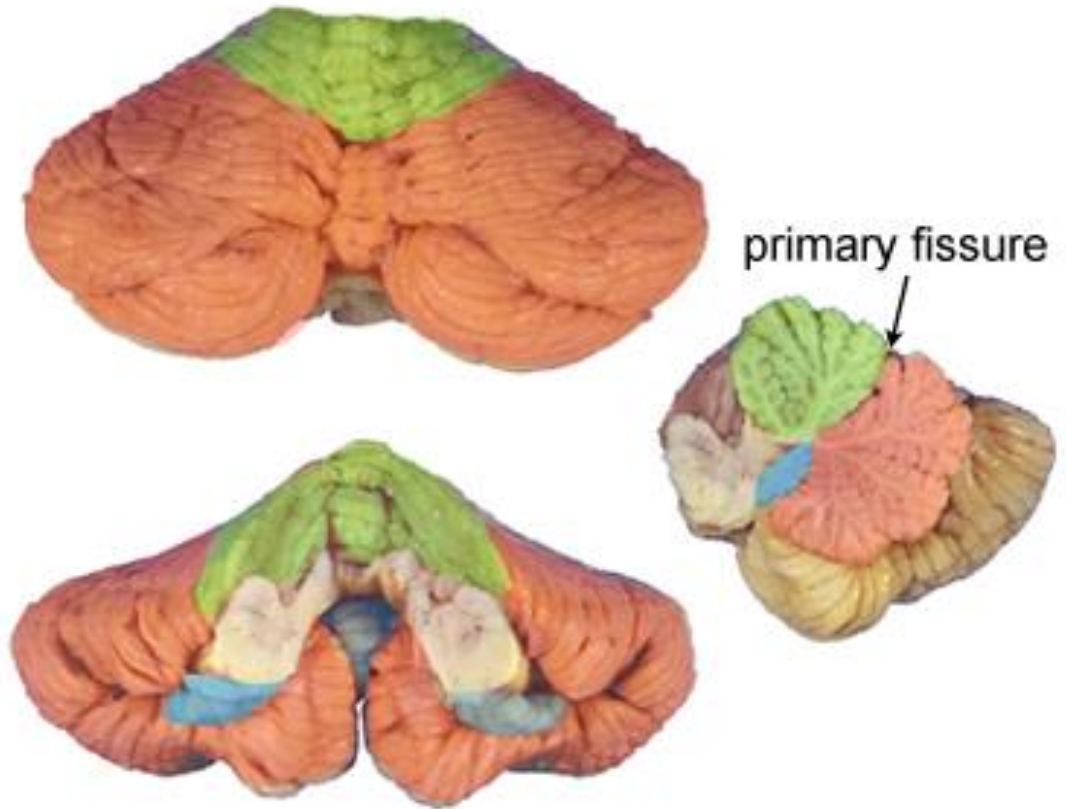
- The cerebellum has approximately half of all the neurons in the central nervous system.
- The cerebellum receives information from all sensory and motor systems.

Anatomy of the Cerebellum



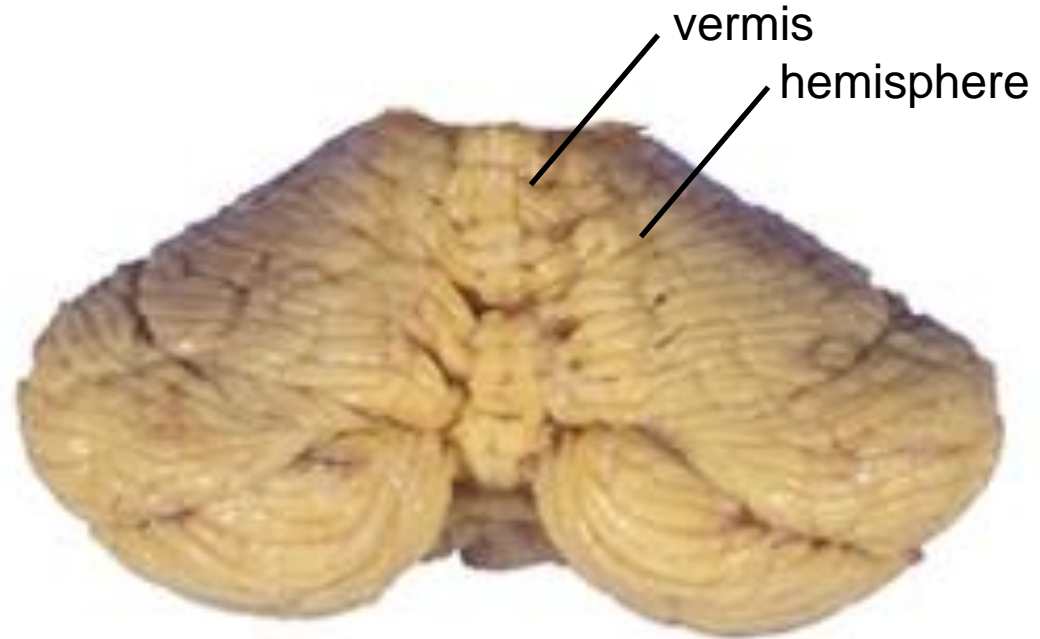
Anatomy of the Cerebellum

- Three anatomical lobes based on fissures:
 - Anterior lobe
 - Posterior lobe
 - Flocculonodular lobe



Anatomy of the Cerebellum

- Two vertical grooves divide the cerebellum into the vermis and two hemispheres.



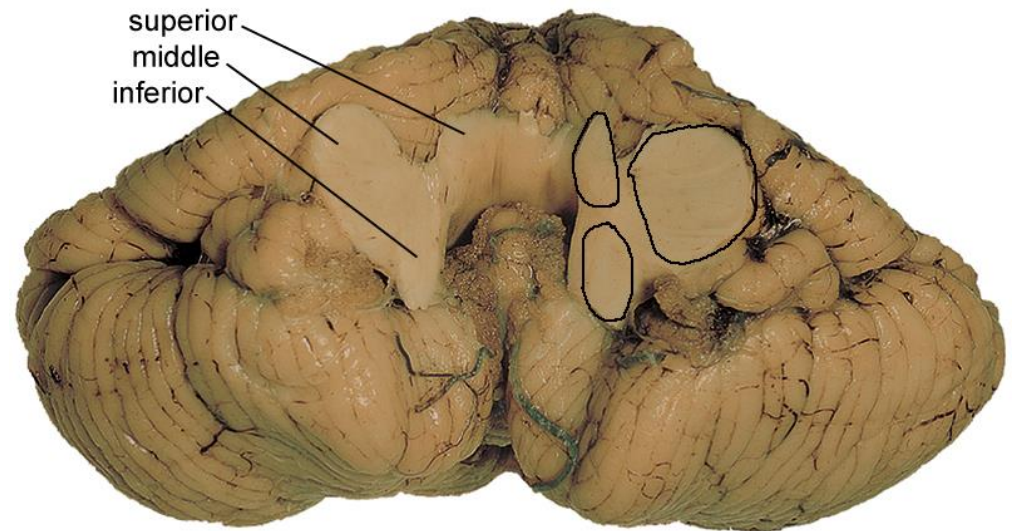
Anatomy of the Cerebellum

- The cerebellar cortex has a series of folia that run from side to side (similar to gyri of the cerebral cortex).



Anatomy of the Cerebellum

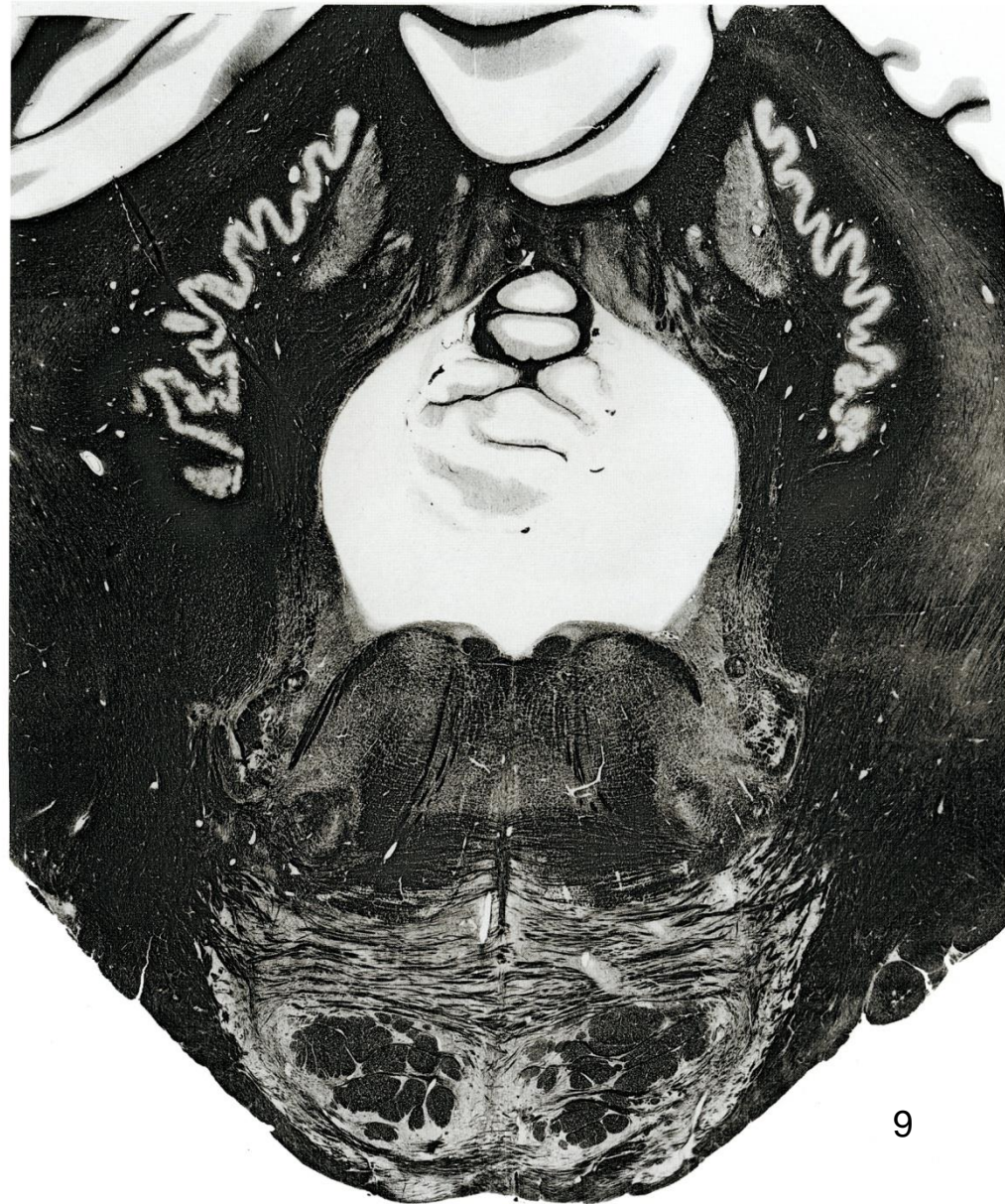
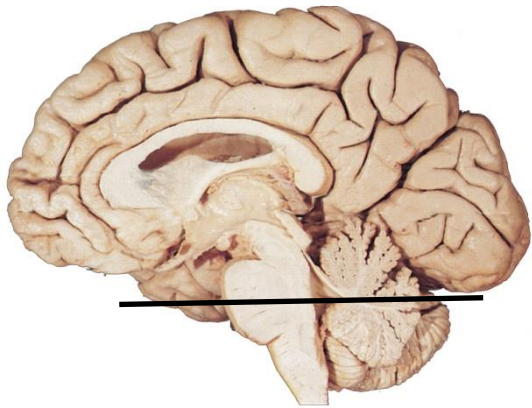
- Superior, middle and inferior cerebellar peduncles attach the cerebellum to the midbrain, pons and medulla respectively on both sides; they are the only routes for axons into and out of the cerebellum.



Ventral surface of the cerebellum

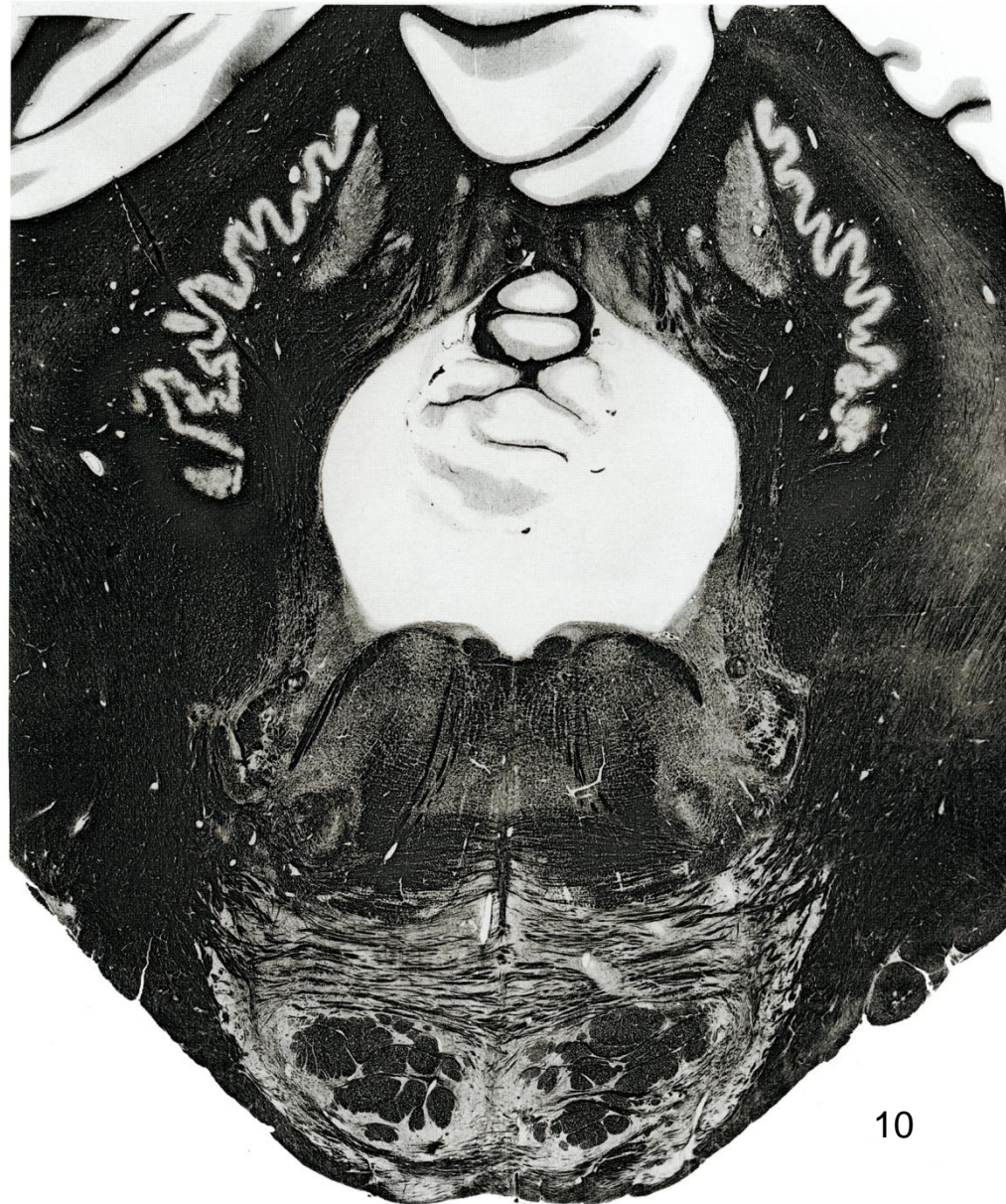
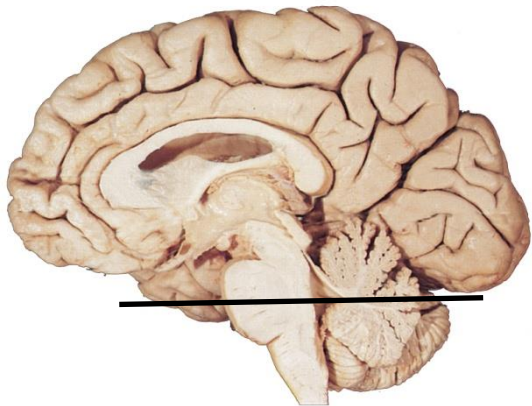
Anatomy of the Cerebellum

- Cerebellum has two cell groups:
 - Cerebellar cortex
 - Deep cerebellar nuclei



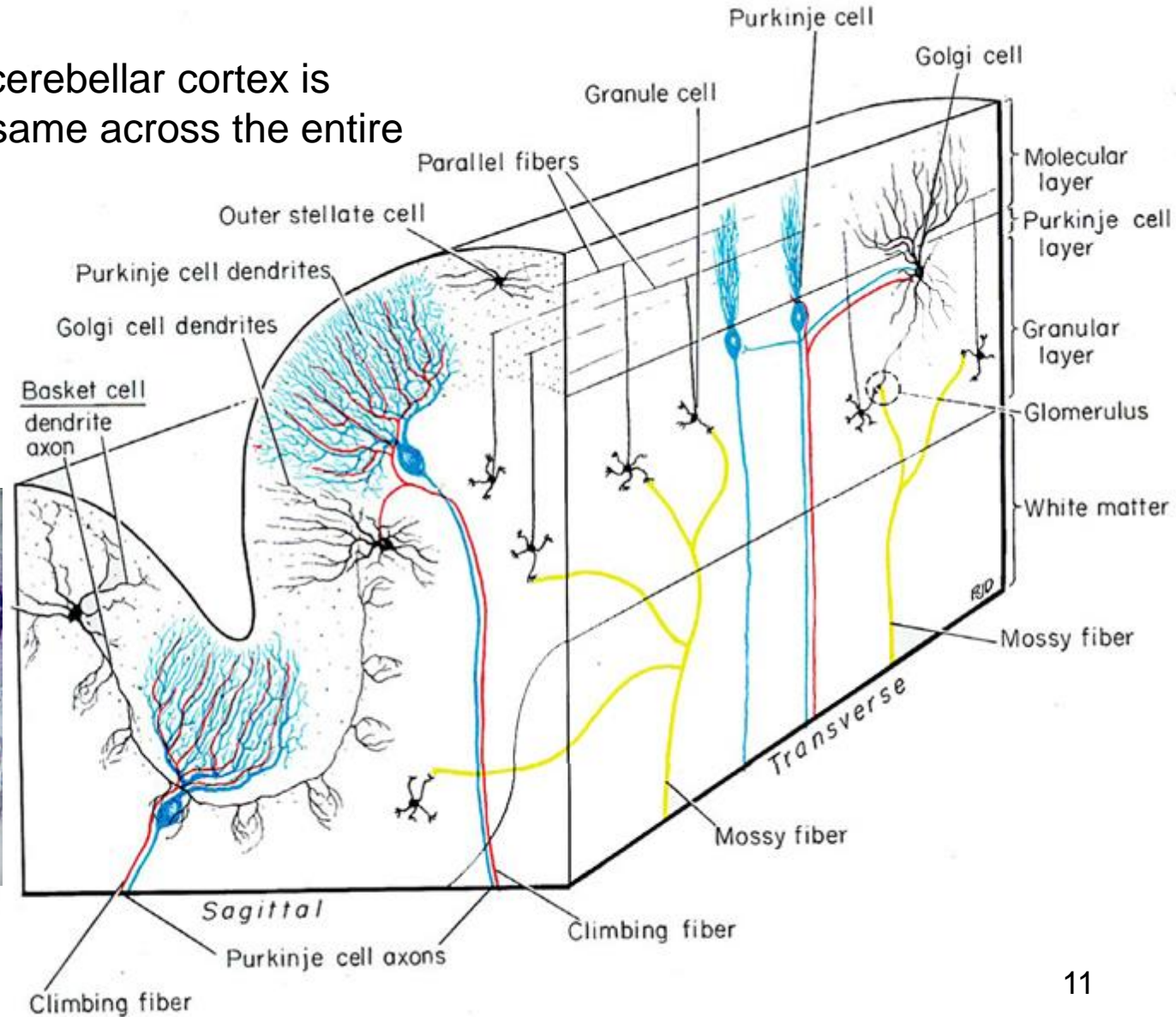
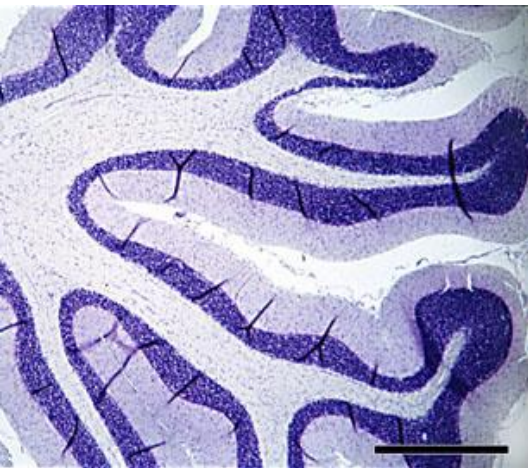
Anatomy of the Cerebellum

- Three pairs of cerebellar nuclei:
 - Fastigial nucleus (medial)
 - Interposed nuclei
 - Dentate nucleus (lateral)
- The main output of the cerebellum is via the deep cerebellar nuclei.



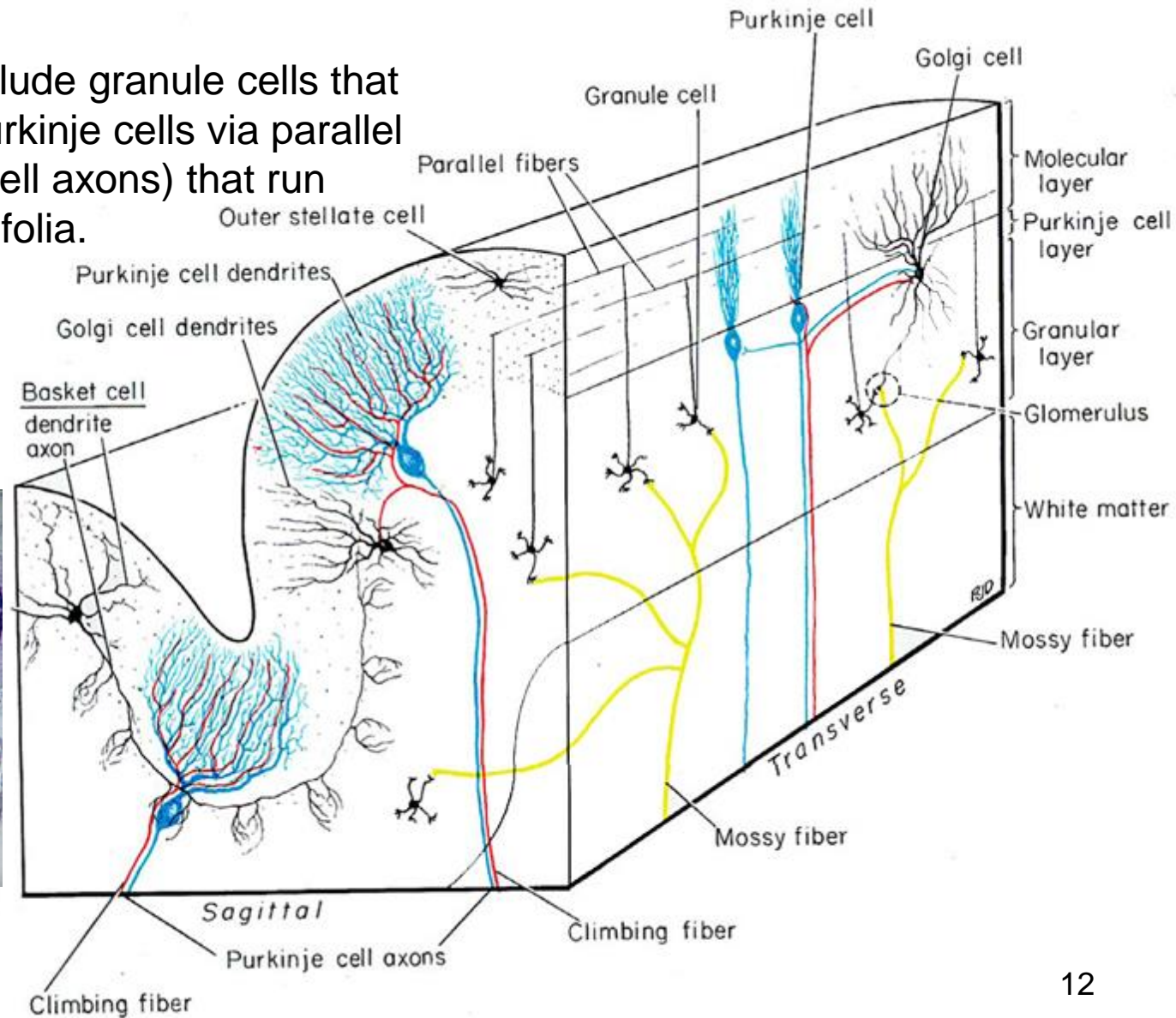
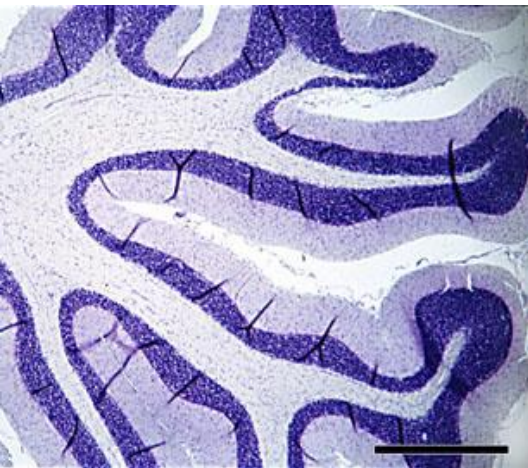
Neuro-Circuitry of the Cerebellum

- The circuitry of cerebellar cortex is remarkably the same across the entire cerebellum.



Neuro-Circuitry of the Cerebellum

- The neurons include granule cells that synapse with Purkinje cells via parallel fibers (granule cell axons) that run parallel with the folia.



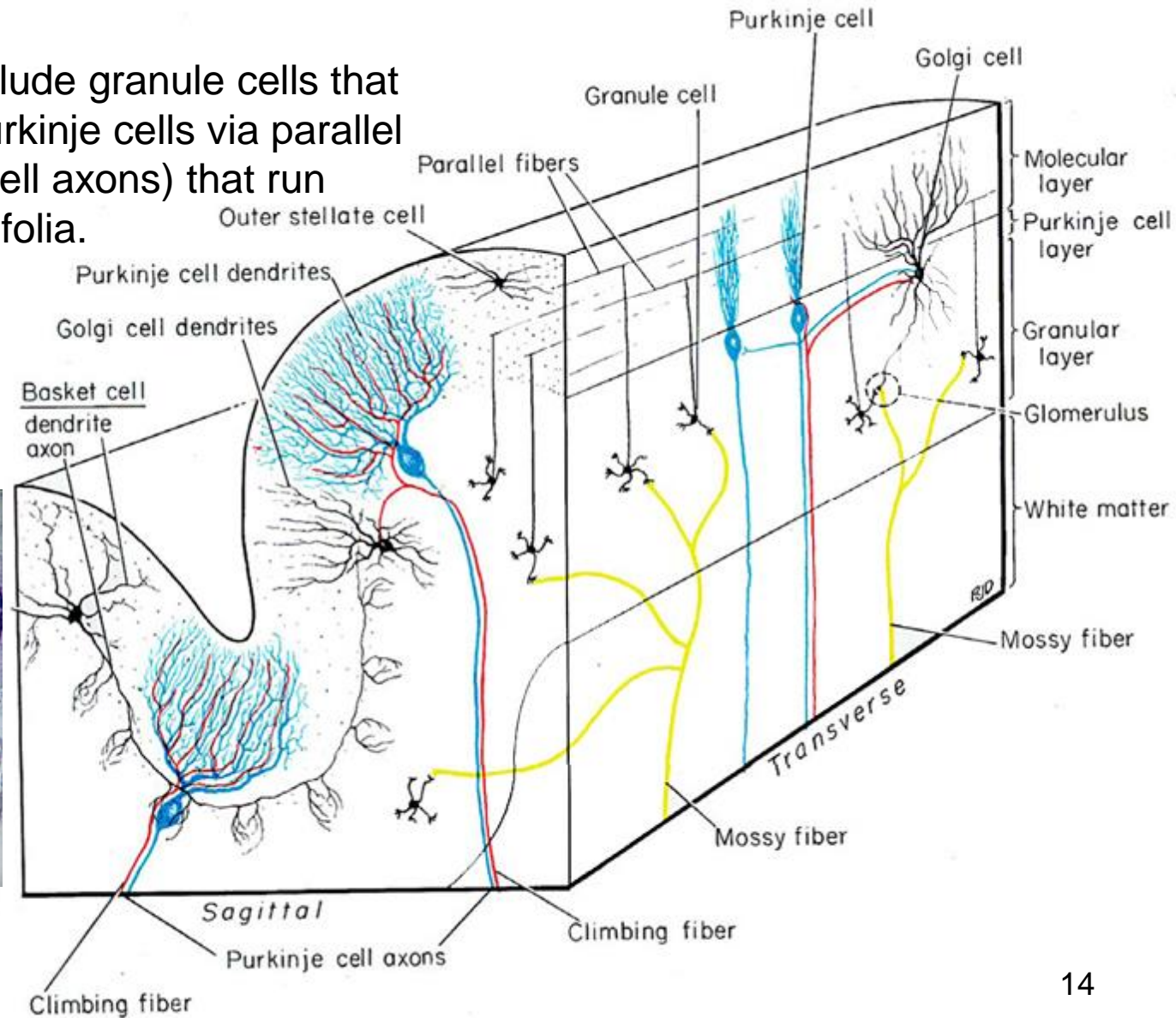
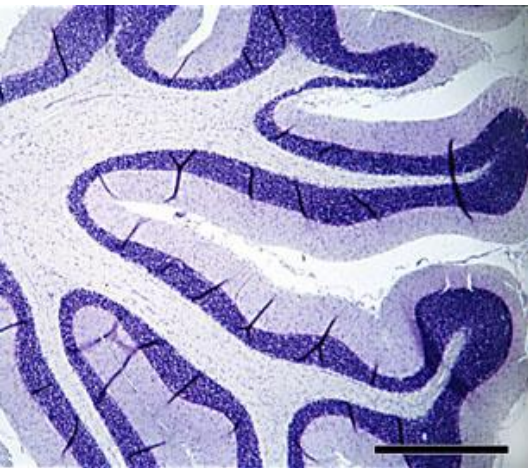
Anatomy of the Cerebellum

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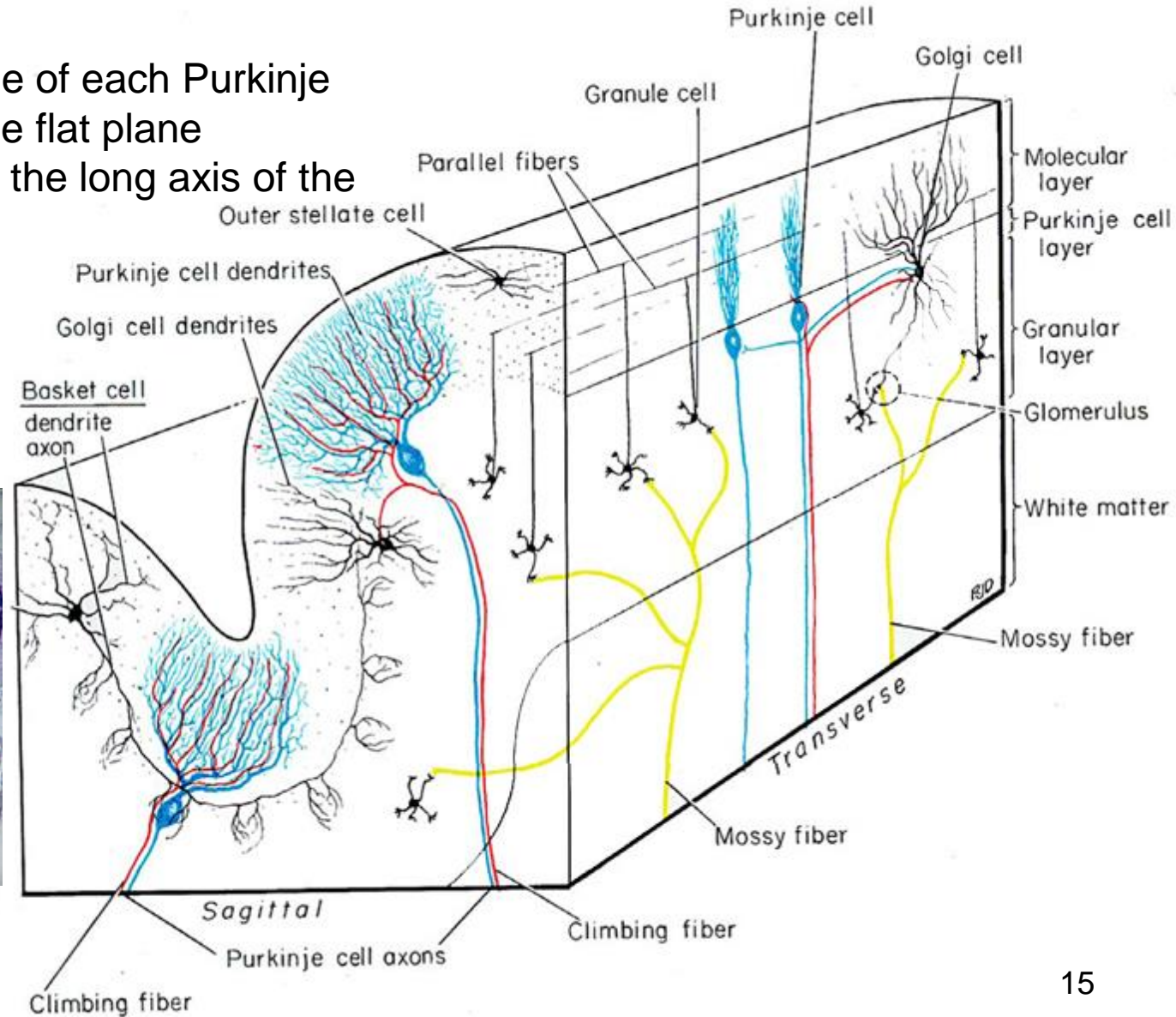
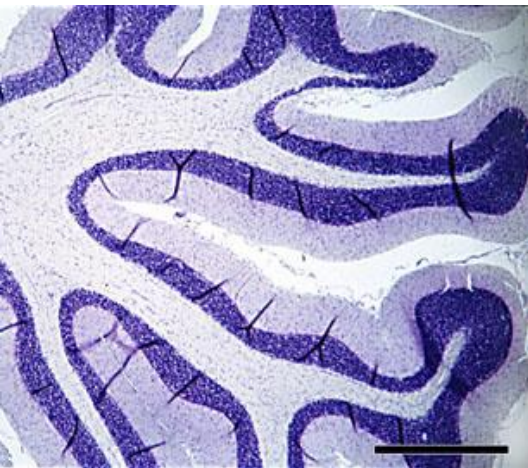
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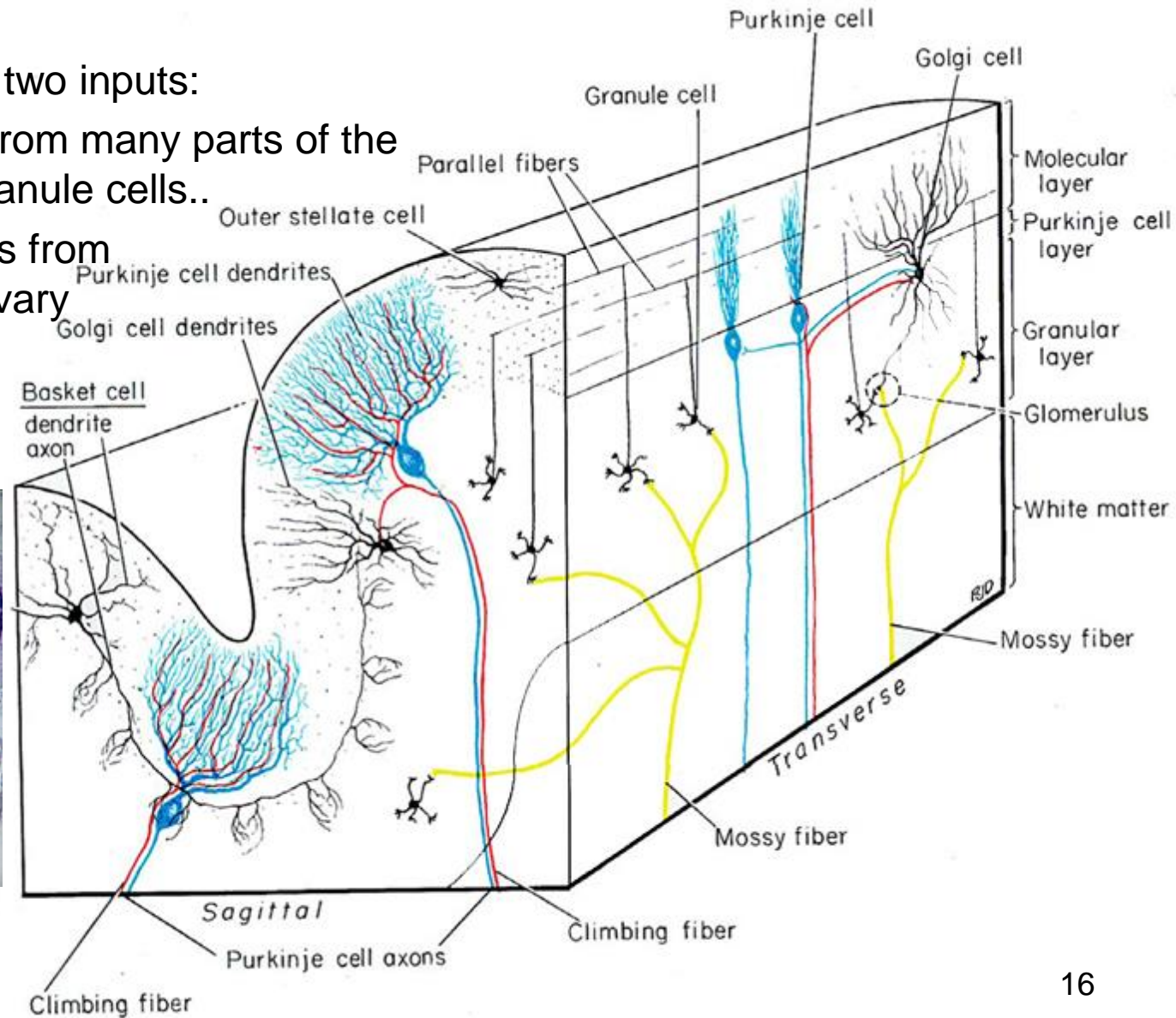
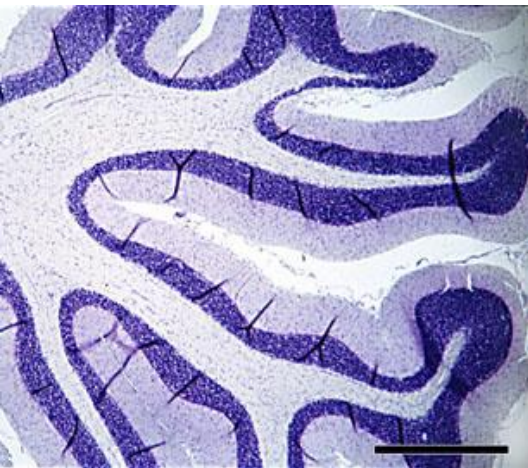
Neuro-Circuitry of the Cerebellum

- The dendritic tree of each Purkinje cell is in a single flat plane perpendicular to the long axis of the folia.



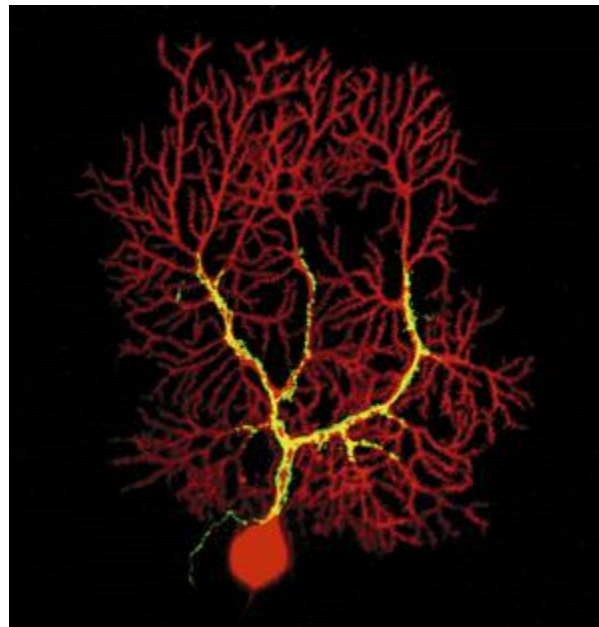
Neuro-Circuitry of the Cerebellum

- Cerebellum has two inputs:
 - Mossy fibers from many parts of the CNS to the granule cells..
 - Climbing fibers from the inferior olivary nucleus to the Purkinje cells.



Neuro-Circuitry of the Cerebellum

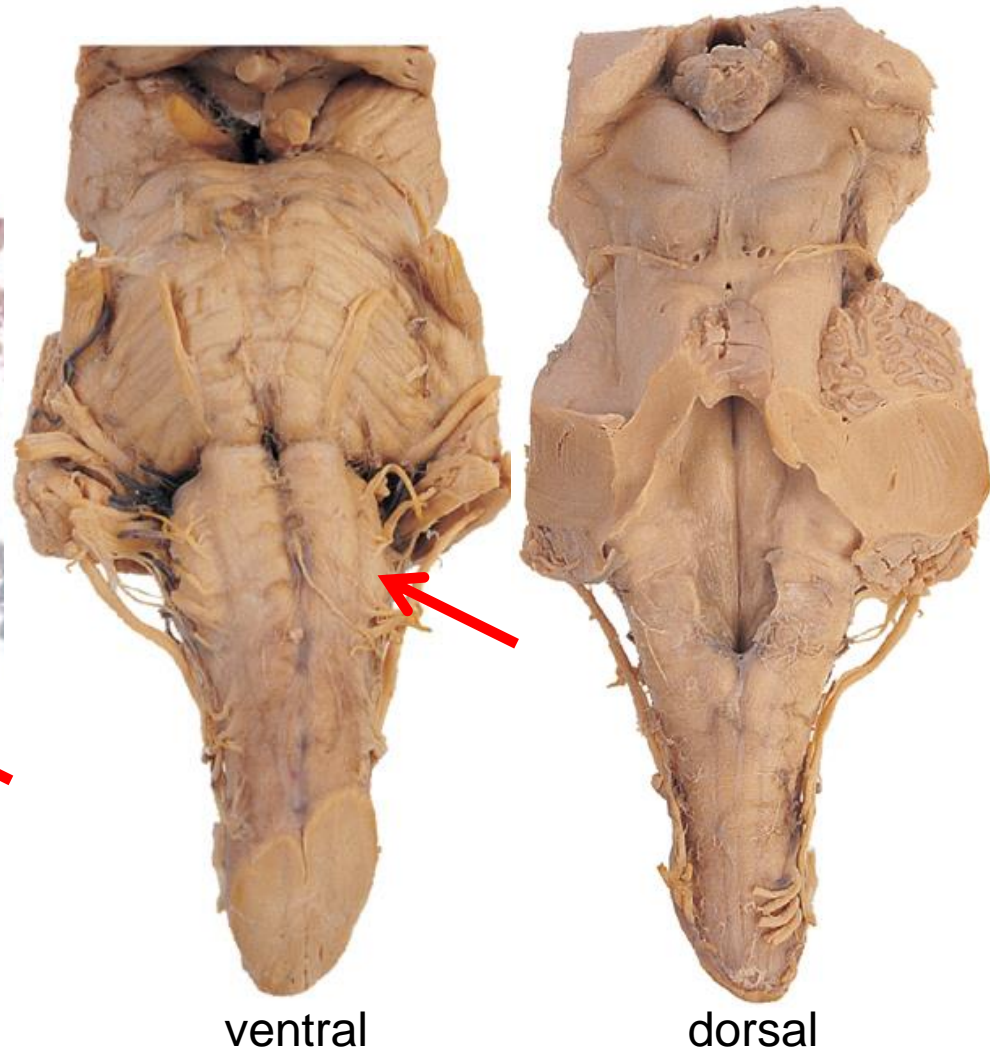
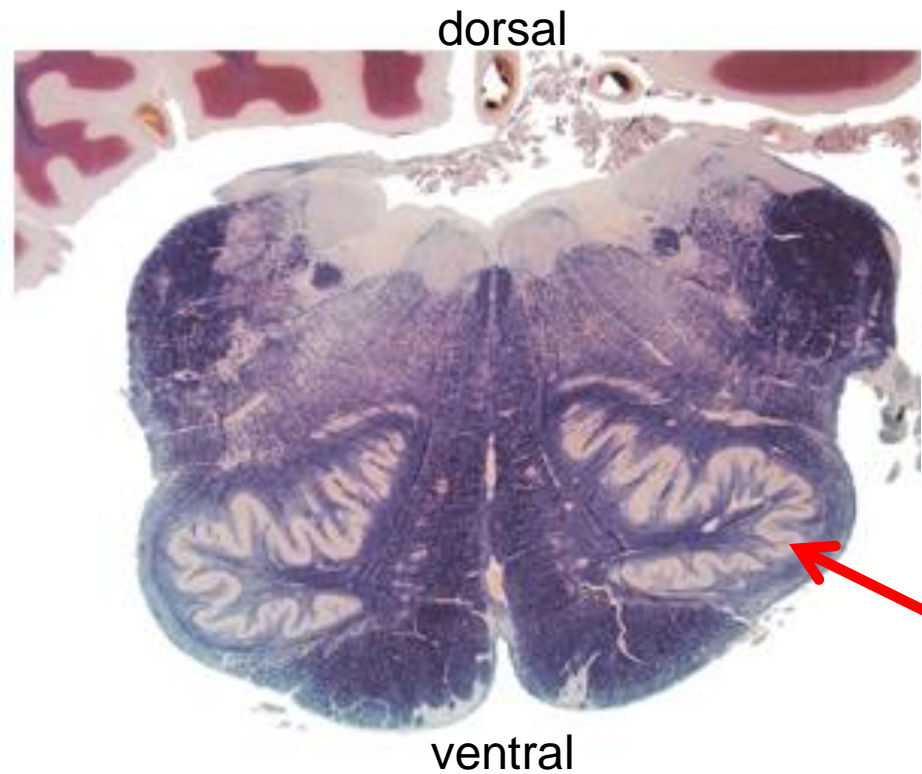
- Each Purkinje cell receives input from a single climbing fiber and from thousands of granule cell axons.



climbing fiber
Purkinje cell

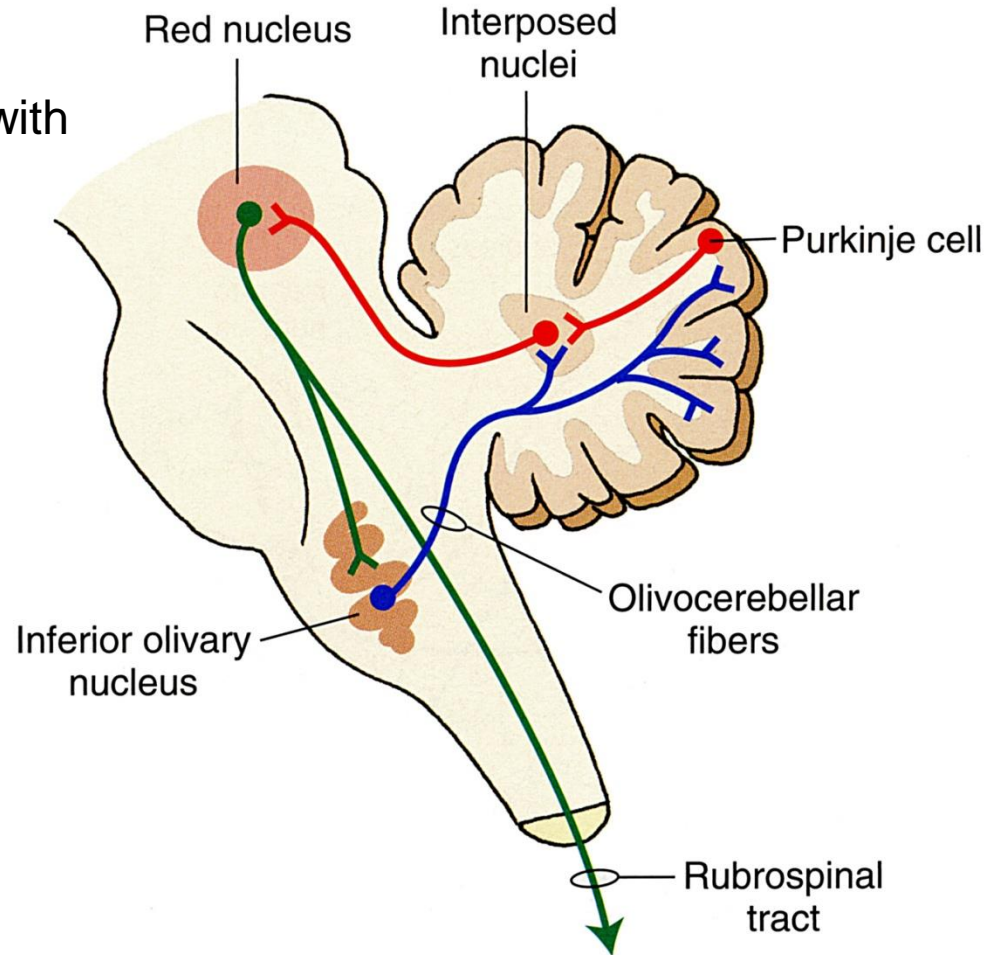
Neuro-Circuitry of the Cerebellum

- Inferior olivary nucleus is in the upper medulla.



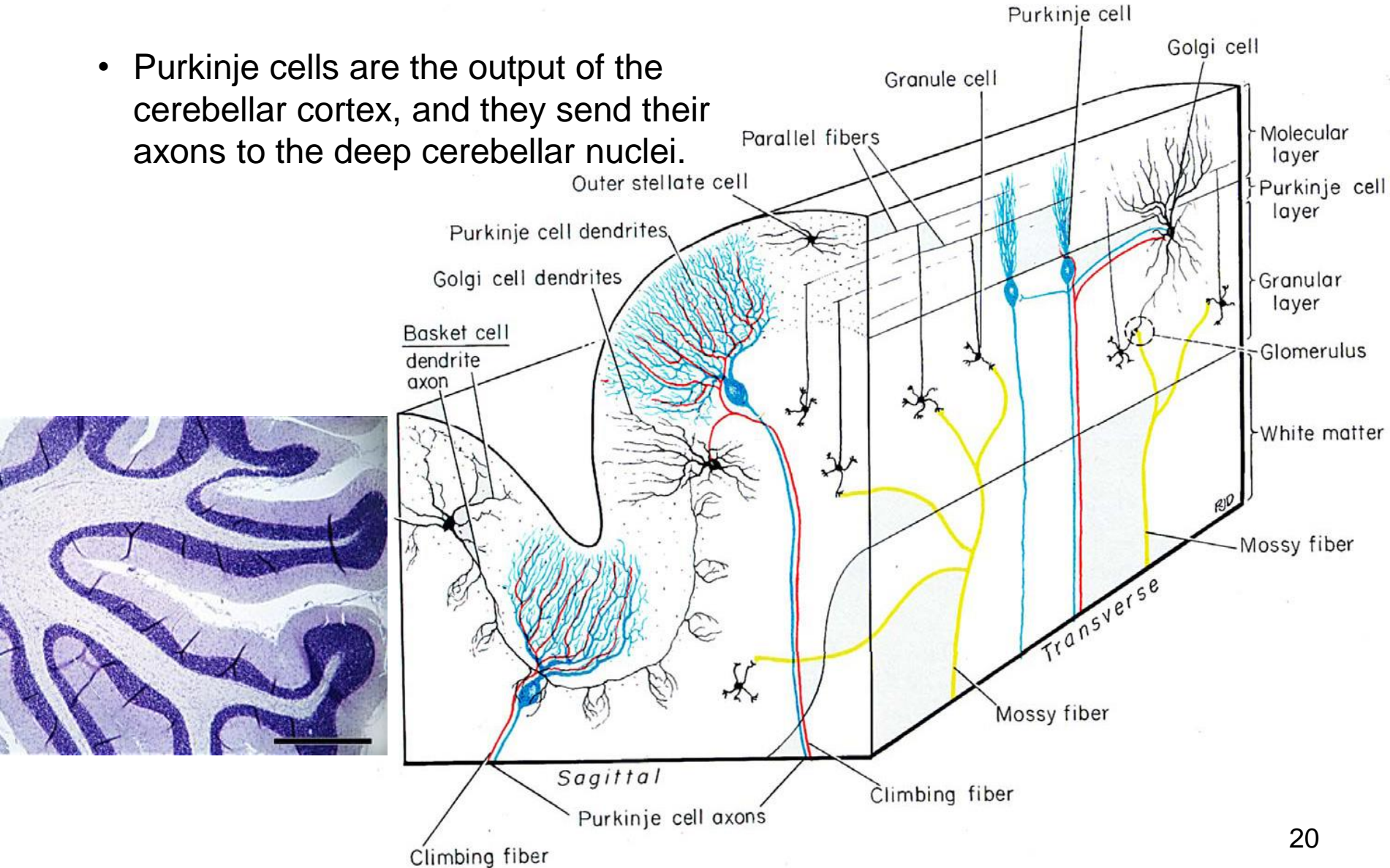
Neuro-Circuitry of the Cerebellum

- The inferior olivary nucleus participates in a feedback loop with cerebellum and red nucleus.



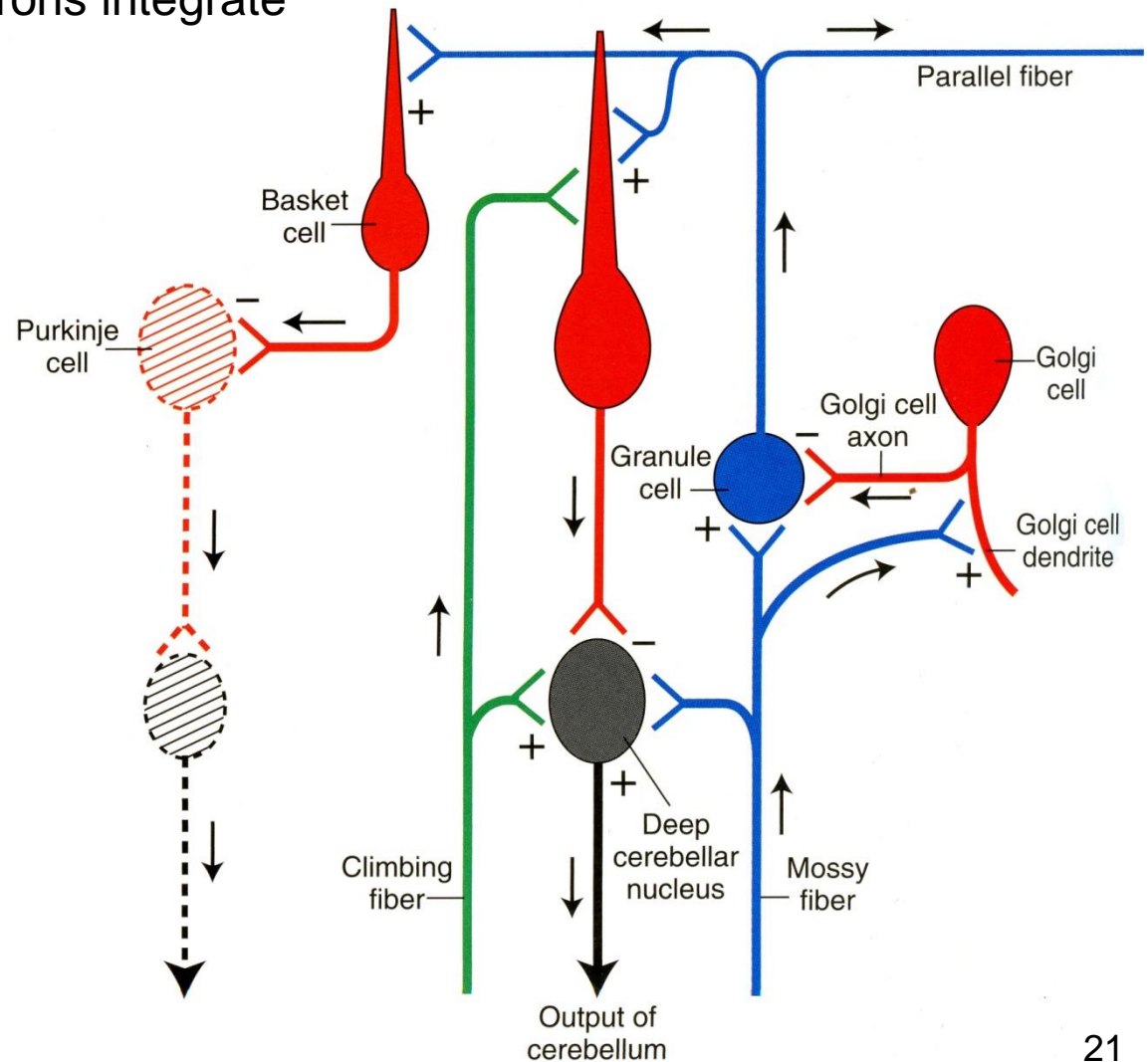
Neuro-Circuitry of the Cerebellum

- Purkinje cells are the output of the cerebellar cortex, and they send their axons to the deep cerebellar nuclei.



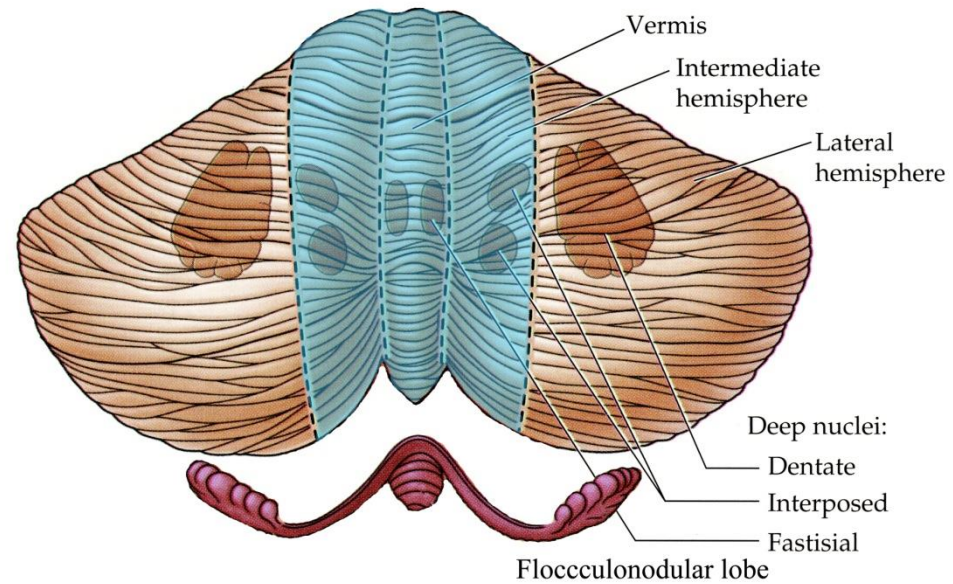
Neuro-Circuitry of the Cerebellum

- Other types of interneurons integrate across folia.



Function of the Cerebellum

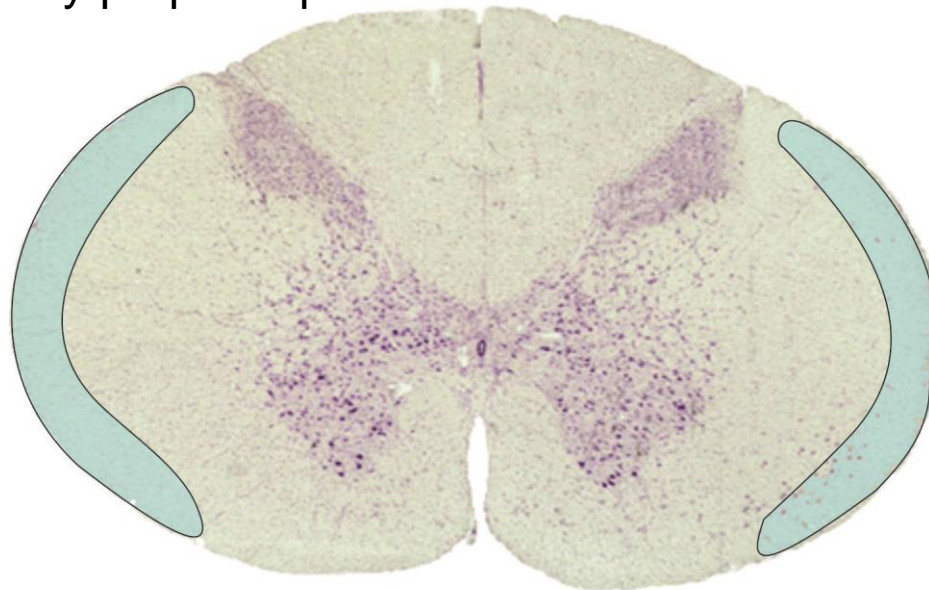
- Cerebellum has three main functional domains:
 - Spinocerebellum (blue)
 - Cerebrocerebellum (brown)
 - Vestibulocerebellum (red)



Function of the Cerebellum

Spinocerebellum:

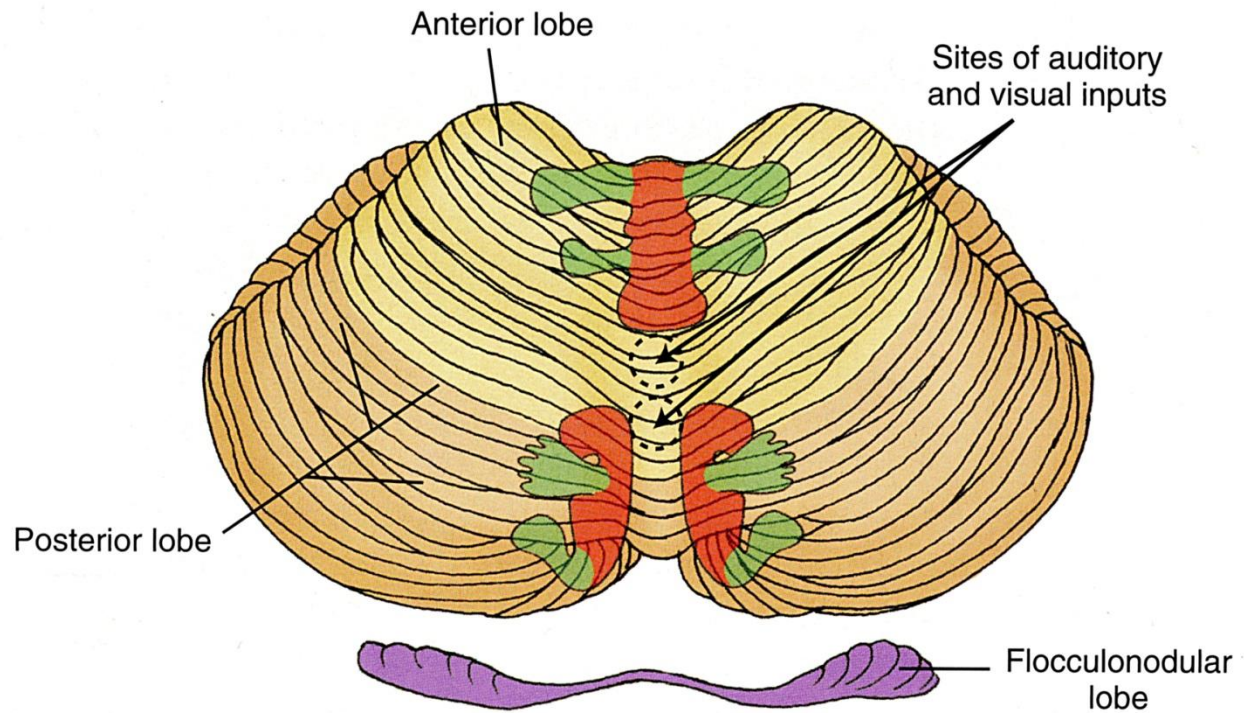
- Main input is from spinocerebellar tracts & tracts from cranial nerve sensory nuclei, which carry proprioceptive information.



Function of the Cerebellum

Spinocerebellum:

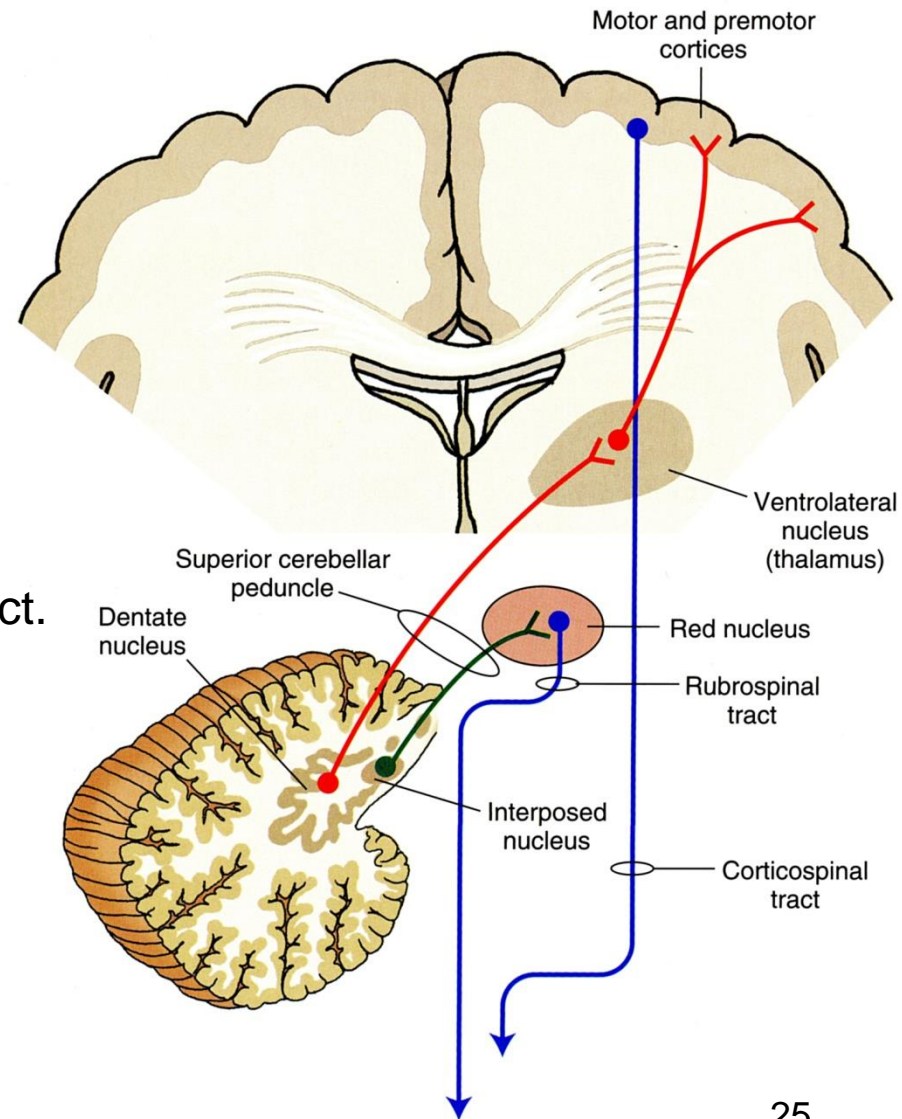
- The input is somatotopically organized.



Function of the Cerebellum

Spinocerebellum:

- Processed in vermis & intermediate hemispheres of cerebellar cortex.
- Output is to interposed nuclei; then to the red nucleus.
- Red nucleus projects to spinal cord & cranial nerve nuclei via rubrospinal tract.
- Coordinates movements; makes mid-course corrections; maintains posture



Ian Waterman, at age 19, had a virus that destroyed his proprioceptive system.

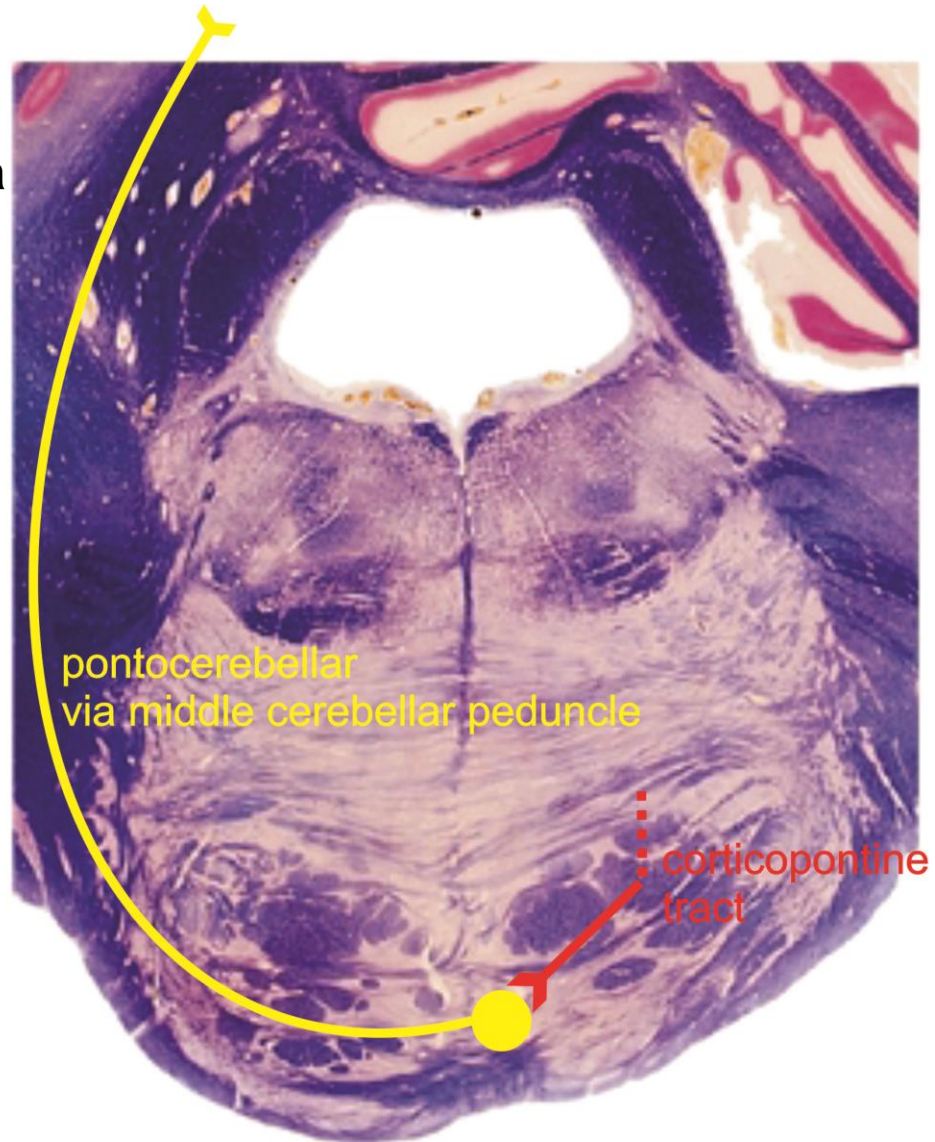
Immediately after his illness, he was unable to walk or do most any motor task.

He learned to walk and do other motor tasks using only vision to monitor a movement.

Function of the Cerebellum

Cerebrocerebellum:

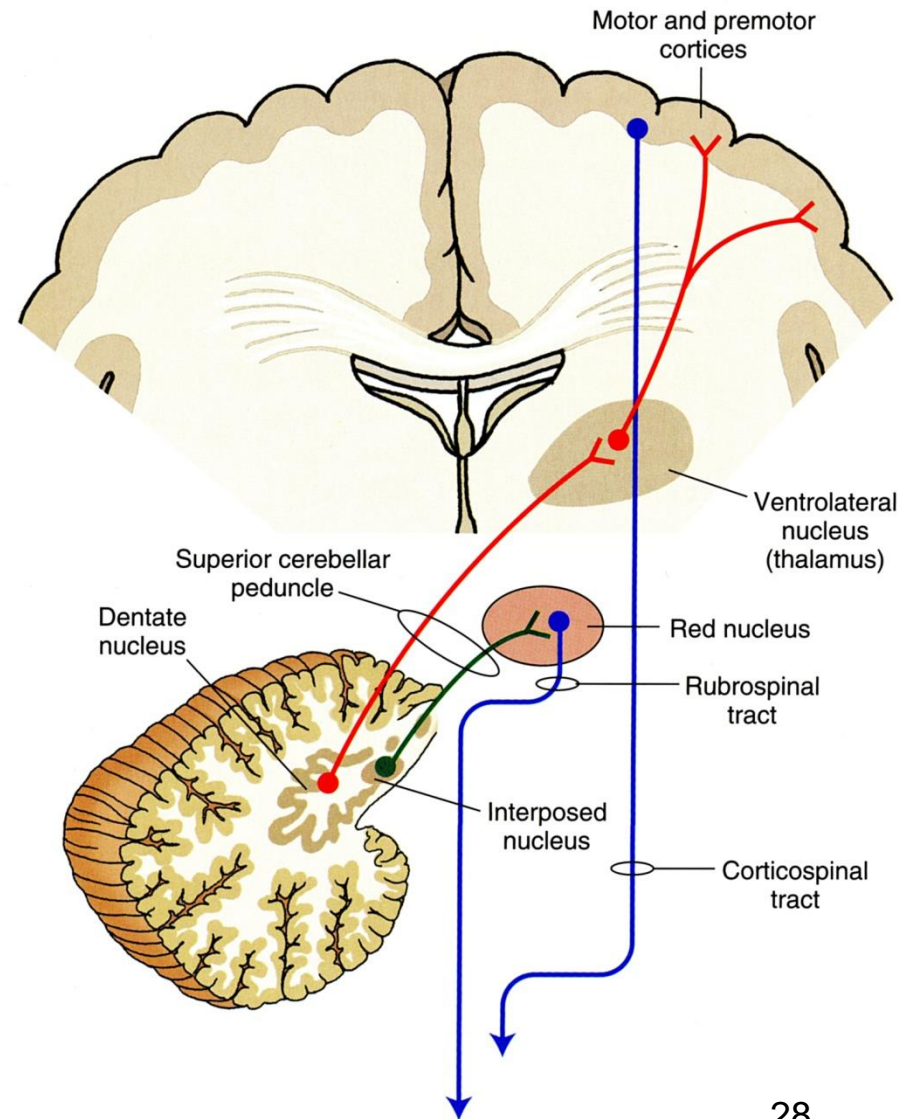
- Main input is from cerebral cortex via the pontine nuclei.
- Pontine nuclei send axons to the contralateral side of the cerebellum via the middle cerebellar peduncle.



Function of the Cerebellum

Cerebrocerebellum:

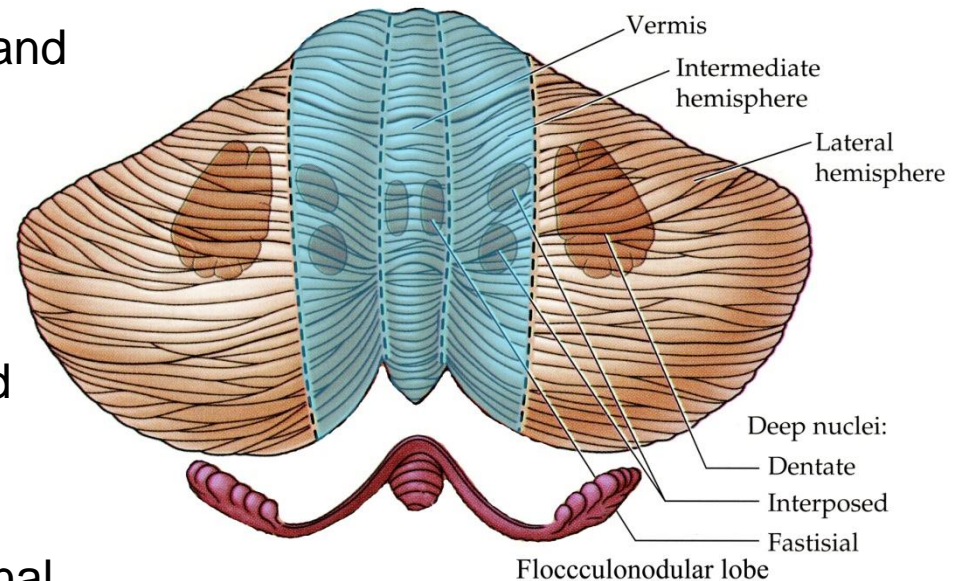
- Processed in lateral hemispheres.
 - Output is to dentate nucleus; then to ventrolateral nucleus of the thalamus; then to cortex.
 - Coordinates movement planning and learned movements.
- Also involved in cognitive functions.



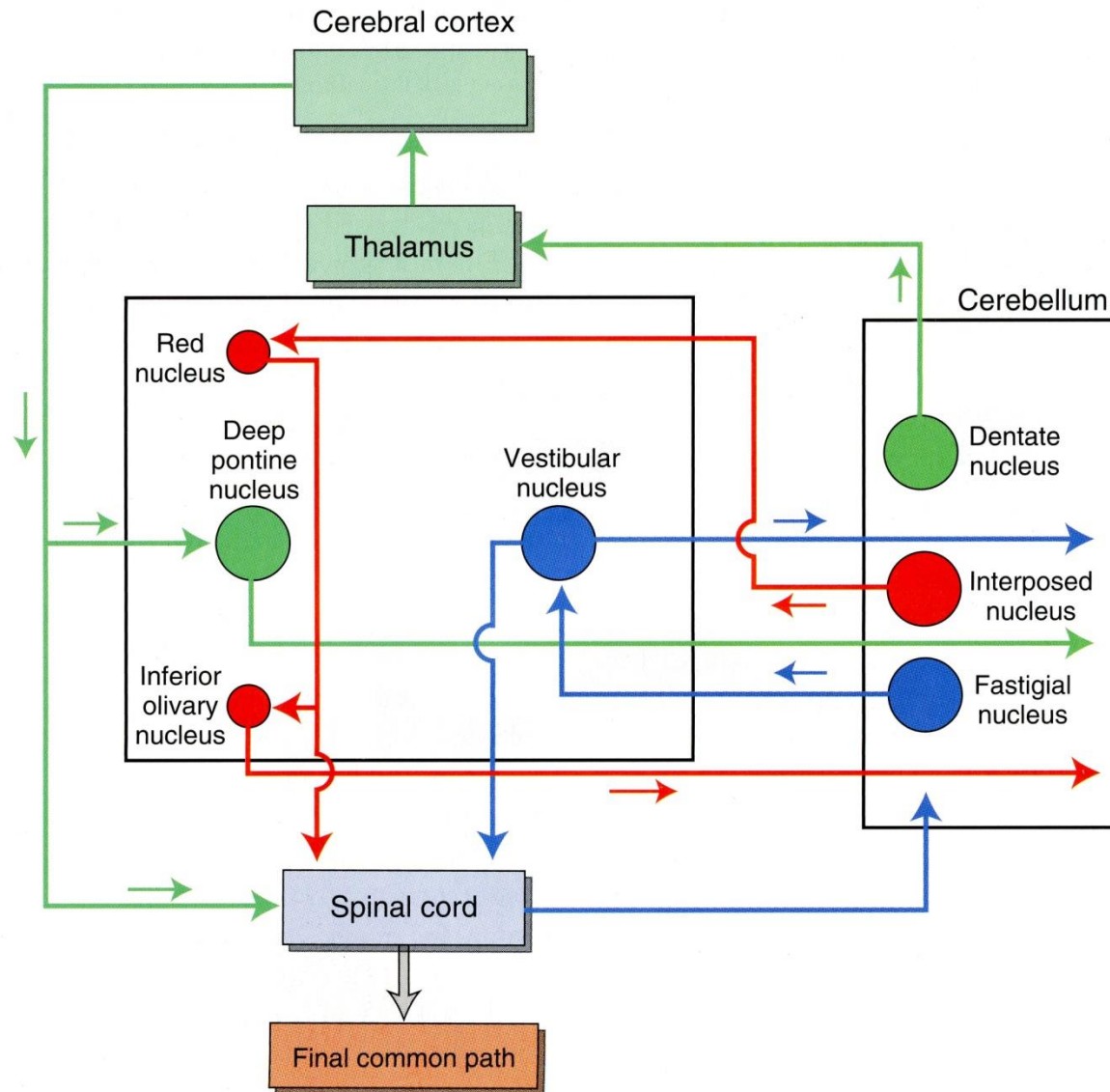
Function of the Cerebellum

Vestibulocerebellum:

- Main input is from vestibular nuclei and vestibular nerve.
- Processed in flocculonodular lobe.
- Output is to the fastigial nucleus and directly to vestibular nuclei.
- Vestibular nuclei send axons to spinal cord & cranial nerve motor nuclei.
- Maintains balance and coordinates head & eye movements.



Function of the Cerebellum



Function of the Cerebellum

Important functions of the cerebellum:

- Movement synergy (coordinate multiple muscles and muscle groups)
- Maintain appropriate muscle tension and speed of movement
- Maintain balance and posture (largely through extensor muscles)

Cerebellar Pathology

Three common symptoms of cerebellar pathology:

- Ataxia – inaccuracy in speed, force and distance of movements (i.e. uncoordinated); often under or over reach for an object; staggering and lurching walk
- Tremor – involuntary movement most pronounced when trying to perform an accurate movement
- Nystagmus – rapid involuntary movements of the eyes

Cerebellar Pathology

- Cerebellar problems are typically due to strokes, tumors or a neurodegenerative disease (often genetically based).
- Unilateral cerebellar pathology results mainly in ipsilateral motor problems.