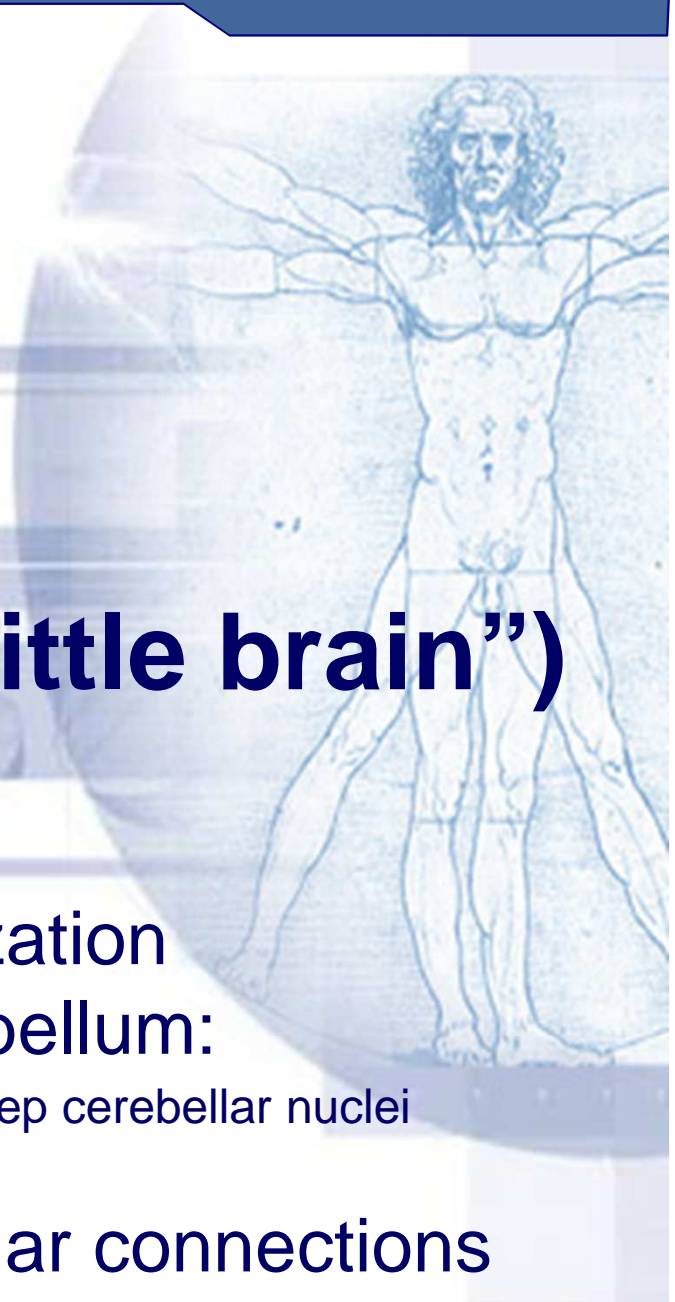


Cerebellum (“little brain”)

1. General and regional organization
2. Internal structure of the cerebellum:
 - ✓ grey matter – cerebellar cortex & deep cerebellar nuclei
 - ✓ white matter – “*arbor vitae*”
3. Afferent and efferent cerebellar connections
4. Cerebellar functions and dysfunctions





Cerebellum – gross anatomy

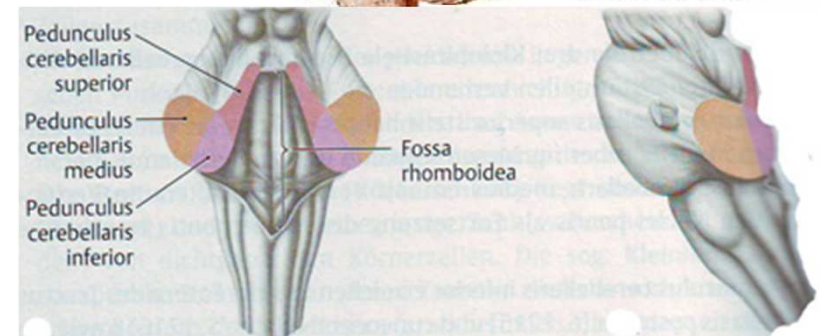
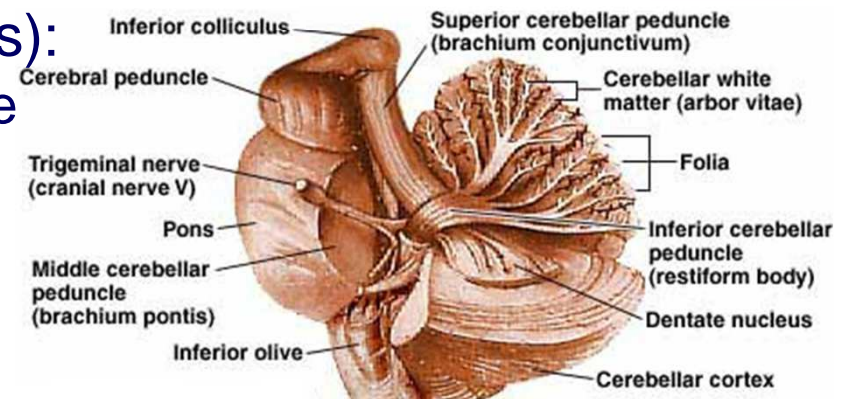
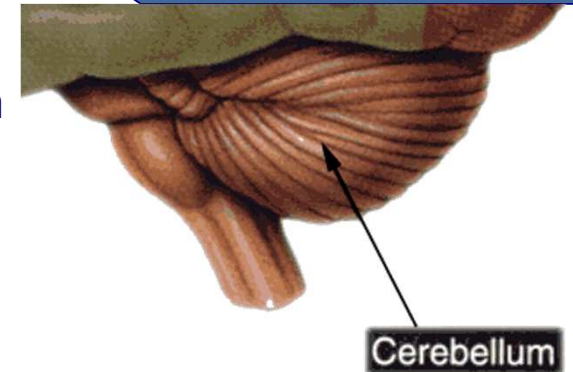
■ Regional location:

- ✓ posterior cranial fossa, covered by cerebellar tentorium
- ✓ beneath the occipital lobes of cerebral hemispheres
- ✓ behind the pons and medulla oblongata
- ✓ roof of the fourth ventricle

■ Connections with brainstem structures (three paired fiber bundles – peduncles):

- ✓ midbrain – superior cerebellar peduncle (*brachium conjunctivum*)
- ✓ pons – middle cerebellar peduncle (*brachium pontis*)
- ✓ medulla – inferior cerebellar peduncle (*restiform body*)

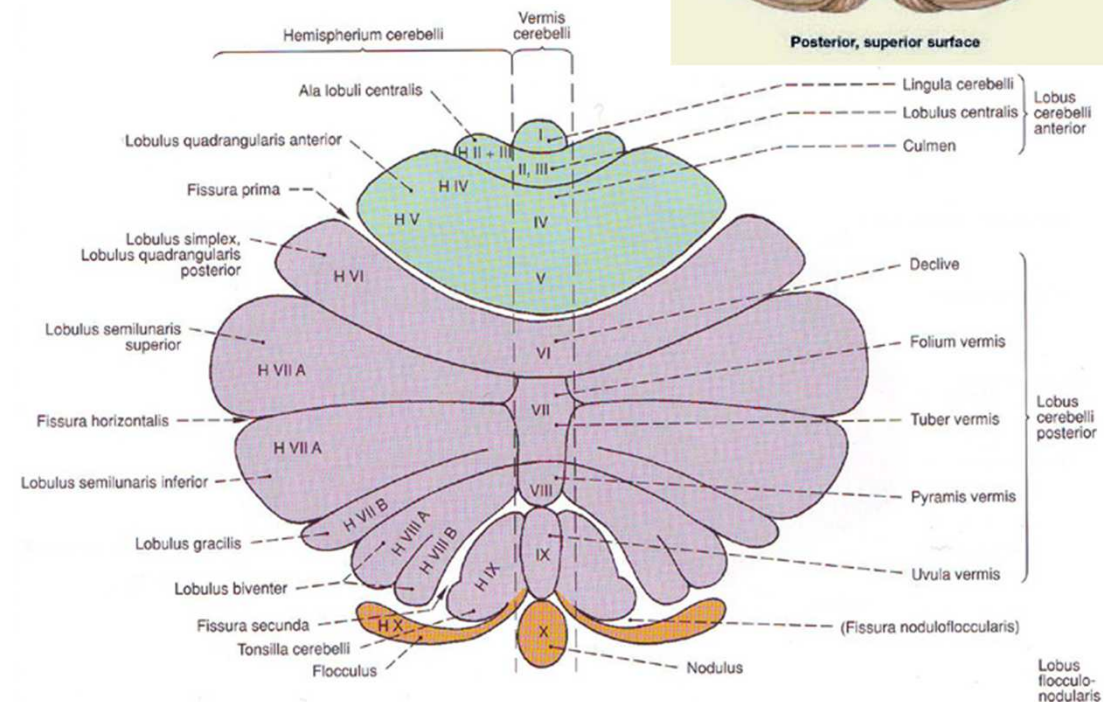
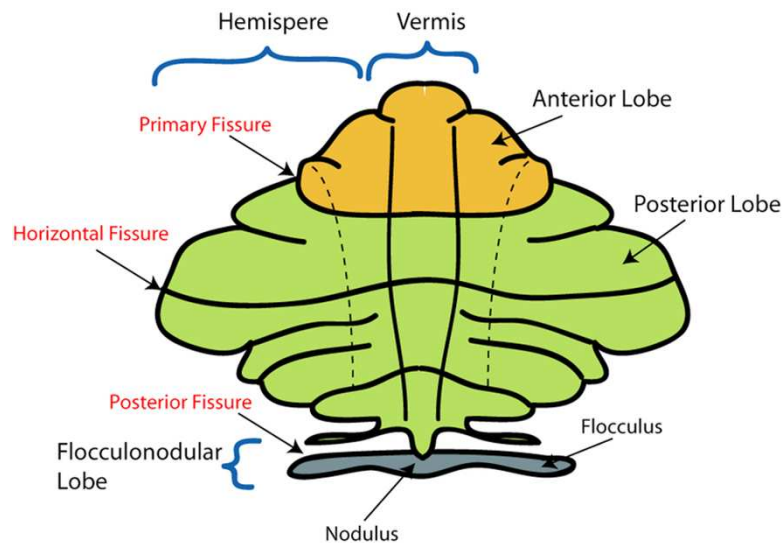
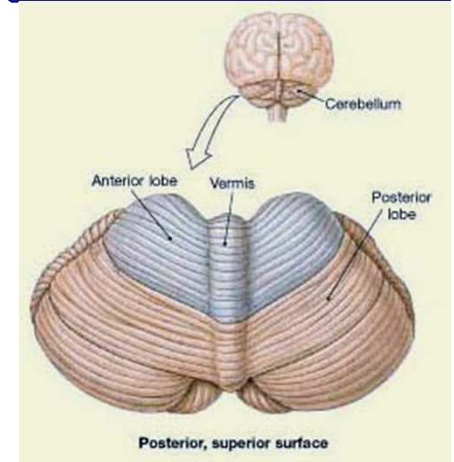
- average weight ~130 g (10% of the total brain volume)
- cerebellum:cerebrum = 1:8 (adult); 1:20 (infant)
- more than 50% of all neurons in the brain
- origin: embryonic hindbrain (rhombencephalon)
- major integrative center for the coordination of muscular activity





Cerebellum – divisions

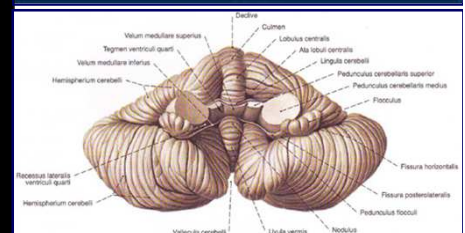
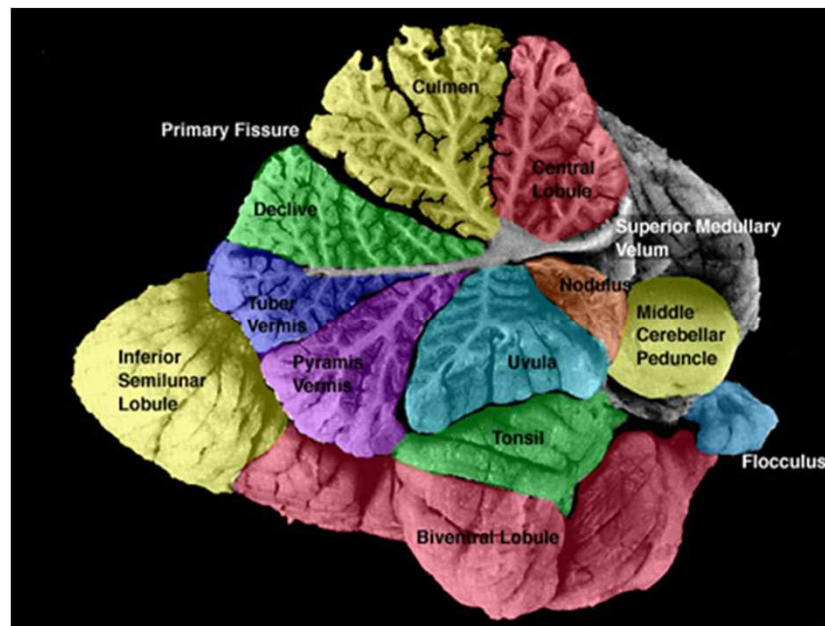
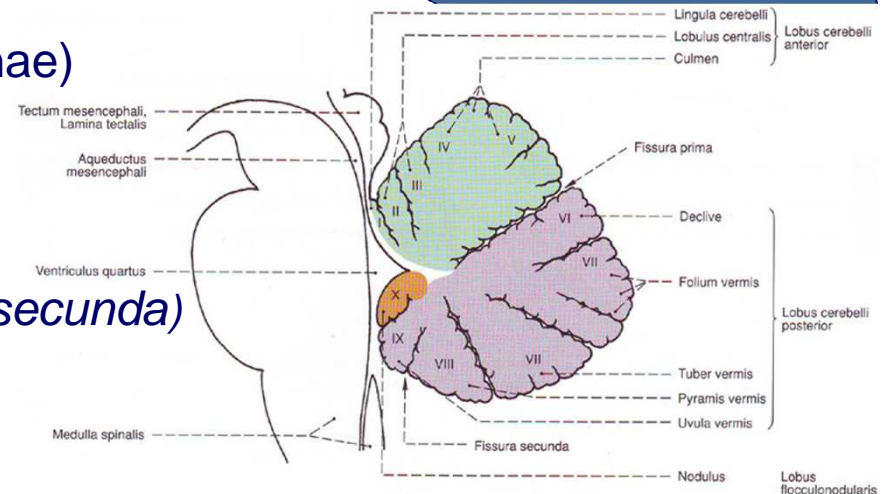
- three sagittal subdivisions:
 - ✓ median portion, cerebellar vermis
 - ✓ two lateral parts, cerebellar hemispheres
- three transverse subdivisions (lobes):
 - ✓ anterior lobe
 - ✓ posterior lobe
 - ✓ flocculonodular lobe





Cerebellum – surface topography

- Foliar pattern:
 - ✓ *folia cerebelli* (transverse leaf-like laminae)
- Cerebellar fissures:
 - ✓ *fissura prima* – V-shaped
 - ✓ horizontal fissure
 - ✓ pre- and postpyramidal fissure (*fissura secunda*)
 - ✓ posterolateral fissure
- Vermis lobules:
 - ✓ superior surface:
 - *lingula*
 - *central lobule*
 - *monticulus*:
 - *culmen*
 - *declive*
 - *folium vermis*
 - ✓ inferior surface:
 - *tuber vermis*
 - *pyramid*
 - *uvula*
 - *nodule*





Cerebellum – surface topography

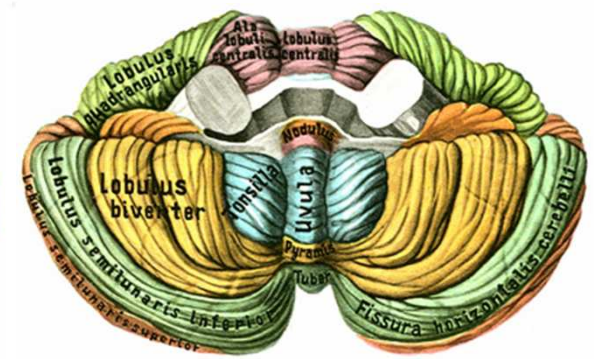
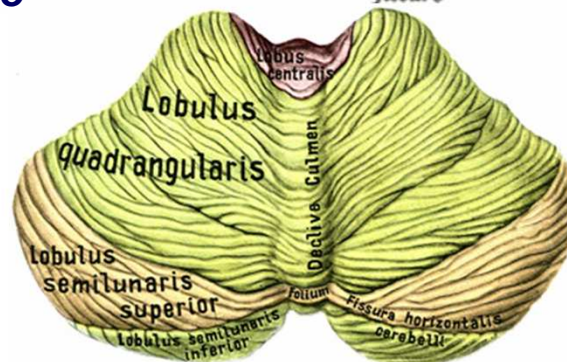
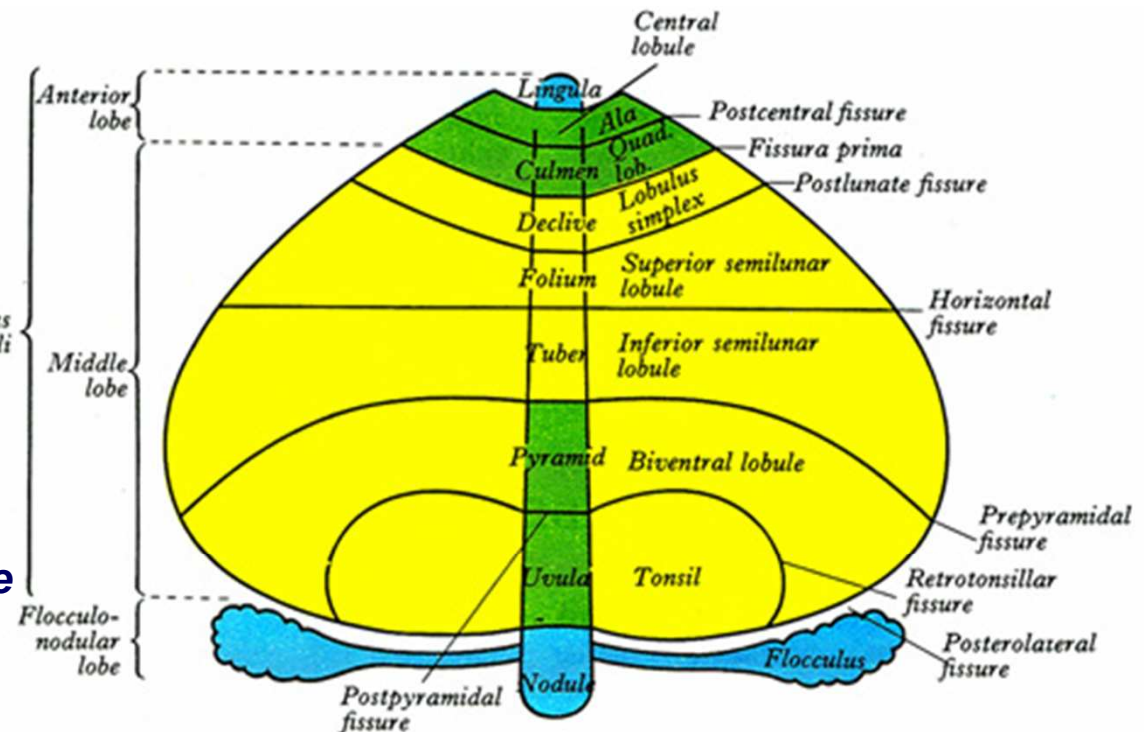
■ Hemisphere lobules:

✓ superior surface:

- (*vinculum lingulae*)
- *alae of the central lobule*
- *anterior quadrangular lobule*
- *lobulus simplex (posterior quadrangular lobule)*
- *superior semilunar lobule*

✓ inferior surface:

- *inferior semilunar lobule*
- *gracile lobule (paramedianus)*
- *biventral lobule*
- *tonsil*
- *flocculus*





Phylogenetic and functional divisions

■ Archicerebellum:

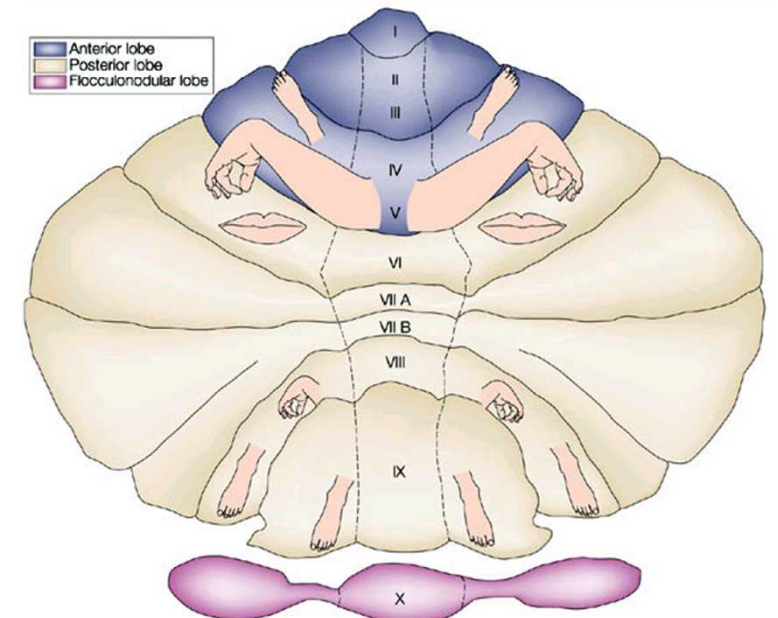
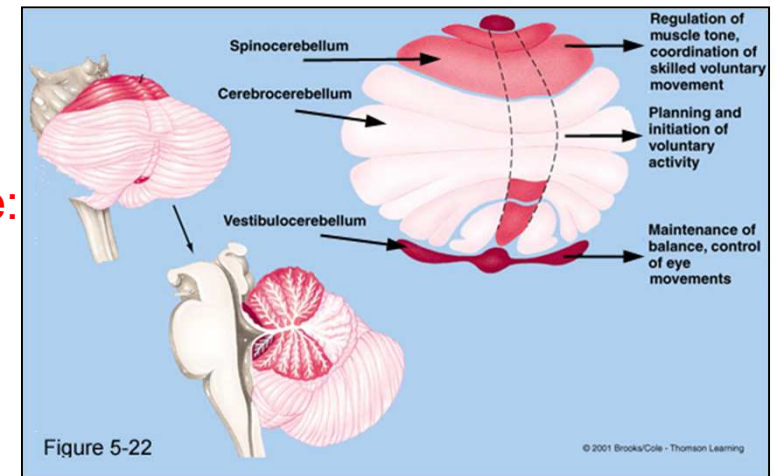
- ✓ flocculonodular lobe = *flocculus* + *nodulus* (+ part of *uvula*)
- ✓ functionally related to maintenance of balance: *vestibulocerebellum*

■ Paleocerebellum:

- ✓ anterior lobe = *lingula*, *central lobule*, *culmen*, *pyramid*, *uvula* (of vermis) + *quadrangular lobules* (of cerebellar hemispheres)
- ✓ regulates body and limb movements, involved in control of muscle tone via the spinal cord: *spinocerebellum*

■ Neocerebellum:

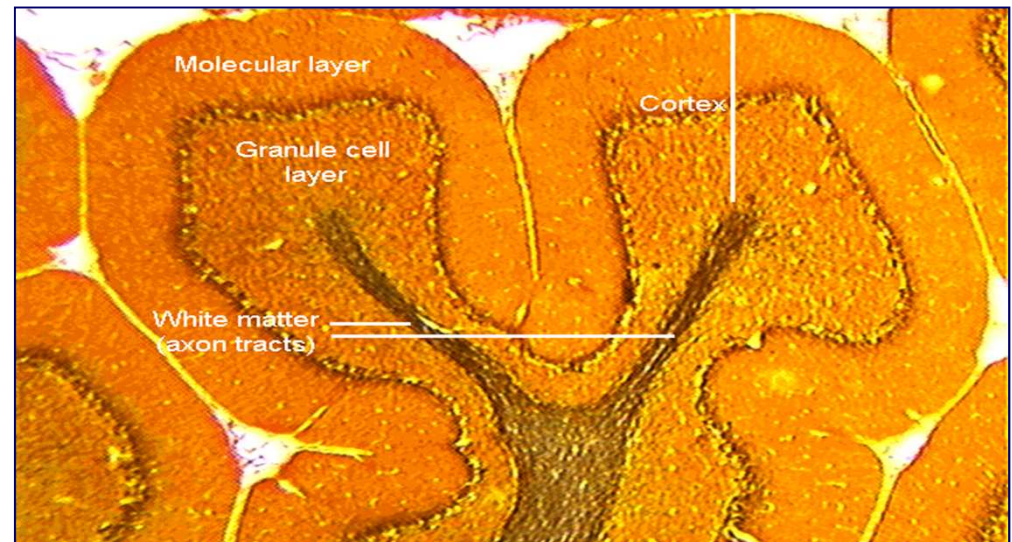
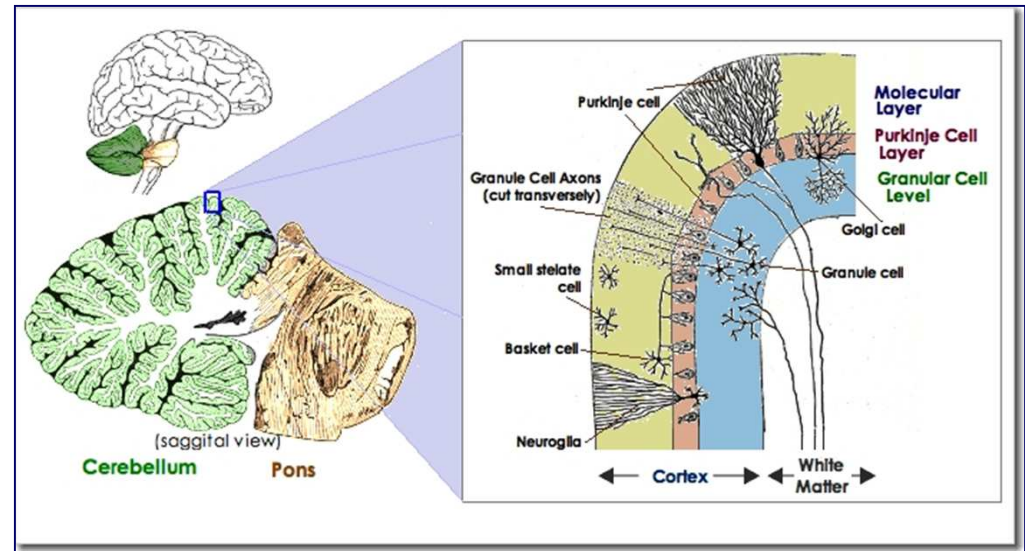
- ✓ posterior lobe = the rest of cerebellum
- ✓ most concerned with planning movement and coordination of somatic motor function: *cerebrocerebellum* (*pontocerebellum*)





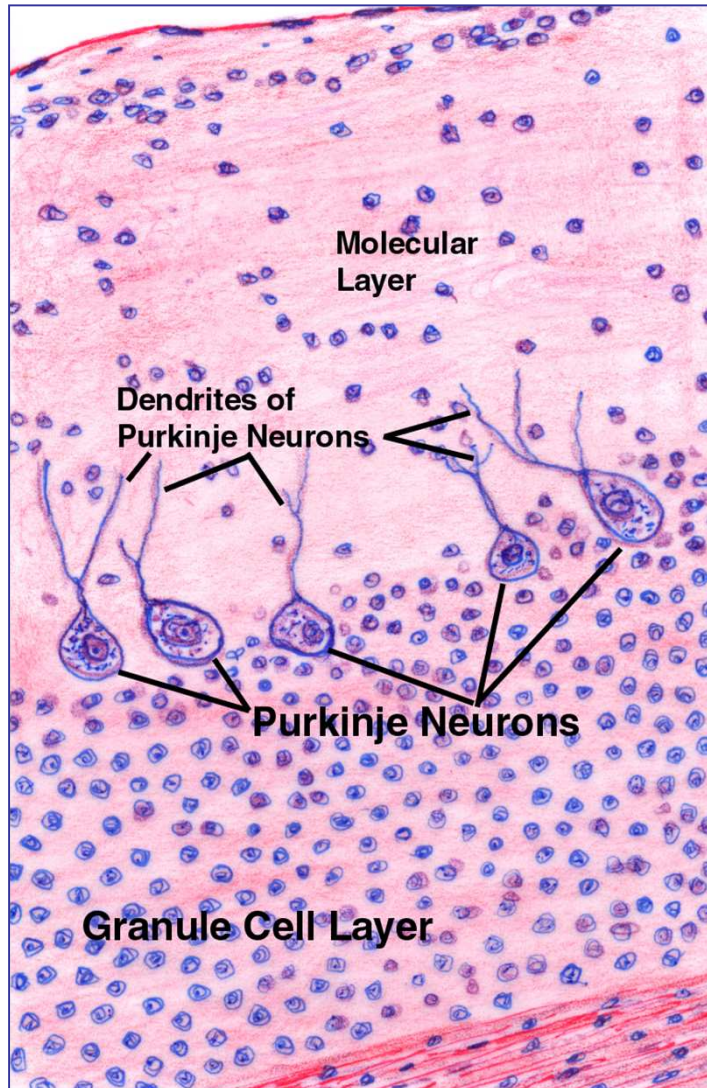
Cerebellum – internal structure

- grey matter:
 - ✓ cerebellar cortex, *cortex cerebelli*
 - ✓ intracerebellar (deep) nuclei, *nuclei cerebelli*
- white matter, medullary substance (*corpus medullare*):
 - ✓ primary laminae – “*arbor vitae*” (tree of life)
 - ✓ intrinsic fibers, *fibrae propriae*
 - ✓ projection fibers
 - ✓ myelinated axons of the Purkinje cells
 - ✓ afferent fibers – ‘climbing’ and ‘mossy’



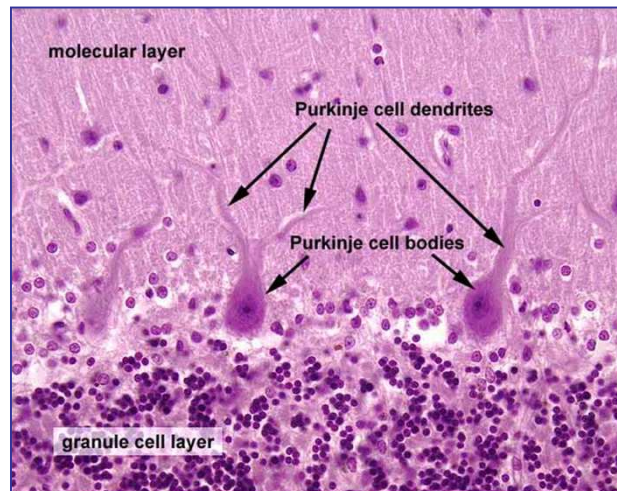
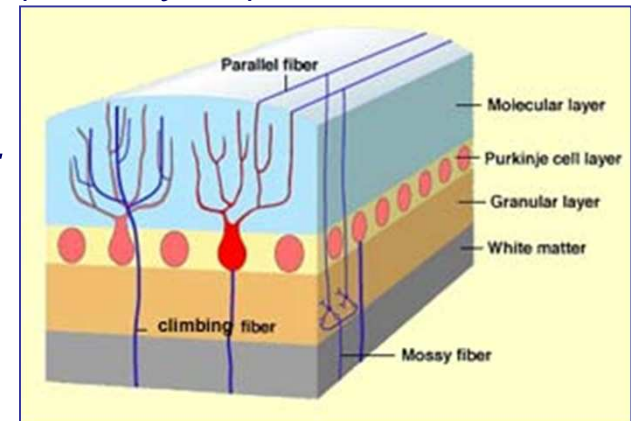


Cerebellar cortex



- Molecular layer, *stratum moleculare* – 300-400 μm
 - ✓ outer stellate neurons and basket cells (GABA)
 - ✓ *Fañanás* glial cells (astrocytes) – feather-like

- Purkinje cell layer, *stratum purkinjense*:
 - ✓ *Purkinje* cells
 - ✓ *Bergmann* glial cells

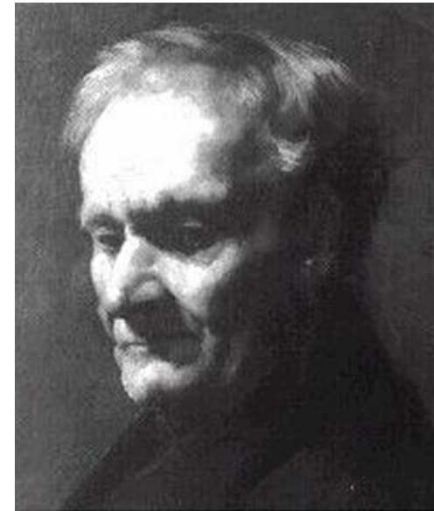


- Granular layer, *stratum granulosum* – 100 μm :
 - ✓ granule cells – 10^{11} (Glu)
 - ✓ *Golgi* type II cells (GABA)

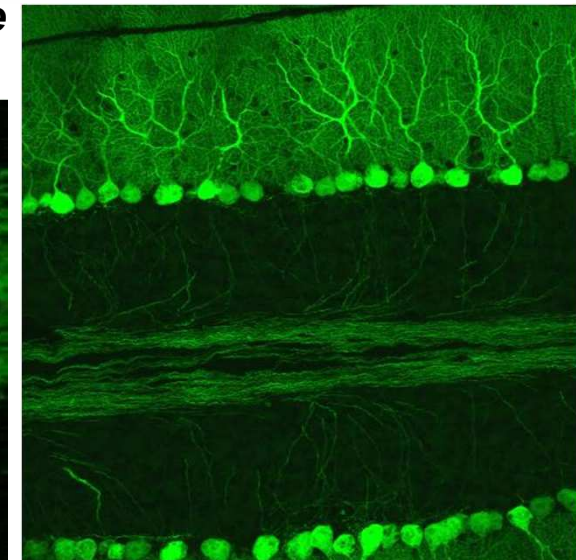
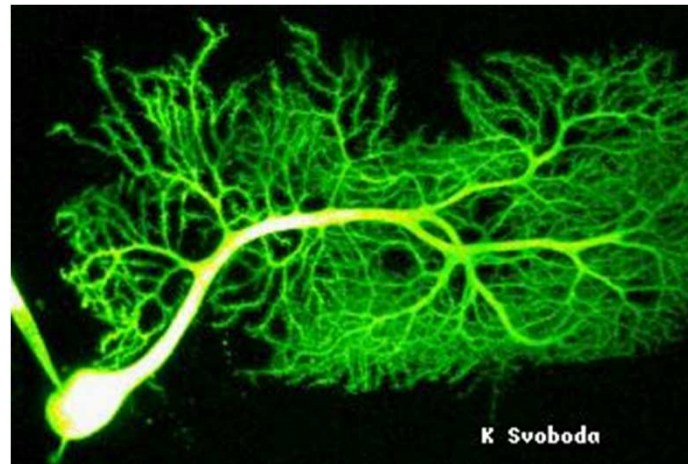
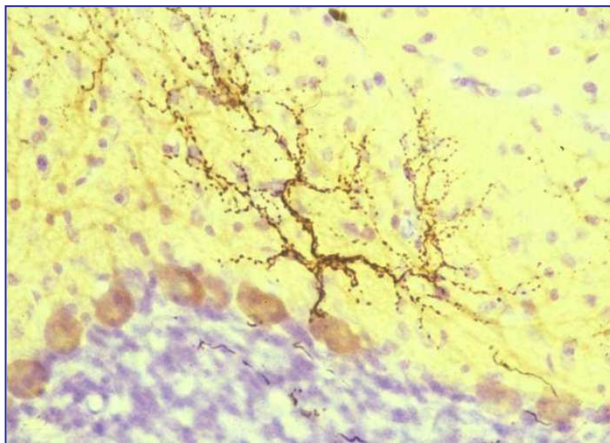
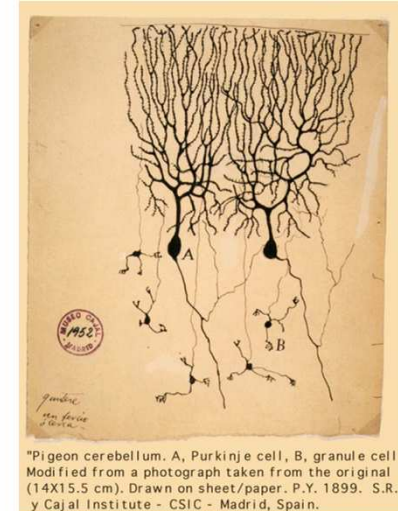


Purkinje cells

- ✓ large flask-shaped – 50-80 μm in diameter
- ✓ most numerous (15×10^6) neurons in CNS
- ✓ large number of dendritic spines (170000/cell)
- ✓ dendritic tree arborizations in the transverse plan to the long axis of the folium
- ✓ Purkinje cell axons – inhibitory synaptic contacts with deep cerebellar nuclei
- ✓ GABAergic inhibitory neurons



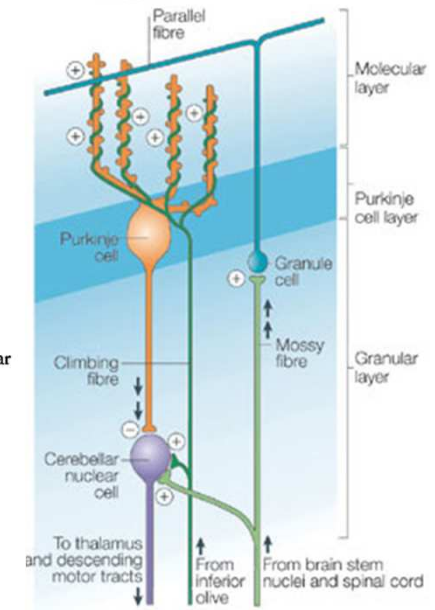
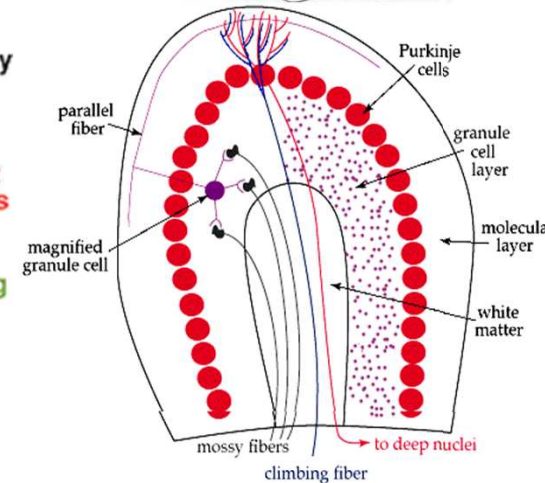
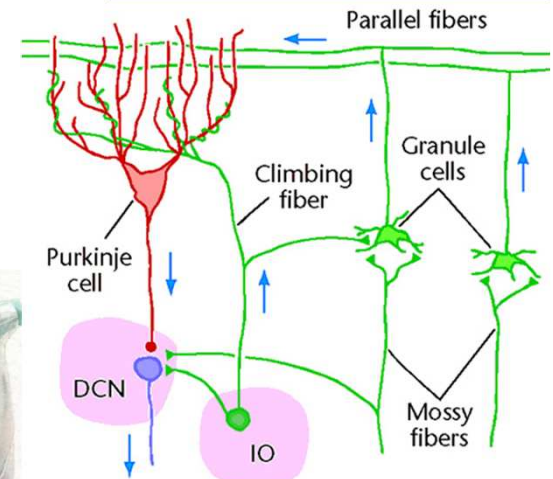
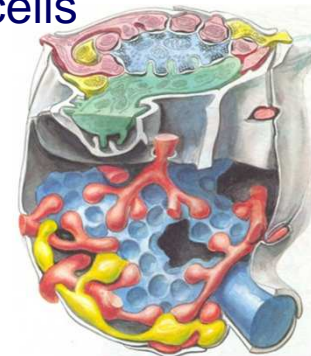
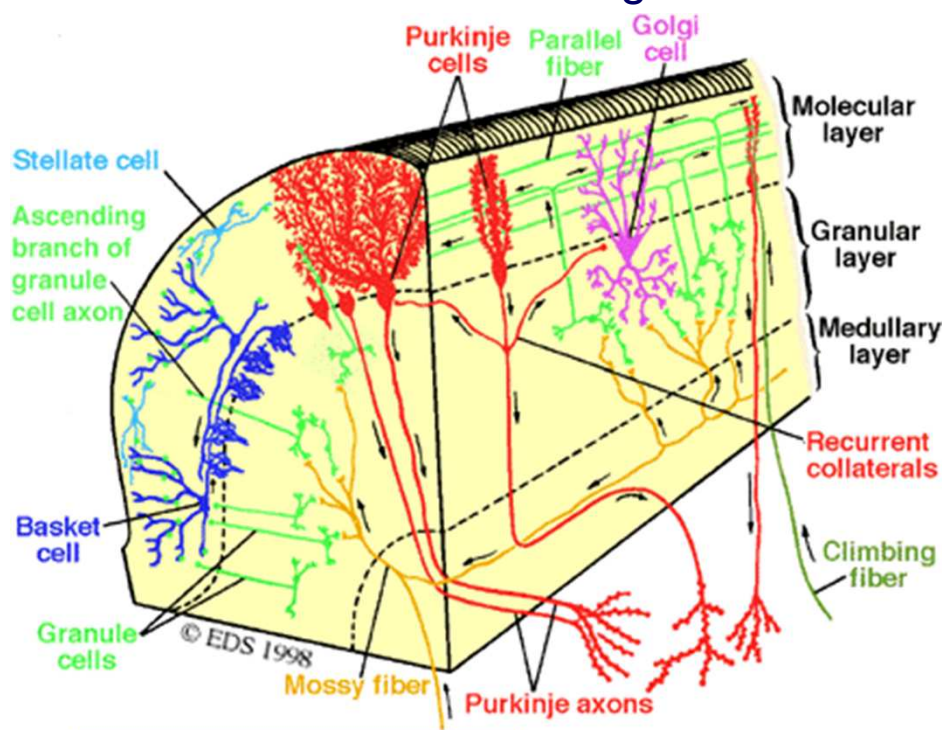
J.E. Purkinje
(1787-1869)





Cortical inputs – afferent fibers

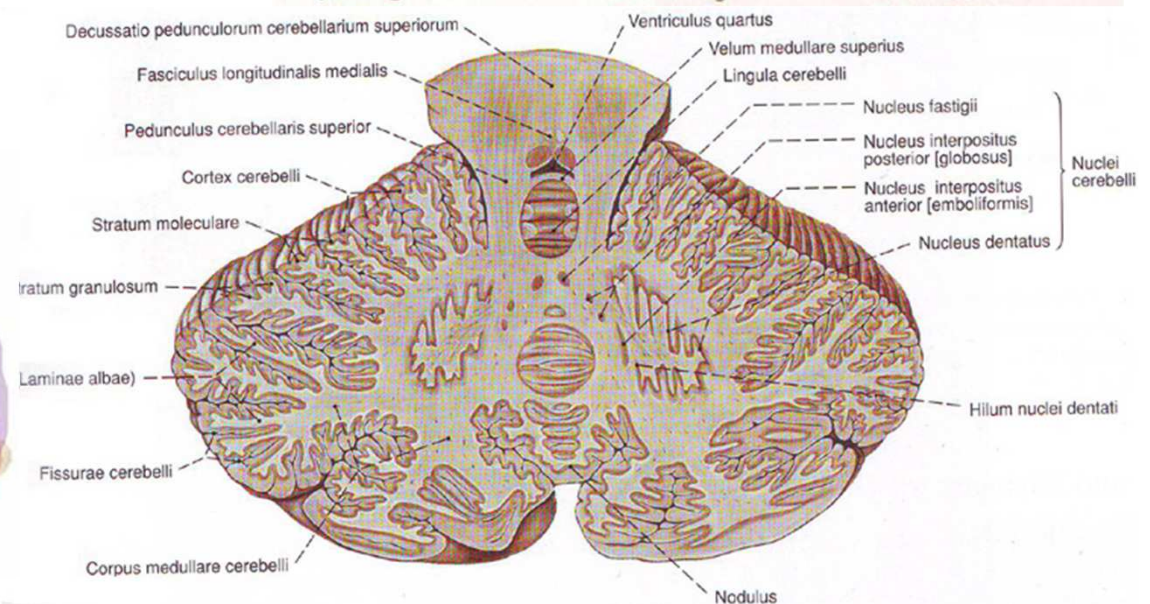
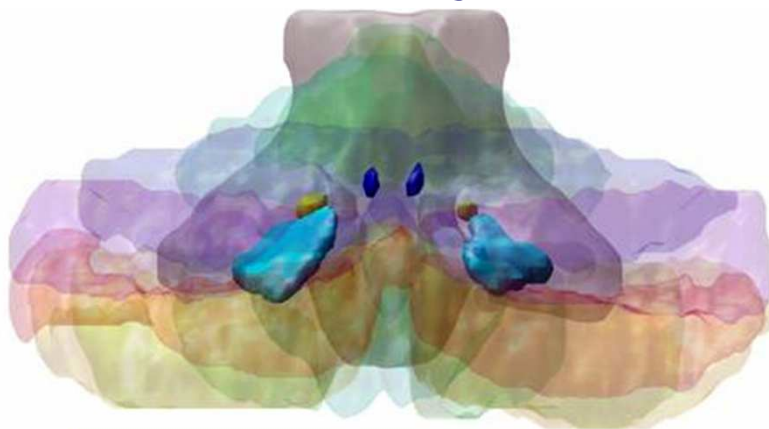
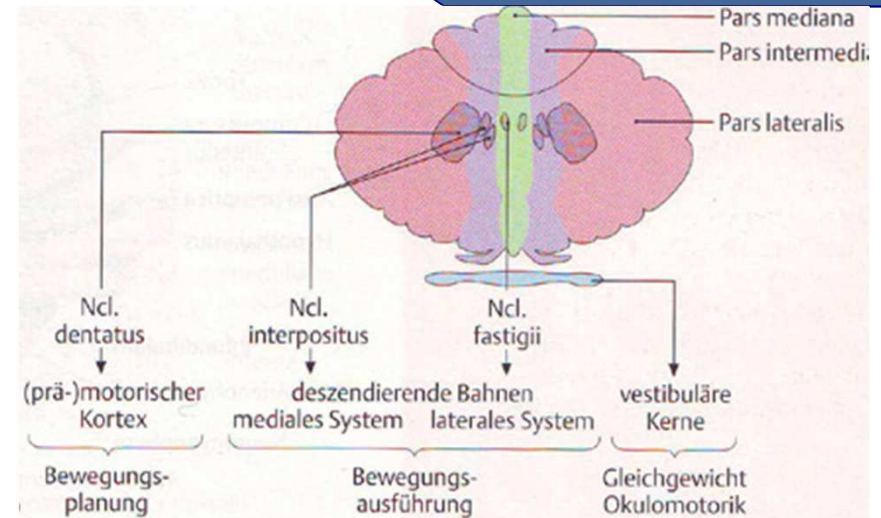
- ✓ climbing fibers:
 - originate from the inferior olivary nucleus
 - direct excitatory contacts with Purkinje cells
- ✓ mossy fibers:
 - excitatory synaptic contacts with granule cells
 - rosettes ⇒ cerebellar glomerulus





Deep cerebellar nuclei

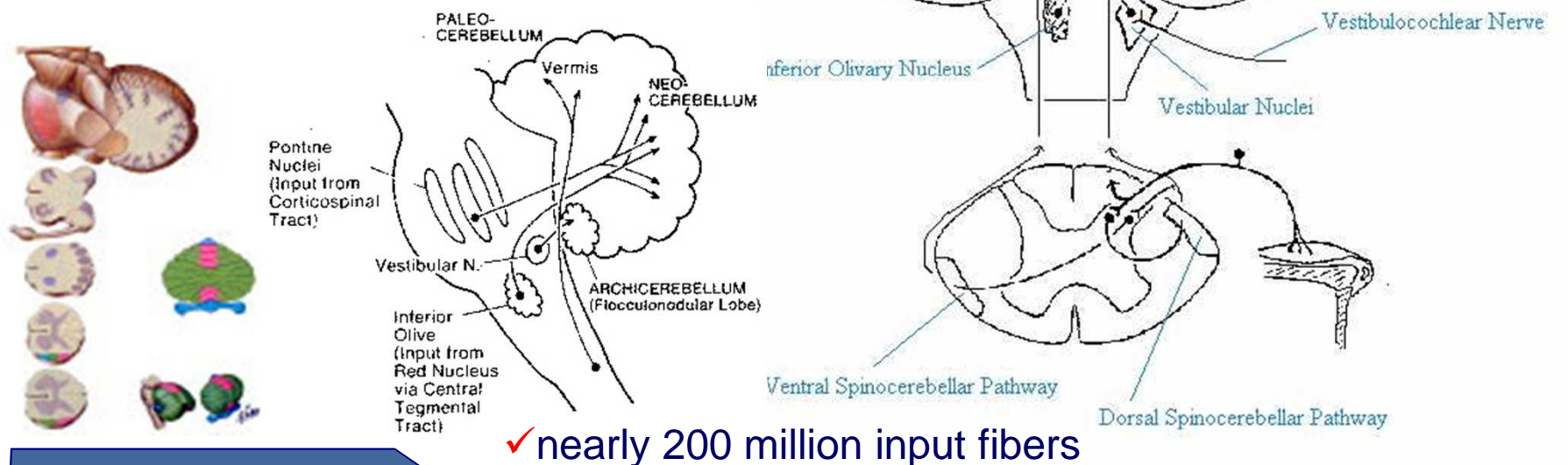
- Dentate nucleus, *nucleus dentatus*
- Interpositus nucleus:
 - ✓ emboliform nucleus, *nucleus emboliformis*
 - ✓ globose nucleus, *nucleus globosus*
- Fastigial nucleus, *nucleus fastigii*





Cerebellar input: afferent pathways

- *pedunculus cerebellaris inferior:* → **archicerebellum, paleocerebellum**
 - ✓ *tractus spinocerebellaris posterior*
 - ✓ *tractus bulbocerebellaris*
 - ✓ *tractus vestibulocerebellaris*
 - ✓ *tractus olivocerebellaris*
- *pedunculus cerebellaris medius:* → **neocerebellum**
- *pedunculus cerebellaris superior:* → **paleocerebellum**
 - ✓ *tractus pontocerebellaris*
 - ✓ *tractus spinocerebellaris anterior*
 - ✓ *tractus reticulocerebellaris*





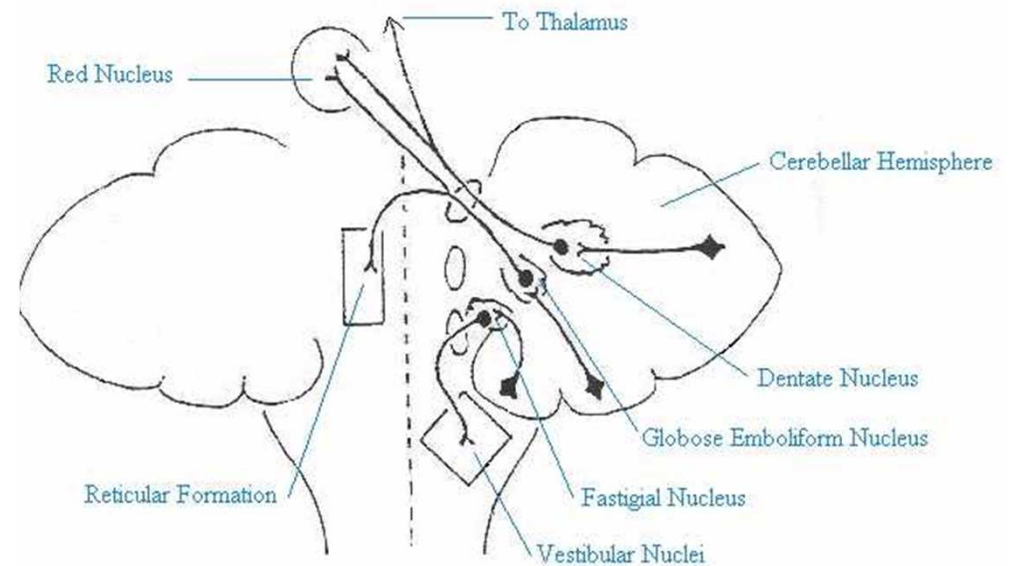
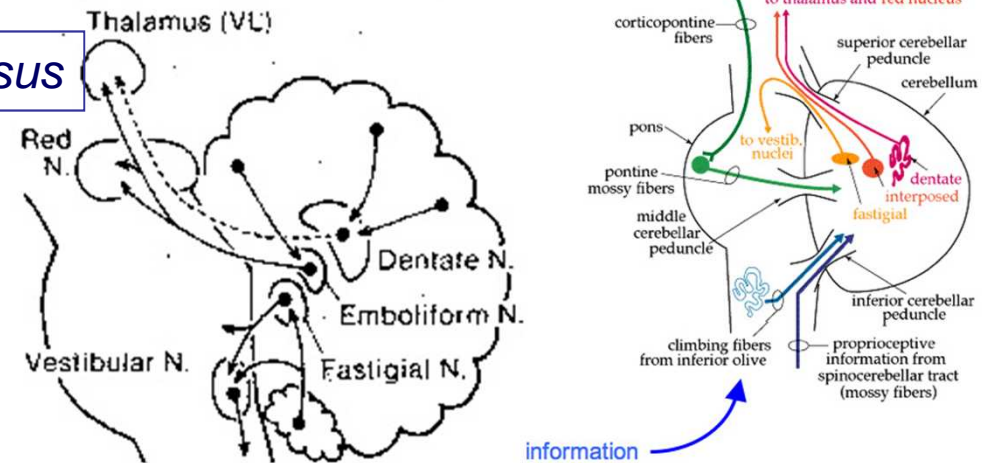
Cerebellar output: efferent pathways

nucleus dentatus, emboliformis et globosus

- pedunculus cerebellaris superior:
 - ✓ tractus cerebellorubralis
 - ✓ tractus cerebellothalamicus
 - ✓ tractus cerebelloreticularis

nucleus fastigii

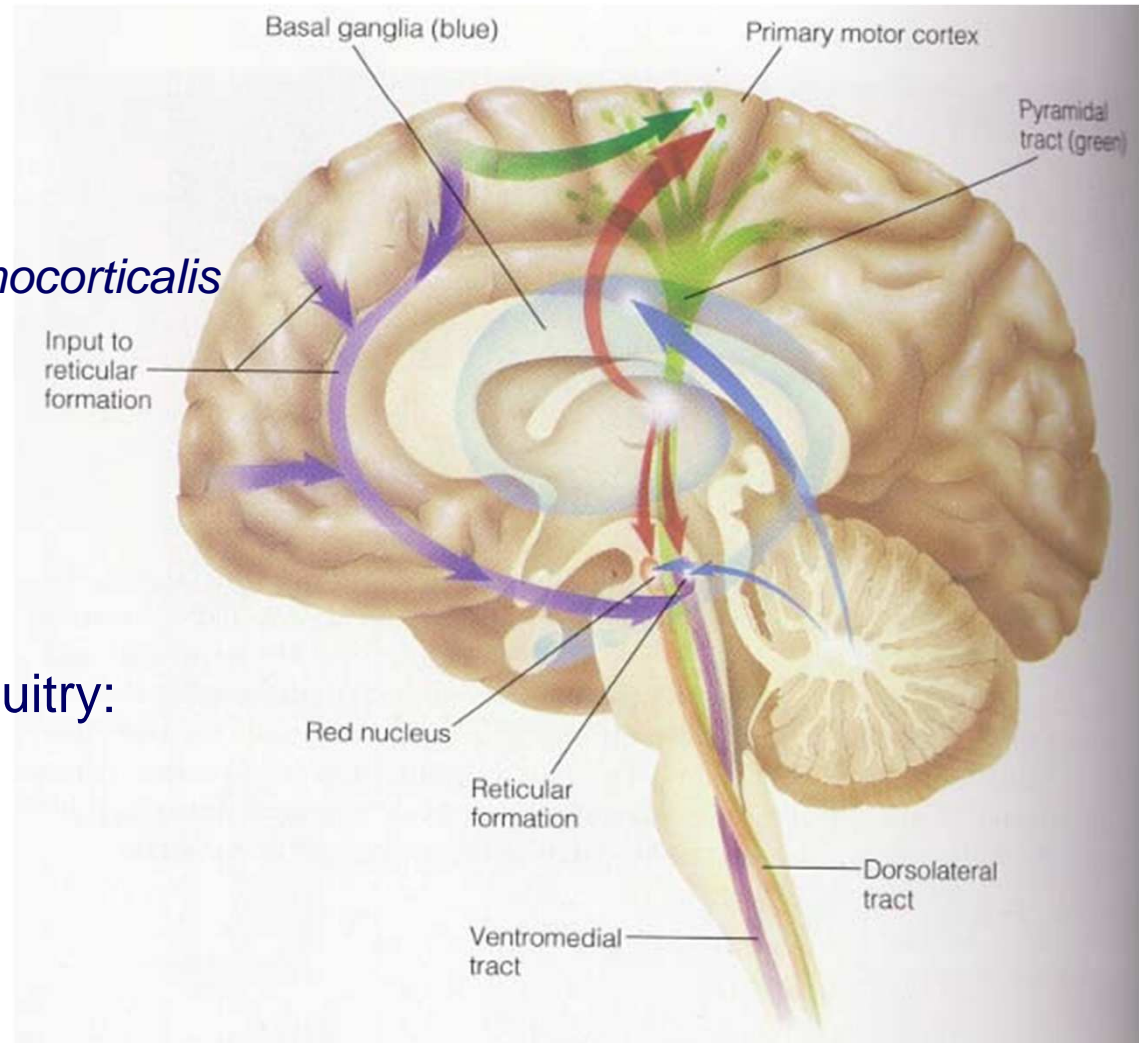
- pedunculus cerebellaris inferior:
 - ✓ tractus cerebelloolivaris
 - ✓ tractus cerebellovestibularis





Cerebellar circuits

- Cortico-cerebellar circuitry:
 - ✓ *tractus corticopontini*
 - ✓ *tractus pontocerebellaris*
 - ✓ *tractus dentato-rubro-thalamocorticalis*
- Trunco-cerebellar circuitry:
 - ✓ *tractus rubroolivaris*
 - ✓ *tractus olivocerebellaris*
 - ✓ *tractus cerebellorubralis*
- Vestibulo-archicerebellar circuitry:
 - ✓ *tractus vestibulocerebellaris*
 - ✓ *tractus cerebellovestibularis*





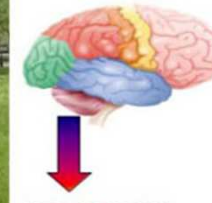
Cerebellar dysfunctions

Neocerebellar disturbances:

- ✓ hypotonia (decreased muscle tone)
- ✓ asynergia (diminished capacity for smooth, cooperative, sequential action between a series of muscle groups)
- ✓ cerebellar ataxia (disequilibrium & incoordination of willed movements)
- ✓ intention tremor (wide tremor during voluntary movements)
- ✓ nystagmus (inability to fixate an object with the eyes)



The Cerebellum and Exercise



CEREBELLUM

Functions:

- Coordinated movement
- Balance
- Muscle timing
- Proper postural alignment
- Cognitive learning

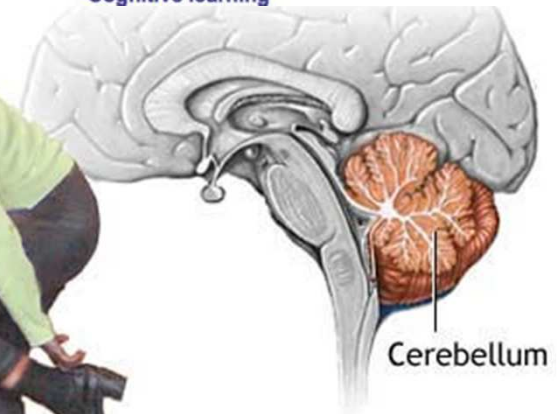


Archicerebellar disturbances :

- ✓ trunk (truncal) ataxia
- ✓ vertigo
(dizziness: a whirling or spinning movement)

Paleocerebellar disturbances:

- ✓ hypotonia
- ✓ dyskinesia (presence of involuntary movements)



Cerebellum helps provide smooth, coordinated body movement



Thank you...

