3 lobes
X lobules
numerous folia

folia: parallel gyri of cerebellar cortex transverse to the neural axis
140 cm³ (10–15% total brain volume)
⇒ 50,000 cm² cerebellar cortex
Cerebellar inputs
Cortex

Pre-cerebellar nuclei:
- Vestibular nuclei
- Reticular formation
- Motor nuclei of cranial nerves

Inferior olivary nucleus
Inferior olive
Dorsal Aspect

rostral

anterior lobe

posterior lobe

vermis

caudal

flocculonodular lobe (buried)

zonal

Deep cerebellar nuclei:

- medial zone (F, fastigius)
- intermediate zone (IP, interpositus)
- lateral zone (D, dentate)

Superficial cerebellar nuclei:

- V, vestibular

Cerebellar Cortex Outputs
Aside  lobe  evolution

flocculonodular
ancient, small

Corpus cerebelli:
recent, large

Anterior lobe of corpus cerebelli:
constant relative size in mammals

Posterior lobe of corpus cerebelli:
expanded in humans
<table>
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<tr>
<th>Zone</th>
<th>Grasping Movements</th>
<th>Eye Movements</th>
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<td>Lateral</td>
<td>Digits</td>
<td>voluntary gaze</td>
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<td>Distal limbs</td>
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<td>Vermis</td>
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<td>conditioned eyeblink</td>
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</table>

- Medial
- Primitive
- Coarse
- Reactive
- Lateral
- Modern
- Fine
- Purposeful

Saccades

Tracking eye movements
VOR

(anatomy)
(evolution)
(control)
PMA, pre-motor area
M1, primary motor area
cST, corticospinal tract
RST, rubrospinal tract
command
context
desability
ca. 20,000,000 axons descend to pons

> 90% synapse onto pontine neurons to relay into cerebellum

pons LHS $\rightarrow$ cerebellum RHS

cf. 2,000,000 axons in descending spinal tracts

pontine nuclei are a massive cerebrum $\rightarrow$ cerebellum interface
Open-loop controller

direct pathway PCN-DCN

Adaptive closed-loop controller

detour through cerebellar cortex

for error correction learning

PCN, precerebellar nuclei

mf, mossy fibers

each mf onto ~30 GC

each GC from ~5 mf

GC, granule cells

pf, parallel fibers

axons of GCs run parallel to folia

PKN, purkinje neurons

large spiny dendritic arbors

orthogonal to pfs

each GC onto ~2000 PKN

each PKN from ~150,000 GCs

PKN GABAergic, output inhibitory
PCN, precerebellar neurons

mf, mossy fibers
1 mf onto ~30 GC
1 GC from ~5 mf

GC, granule cells

pf, parallel fibers
GC axons run parallel to folia
PKN, purkinje neurons

large spiny dendritic arbors
orthogonal to pfs

1 GC onto ~ 2000 PKN
1 PKN from > 150,000 GC.

PKN GABAnergic
inhibitory output onto DCN
~ 50 Hz
IO, inferior olive neurons
cf. climbing fibers

1 PKN receives many
synapses onto soma
and proximal dendrites
from just 1 cf

1 cf onto ~10 PKN

IO itself receives performance
info from spinal cord,
brainstem, and cerebrum
extracellular trace of PKN

during learning

phasic complex spikes from cf frequent when learning a new movement or context but otherwise ≤ 1 spike/sec

tonic simple spikes from pfs frequent even during well established movement

after learned

gap

1/6
IO, inferior olive of medulla

cf, climbing fibers

each PKN receives many synapses onto soma and proximal dendrites from just 1 cf

each cf onto up to 10 PKNs

IO itself receives from spinal cord, brainstem and cortex
tutor model (David Marr 1969)

complex spikes are IO neurons firing when performance falls below/behind reference value.

\[ \text{error signal} = I - R \]

any GC that fires while the PKN is depolarized has synapse weakened LTD

now DCN output is increased in similar contexts because GCs no longer fire PKN (which itself inhibits DCN)