Cerebellum

- little brain - silent area - Balance & Coordination.
- part of hindbrain - post cranial fossa.
- below occipital lobe - 3 cerebellar peduncle used to connect with brain stem.
- 2 cerebral hemisphere → divided by vermis.

Class

- anatomical → Ant, post flocculonodular.
- (2) phylogenetic → archicerebellum → flocculonodular lobe & lingula
  paleocerebellum → entire ant. lobe (except lingula) & post lobe (pyramid & uvula).
  neocerebellum → post lobe (except pyramid & uvula).
- 3) functional classification.

1) Vestibulocerebellum / archicerebellum

- → flocculonodular lobe.
- → highly connected with vestibular apparatus & vestibular nuclei
- → function: balance & posture maintainence.
- → coordinate head movement with eye movement: vestibulocular reflex.

(2) Spinocerebellum

- vermis & paravermis.
- receive proprioceptive & other sensory inputs from all body parts through spinal cord. Hence called spinocerebellum.
- Also receives inputs from motor cortex where motor planning is carried out

- by comparing plan with performance of smoothness & coordinated movement.

- Vermis - controls proximal & axial limb muscle.: maintains posture.
- paravermis : controls distal limb muscle.
  controls skilled voluntary movements.

(3) Cerebrocerebellum / Neocerebellum

- connects with cerebral cortex.
- includes 2 cerebellar hemisphere.
- function: As it interacts with cortex. the function is planning & programming of movements.

Functional histology.

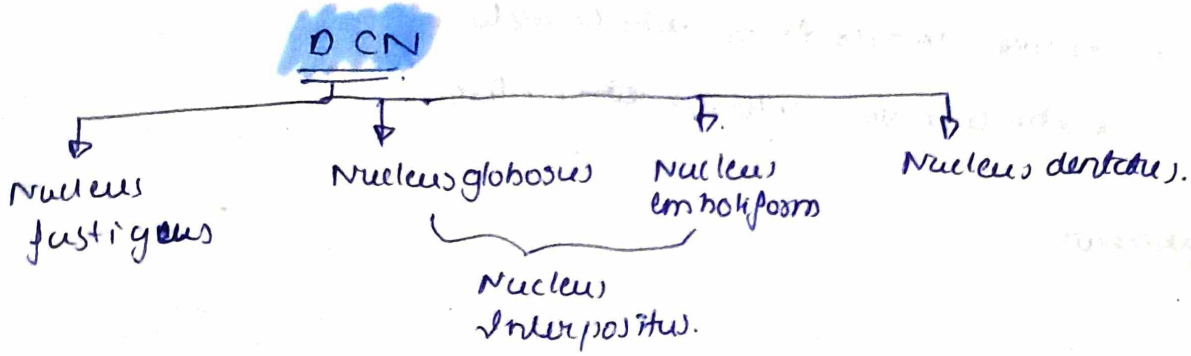
- Outer cortex
  - molecular
    - stellate
    - basket
  - purkinje
  - granular
    - golgi
    - granule.
- deep cerebellar nucleus.

purkinje cells → largest neurons with extensive dendrites which enters into molecular layer.

→ only neuron that projects from outer cortex into deep cerebellar nucleus ∴ connecting centre btwn cerebellar cortex & deep cerebellar nucleus.

→ purkinje cell recieve input from directly - climbing fibres

→ granule cells → receive inputs from mossy fibres & ff. projects to PC, basket, stellate, golgi cell via parallel fibres.



- vermal part of cerebellum projects into fastigeus.
- NI — paravermal part projects.
- ND → Hemisphere part of cerebellum receives inputs from cerebrocerebellum.

Vestibulocerebellum no conn with nucleus of deep cerebral nucleus.

Cerebellar Connections.

(1) Inputs.

(1) Vestibulocerebellar tract.
(2) dorsal & ventral spino
(3) cerebellar tract.
(4) cuneocerebellar tract. → O: lateral cuneate nucleus.
(5) lectocerebellar tract.
(6) Pontocerebellar tract. → coming from motor cortex → 1/L pons → 1/L cerebellum
(7) olivocerebellar tract.

corticopontocerebellar tract.

↓

proprioceptive inputs from whole body reach cerebellum via inferior olive.

~~olivocerebellar~~.

↓

mo

• Mode of Inputs.

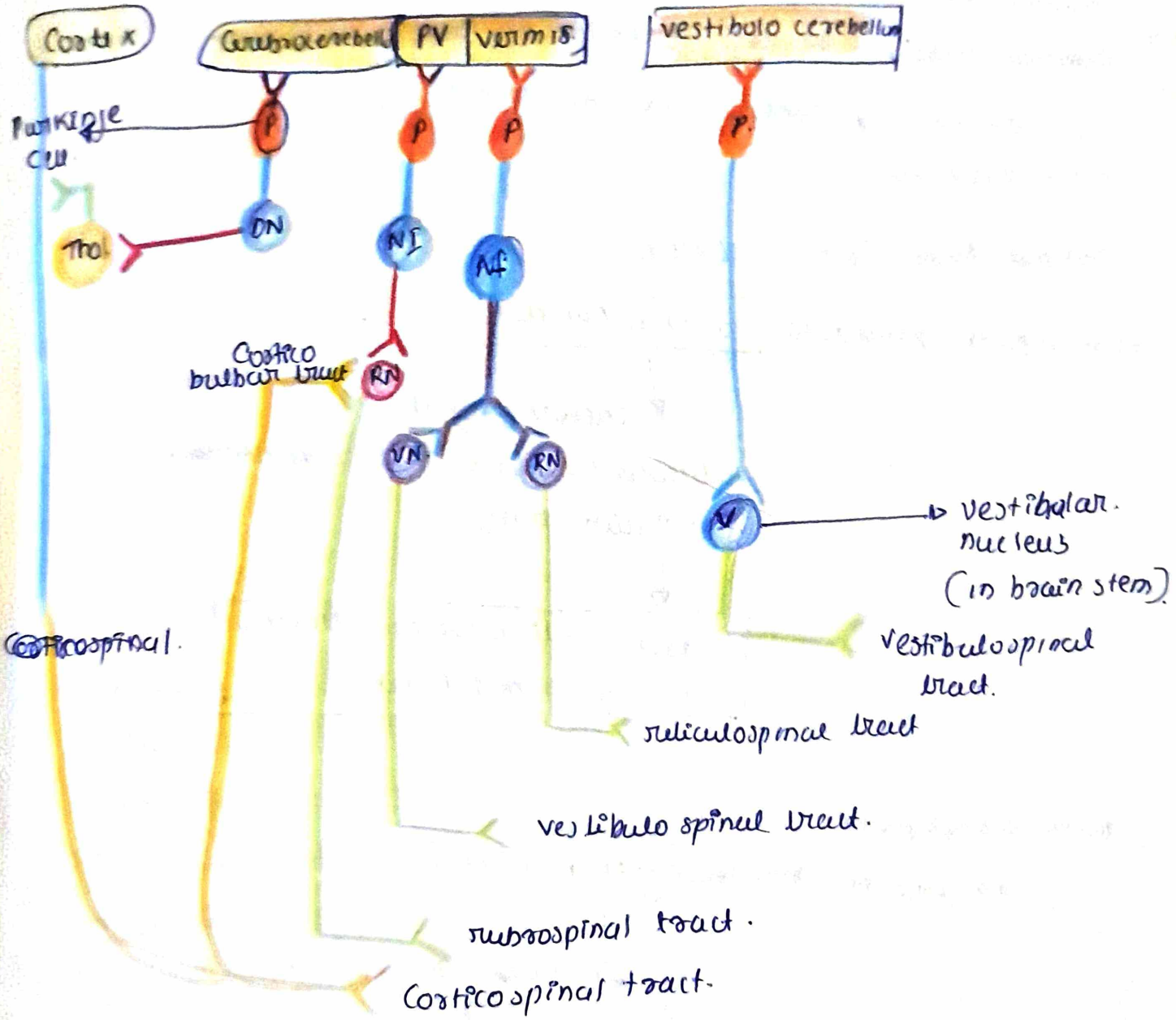
(a) **mossy fibres.** → major source of inputs to cerebellum.
- all tracts except olivocerebellar tract give input through mossy fibres.
- mossy fibre projects to granule cell.

(b) **Climbing fibres:**
conveys inputs from Inferior olivary nucleus to cerebellum → (olivocerebellar tract).

• climbing fibres project to purkinje cell

Outputs.

15 marks Essay. – OUTPUTS.



Output

deep cerebellar nuclei are the output pathway of cerebellum.

Output from vestibulocerebellum.

- Vestibulocerebellum directly projects to vestibular nucleus without relay in deep cerebellar nucleus.
- Thus, it directly controls vestibulospinal tract activities.

Output from Spinocerebellum.

vermal part projects to fastigial nucleus

↓ in turn projects to.

reticular nucleus & vestibular nucleus (in Brain stem).

↓

Controls reticulospinal tract & vestibulospinal tract.

paravermal part projects to nucleus interposita

↓ in turn projects to.

red nucleus

↓

Controls activity of rubrospinal tract

output from Cerebrocerebellum.

- projects to **dentate nucleus.**
  - ↓ In turn projects to
  - **motor cortex** via thalamus
    - ↓
    - Controls activity of
      - Corticospinal &
      - Corticobulbar tract

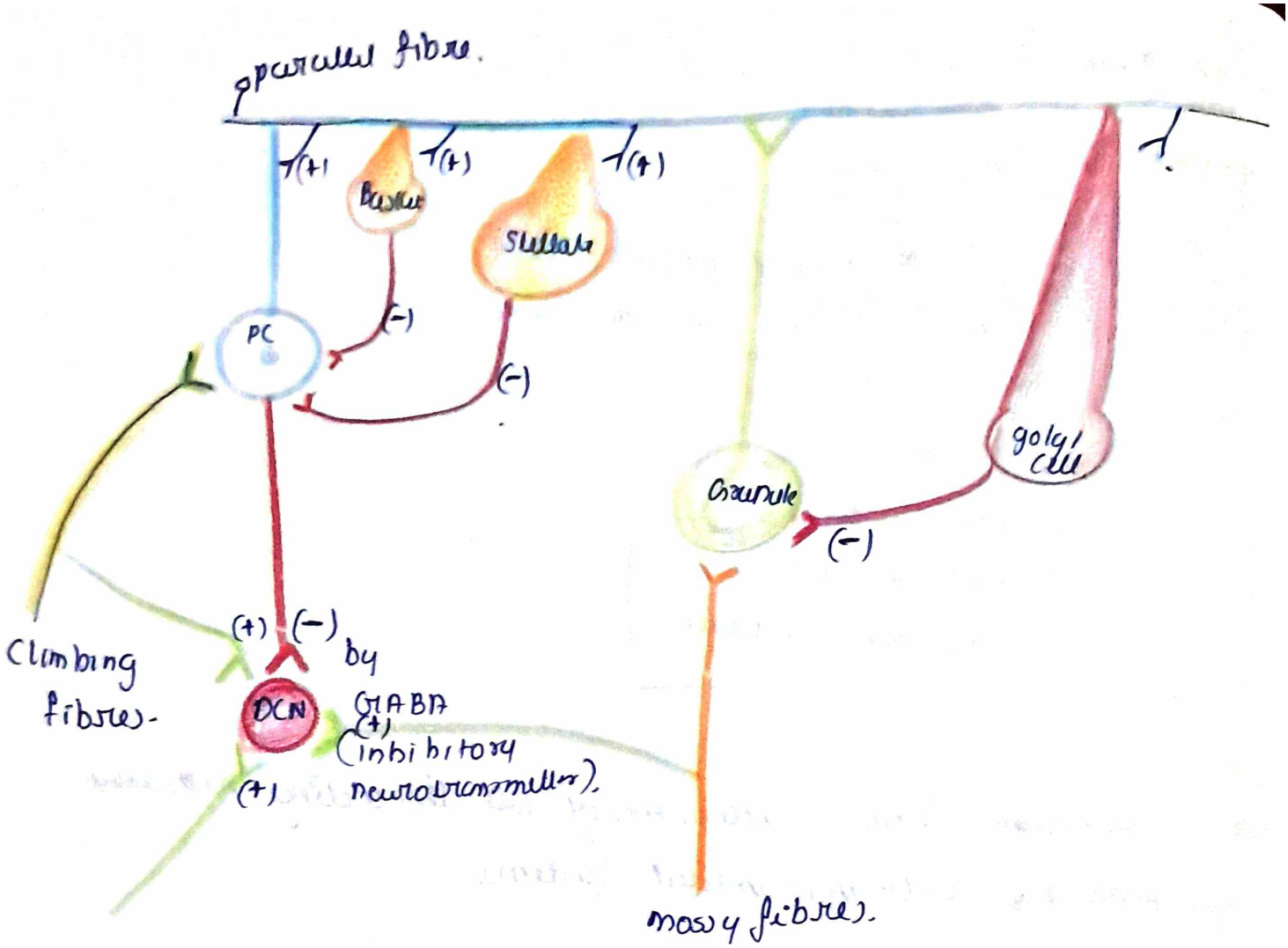
Thus, cerebellum controls activities of all descending pathways → pyramidal & Extrapyramidal systems.

Internal Connections.

- purkinje cells can be stimulated by two ways
  - (a) directly by climbing fibres input
  - (b) indirectly by mossy fibres via granule cell - parallel fibre pathway.

* Basket cells and stellate cells that are activated by mossy-fibre - parallel fibre pathway finally inhibit purkinje cell.
- This is called **feed forward inhibition.** 4 marks

- Granule cell also stimulate golgi cell which in turn inhibits activity of granule cells → called local feedback inhibition.



Only Excitatory ~~nucleus~~ neuron in cerebellar cortex.
is Granule cell.

all others have inhibitory output.

- most common inhibitory neurotransmitter.
in CNS → GABA.

- Deep cerebellar nucleus receives inhibitory input from Purkinje cells.
- but receives multiple excitatory input
  from (1) climbing fibres
  (2) mossy fibres
  (3) others.

net effect → always excitatory.

Purkinje cell output to deep cerebellar nuclei is (-) as neurotransmitter secreted by PC is GABA.
- but deep cerebellar nuclei receives excitatory input from mossy fibre, climbing fibre & from other sources.
- thus, inspite of inhibition by PC., out put of DCN to brain stem is always excitatory ∴ lesion of cerebellum results in hypotonia.

- inputs, outputs, internal connection. Essay 15 marks.

Clinical Question

FUNCTIONS OF CEREBELLUM.

- control of body posture & eqm } vestibulocerebellum
- control of eye movements.

Spinocerebellum

- control of muscle tone & stretch reflex.
- control of voluntary movements.
  - comparator function.
  - damping function.
  - control of ballistic movements.

Neocerebellum

Timing & planning of sequential movmts.
motor skill learning

- functions — short essay 8 mark Explain each.

(1) Control of Body posture & Equilibrium

- function of vestibulocerebellum.
- sensory organ: vestibular apparatus.
- centre: vestibular nuclei.
- signals to flocculonodular lobe.
- Back to vestibular & reticular nucleus.
- vestibulospinal & Reticulospinal tracts
- thus controls body posture & eqm.

2. Control of eye movements.

- signals to 3, 4, 6 - CN.
- Innervation of Extra ocular muscle.
- Role in vestibulo-Ocular reflex.

3 - Oculomotor
4 - trochlear.

3. muscle tone & stretch reflex.

Cerebellar outputs.

- excitatory.
- muscle tone.

- functions of spinocerebellum via Fastigial nucleus.
- stimulates vestibulospinal & reticulospinal ~~tract~~ activity.
- vestibulospinal — (controls) α motor activity.
- Reticulospinal — (controls) γ motor activity.
- cerebellum — major site of α-γ-CO linkage.

4. Control of Voluntary movements.

- function of spinocerebellum via Interpositus nucleus. & paravermis).
- recieve 2 types of inputs:
  - Intended motor plan (from motor cortex).
  - actual movement carried out (proprioceptive inputs from body)

→ comparator function.
→ Error detection & correction function.
→ smooth, coordinated movements of agonists & antagonists.

a) Comparator function {short note} 4 marks

- Cerebellum integrates and coordinates movement involving distal parts of limbs by it's comparator function.
- when the motor cortex sends impulses through corticospinal tract to lower motor neurons for commanding movements, it sends messages on the way to paravermis about the sequential intended plan of movements.
- Cerebellum also gets feedback from proprioceptors in muscles, tendons & ~~movements~~ joints about what actual movements are.
- paravermal cerebellum then compares intended movment with actual mv & through nucleus interpositus sends corrective signals.

3(b) Damping Function. 4 mark

- all mvm are pendulum & has tendency to overshoot because of momentum of muscle.
- Intact cerebellum has a breaking action which allows movements to stop at intended point.
- Thus, cerebellum determines the rate, range, force, direction & termination of movement

(c) control of Ballistic movements.

- Rapid alternate movements while doing skilled works. (dancing, typing etc) → Ballistic.
- Cerebellum coordinates the action of agonists & antagonists muscle especially when they occur rhythmically.

5. Planning & timing of Sequential movements.

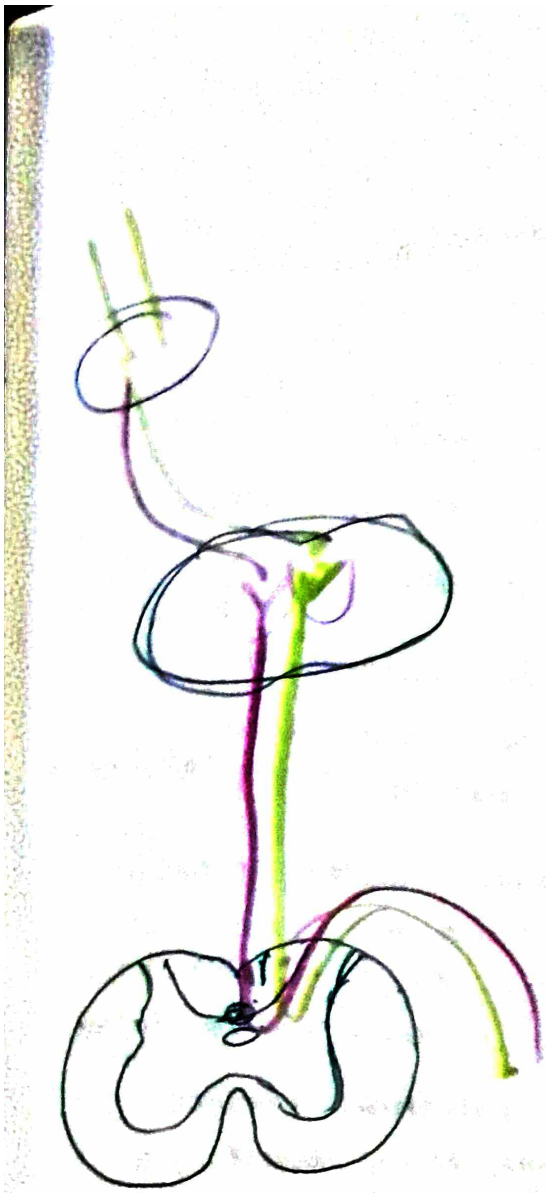
- function of Neocerebellum.
- allows smooth progression of sequential muscle in a timely fashion.

6. Motor skill learning.

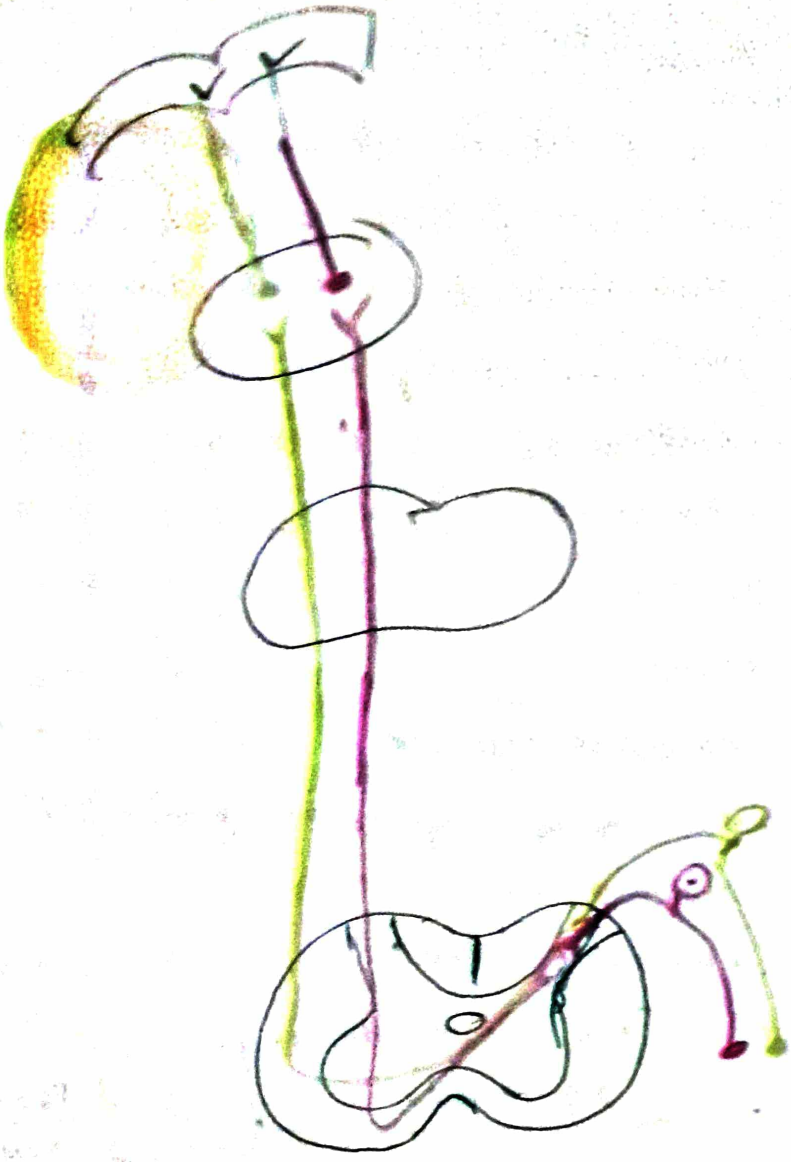
- function of climbing fibres from inferior olivary nucleus
- Feedback loop from red nucleus.
- cerebellum → red nucleus → inferior olive → cerebellum

7. Control of movements of same side of body.

- motor cortex of one side is connected to the cerebellar hemisphere of opposite side through a closed circuit called cerebral – cerebellar – cerebral circuit.
- Thus, each cerebellar hemisphere influences the output of opposite cerebral cortex.
- However, cerebral cortex via corticospinal tract (that decussates to opposite side) controls motor function of contralateral half of body.
- ∴ due to double decussation, each cerebellar hemisphere controls movements of same side of body.



DORSAL
COLOUMN.



ANT & LAT
Spinothalamic.

Ataxia.

- loss of control over voluntary movements.
- correction of rate, of range, force, direction & termination of movement function lost.
- muscular incoordination.
- Drunken gait → wide based, unsteady gait.
- dysarthria / scanning speech. - due to ataxia involving muscles of speech.

Hypotonia.

- ataxia
- pendular knee jerk.
- failure to acquire new motor skills.
- Nystagmus
- motion sickness.

No sensory deficit.
No paralysis

- dysmetria / past-pointing.
  - due to inability to measure length / distance
  - when patient attempts to touch an object. usually the hand overshoots instead of reaching the target.

Reason: cerebellum controls rate, range, force, direction & termination of movement

* Intentional tremor.

Reason: due to dysmetria, the corrective measures are immediately initiated, but this time hand overshoots in opposite direction

- This repeated overshoot & re correction result in Intentional tremor. { tremor is absent @ rest resting tremor is seen in parkinsonism }.

- Dysdiadokokinesia → Inability to perform rapid alternate movements like pronation & supination.

physiological basis: control of Ballistic movements is by cerebellum

——→ write. things under heading of control of Ballistic movmnts.

- Rebound phenomenon.

PB → Inability to stop movements promptly.

- when a patient is asked to flex his limb against resistance & then asked to stop immediately by withdrawing the resistance, rather his arm moves with a wider arc.

→ due to absence of braking action of cerebellum.

——→ Explain breaking action ——

- pendulur knee jerk

- due to hypotonia & lack of breaking action.

decomposition of movements.

- Inability to perform movements that involve more than one joint simultaneously.

→ actions are carried out one at a time, in an exaggerated fashion.

reason —→ cerebellum controls rate, range ...

Nystagmus

- due to dysfn in vestibulo-ocular reflex.

Romberg's sign → +ve in sensory ataxia

Tests for Cerebellar function

(1) For coordination.

UL → finger-nose test,
finger-fingers test.

LL - heel-knee test.
straight line test.

2. posture: Romberg's test.
(+ for sensory ataxia)
(- for cerebellar ataxia)

1 Mark

3. Gait.
4. speech.
5. tone.
6. reflexes
7. rebound phenomenon.
8. dysdiadokokinesia.

- hands side, feet together - stand.
  - If can balance with eyes open but not with eyes closed → sensory ataxia.
  - If unbalance both open & closed → cerebellar ataxia