

# The cerebellum

المخيخ

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the little brain

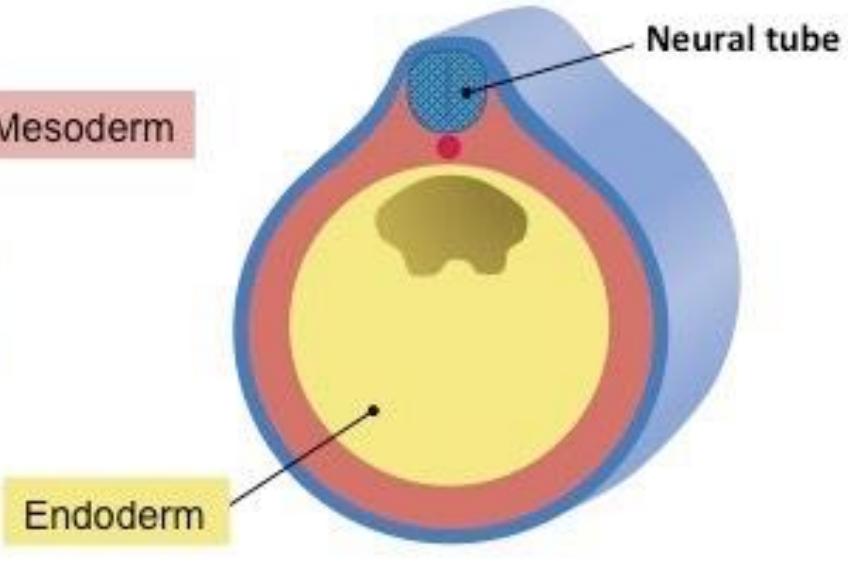
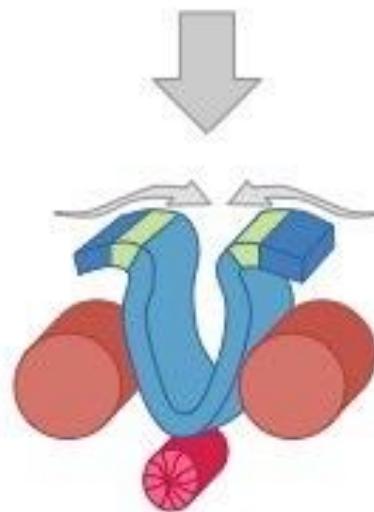
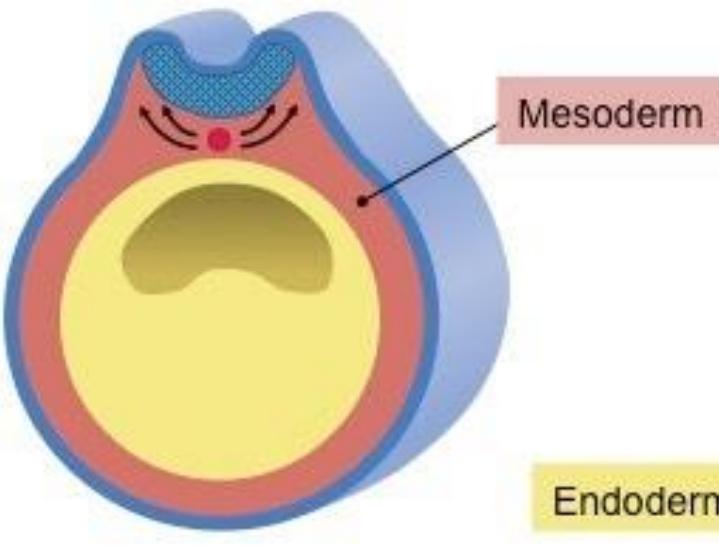
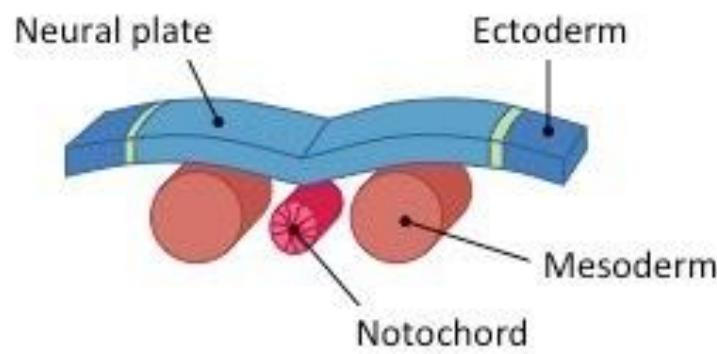
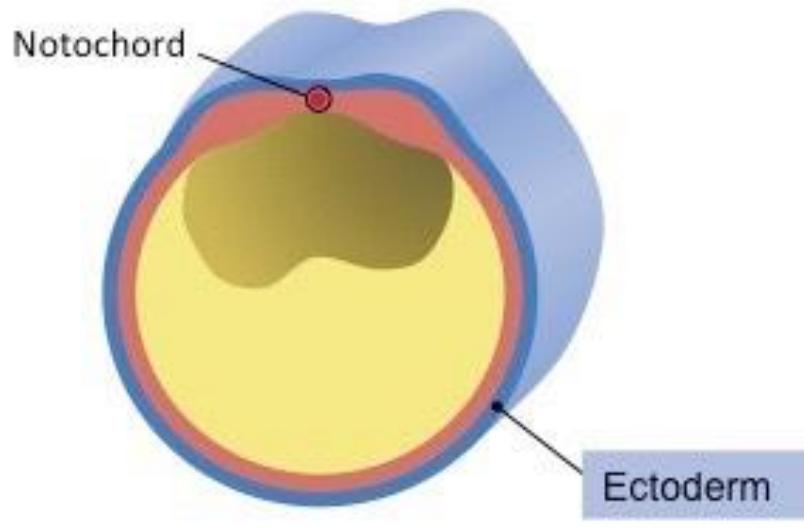




## Contents:

- Embryology
- Gross Anatomy
- Microanatomy  
(Histology-inner circuitry)
- Functional subdivisions
- Peduncles and pathways

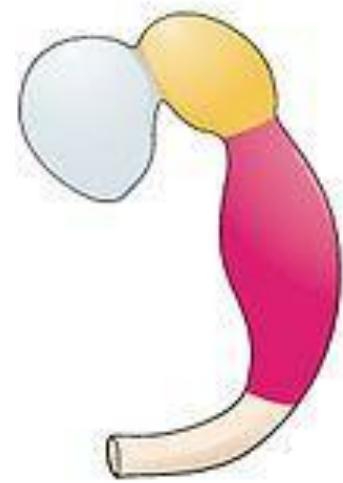
embryology



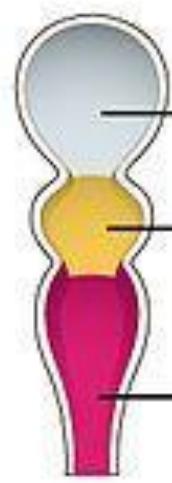
**1.** Notochord forms from mesoderm cells soon after gastrulation is complete

**2.** Signals from notochord cause inward folding of ectoderm at the neural plate

**3.** Ends of neural plate fuse and disconnect to form an autonomous neural tube



Three primary  
brain vesicles



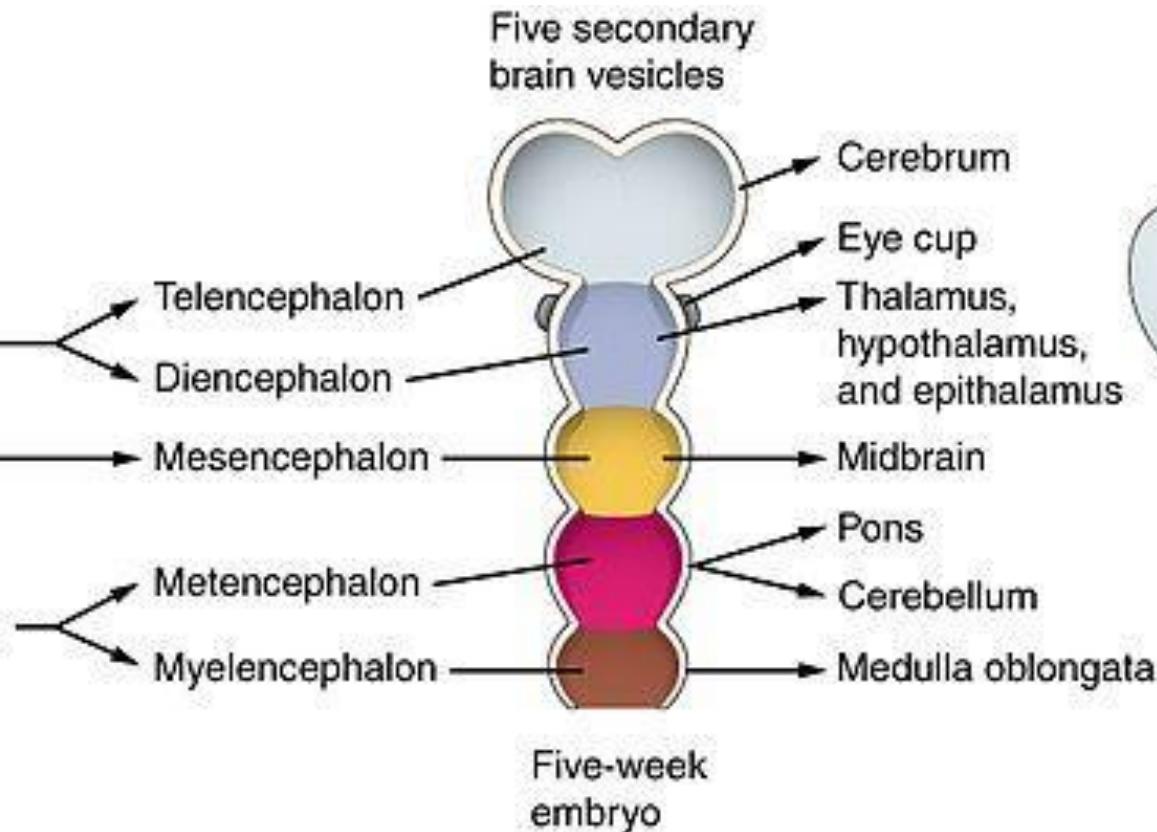
Prosencephalon  
(Forebrain)

Mesencephalon  
(Midbrain)

Rhombencephalon  
(Hindbrain)

Lateral view  
Three- to four-week  
embryo

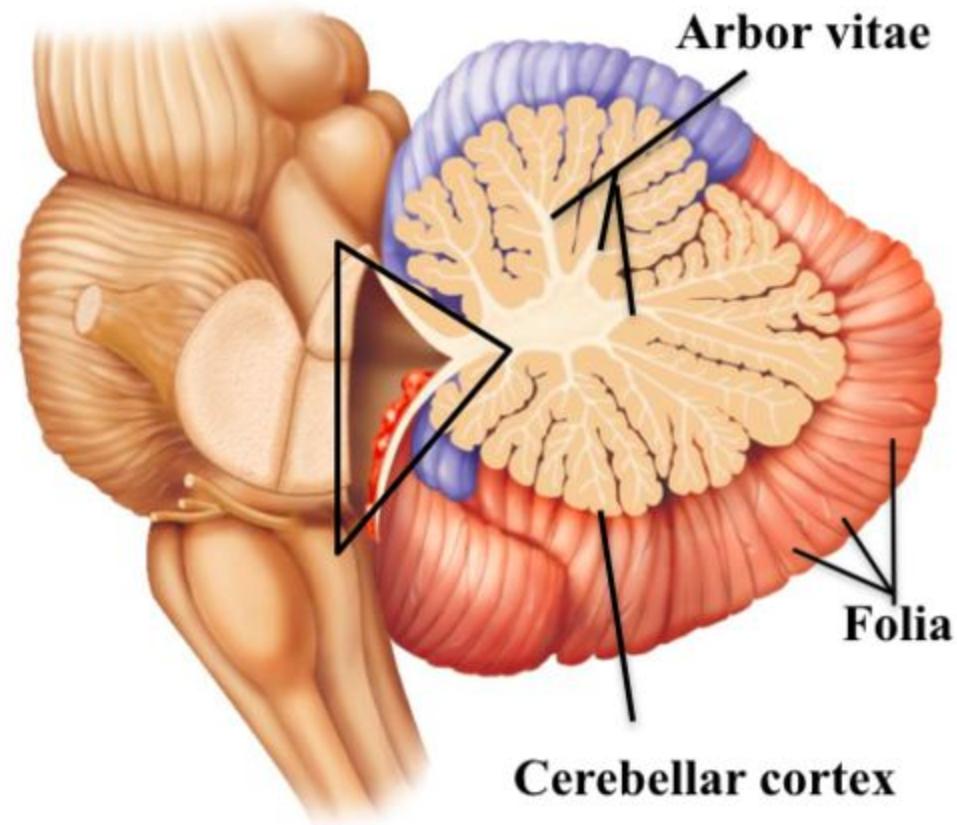
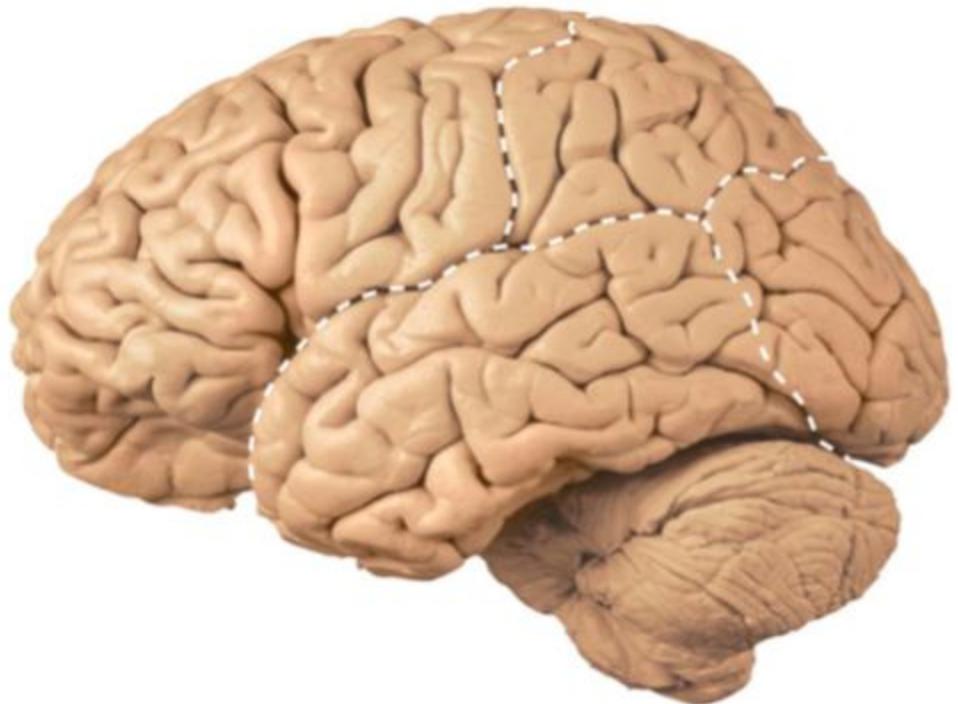
(a)



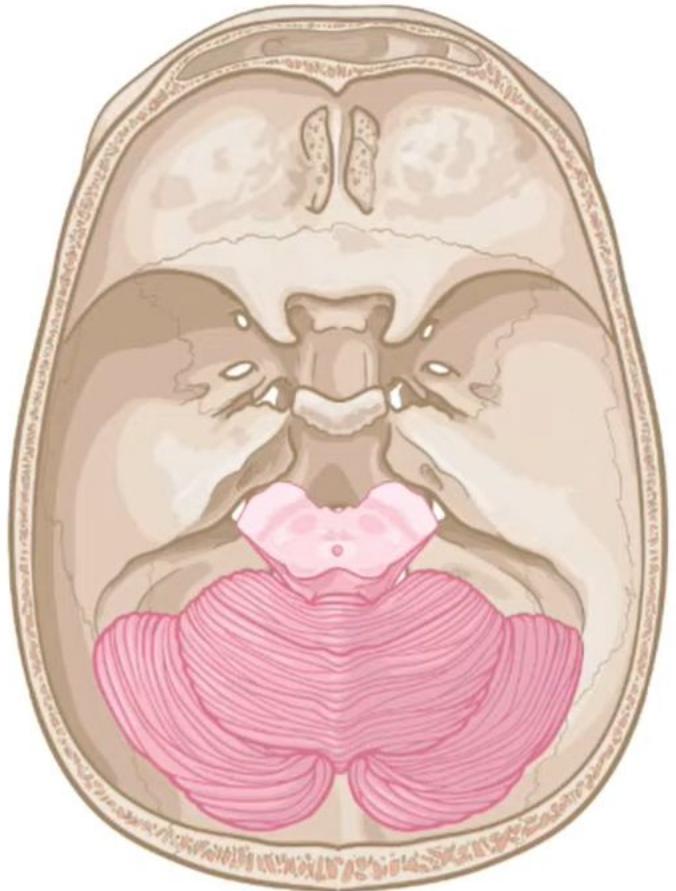
Lateral view

(b)

gross anatomy

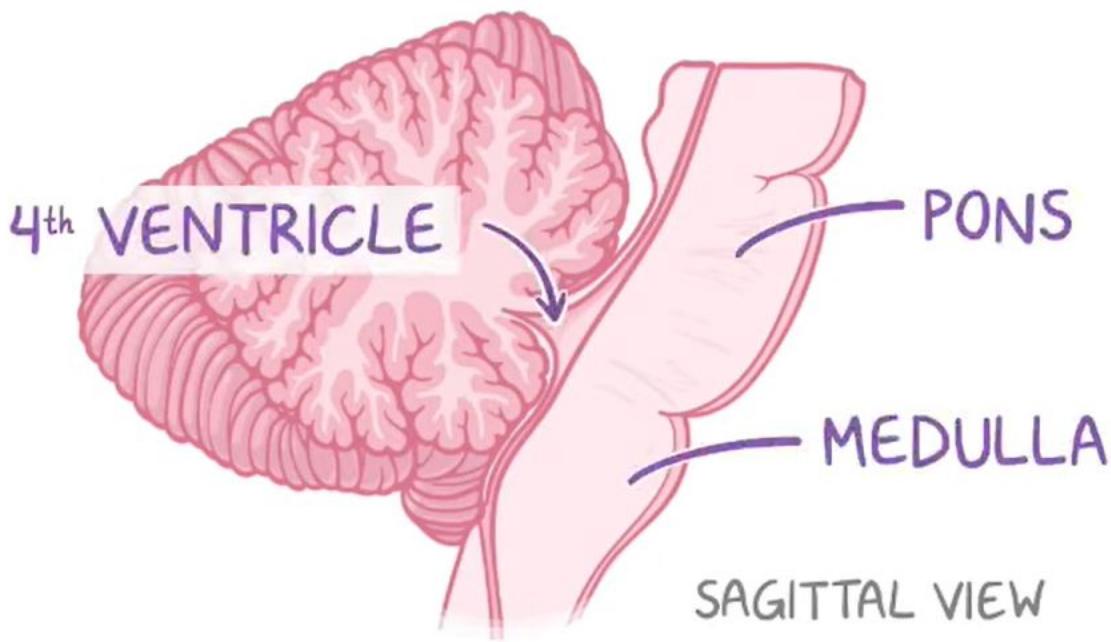


# CEREBELLUM

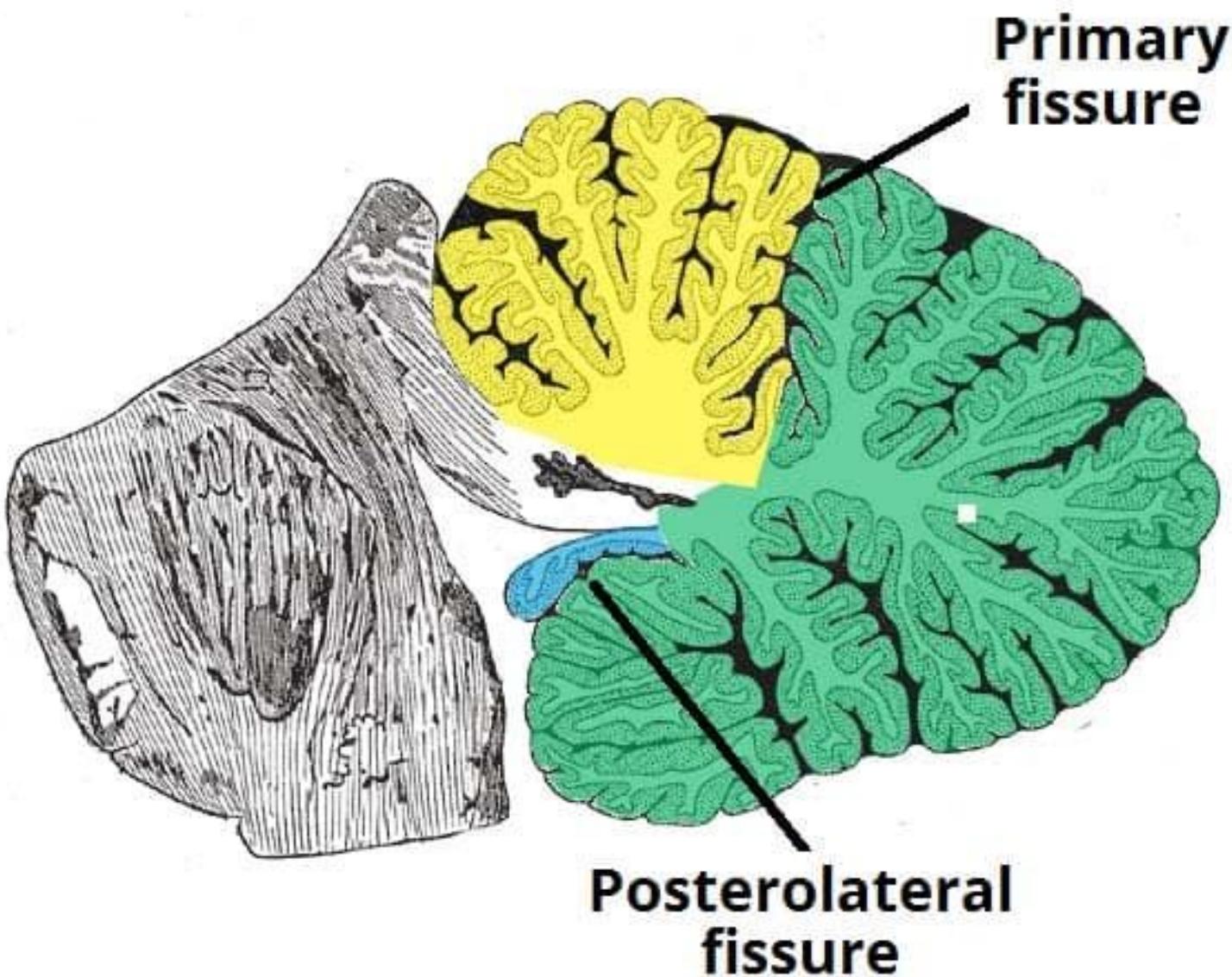


SUPERIOR VIEW

\* LOCATED in POSTERIOR CRANIAL FOSSA



SAGITTAL VIEW

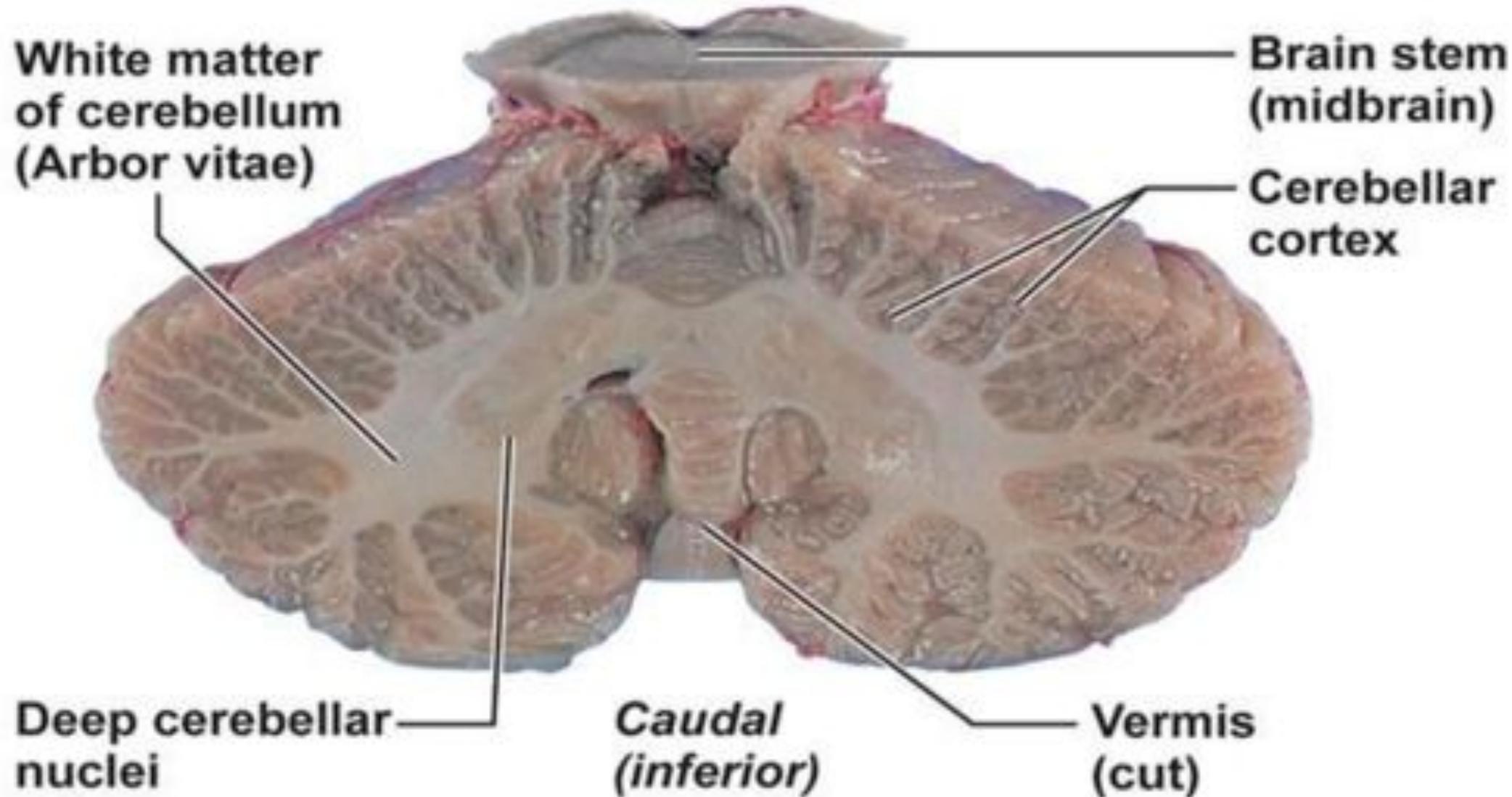


Primary  
fissure

Posterolateral  
fissure

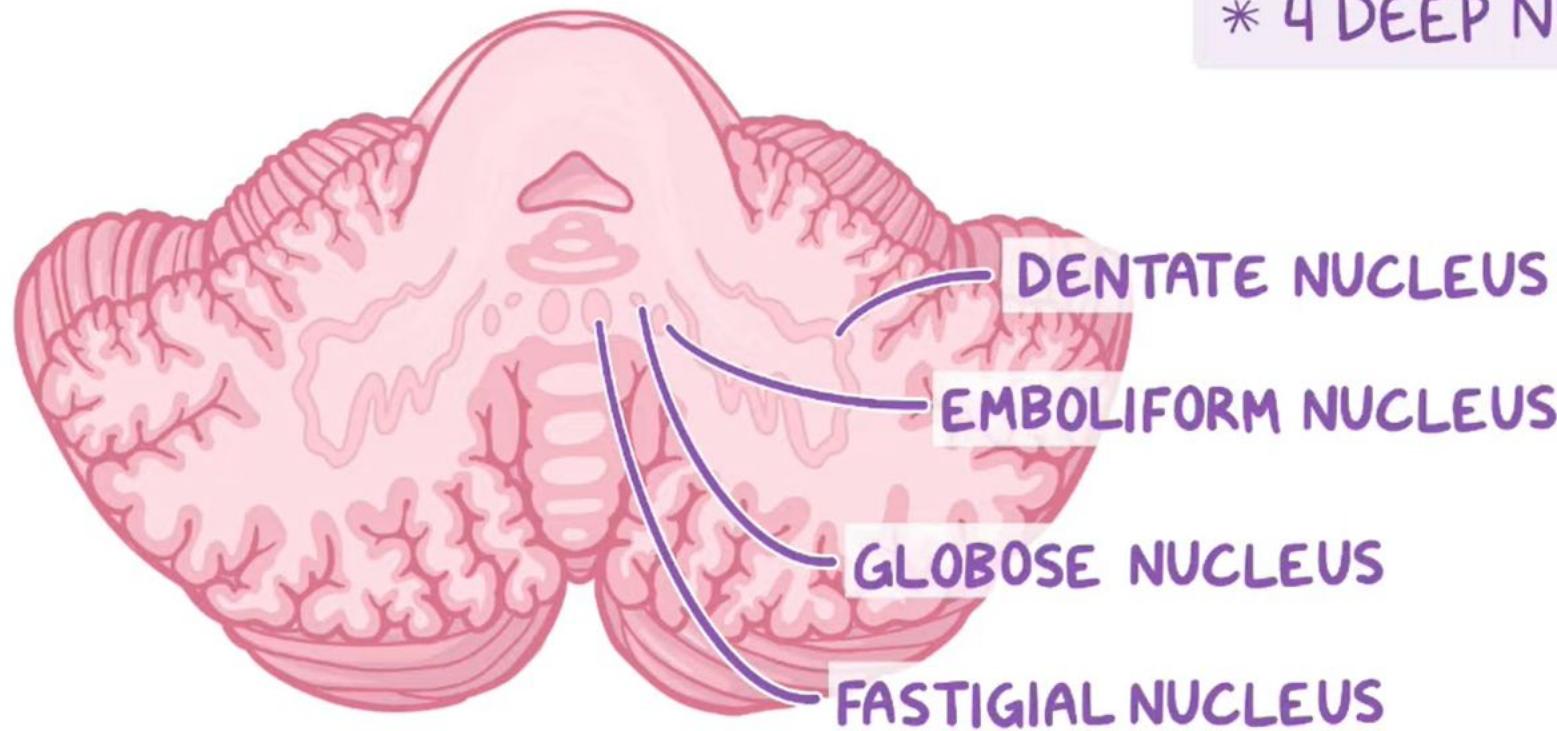
- Anterior lobe**
- Posterior lobe**
- Flocculonodular lobe**

## The Cerebellum – White and Gray Matter



(d) Coronal section, posterior view

# CEREBELLUM



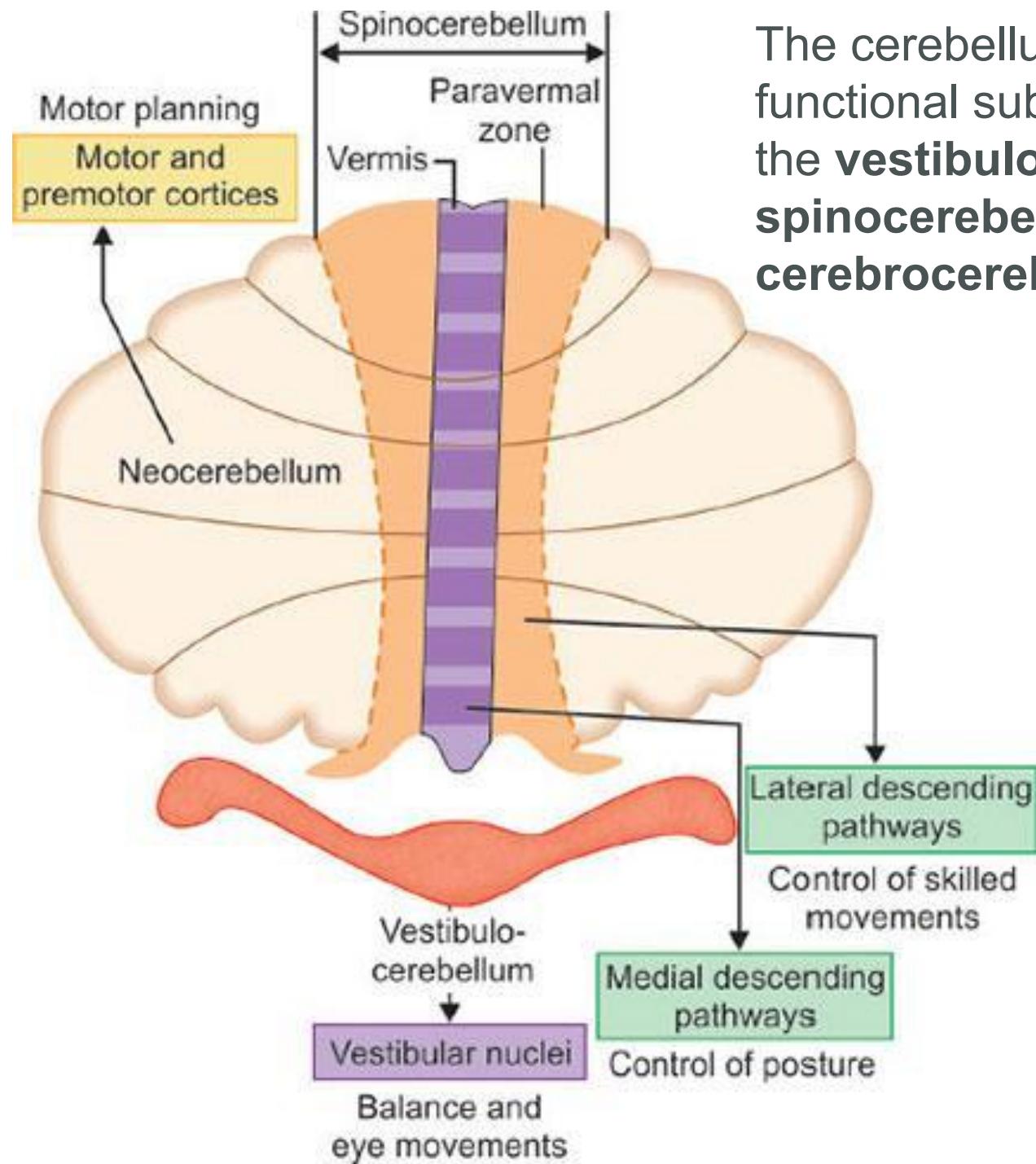
TRANSVERSE SECTION

- \* GRAY MATTER FOLDS w/ WHITE MATTER WITHIN → FOLIA
- \* 4 DEEP NUCLEI:

functional subdivisions  
& functions

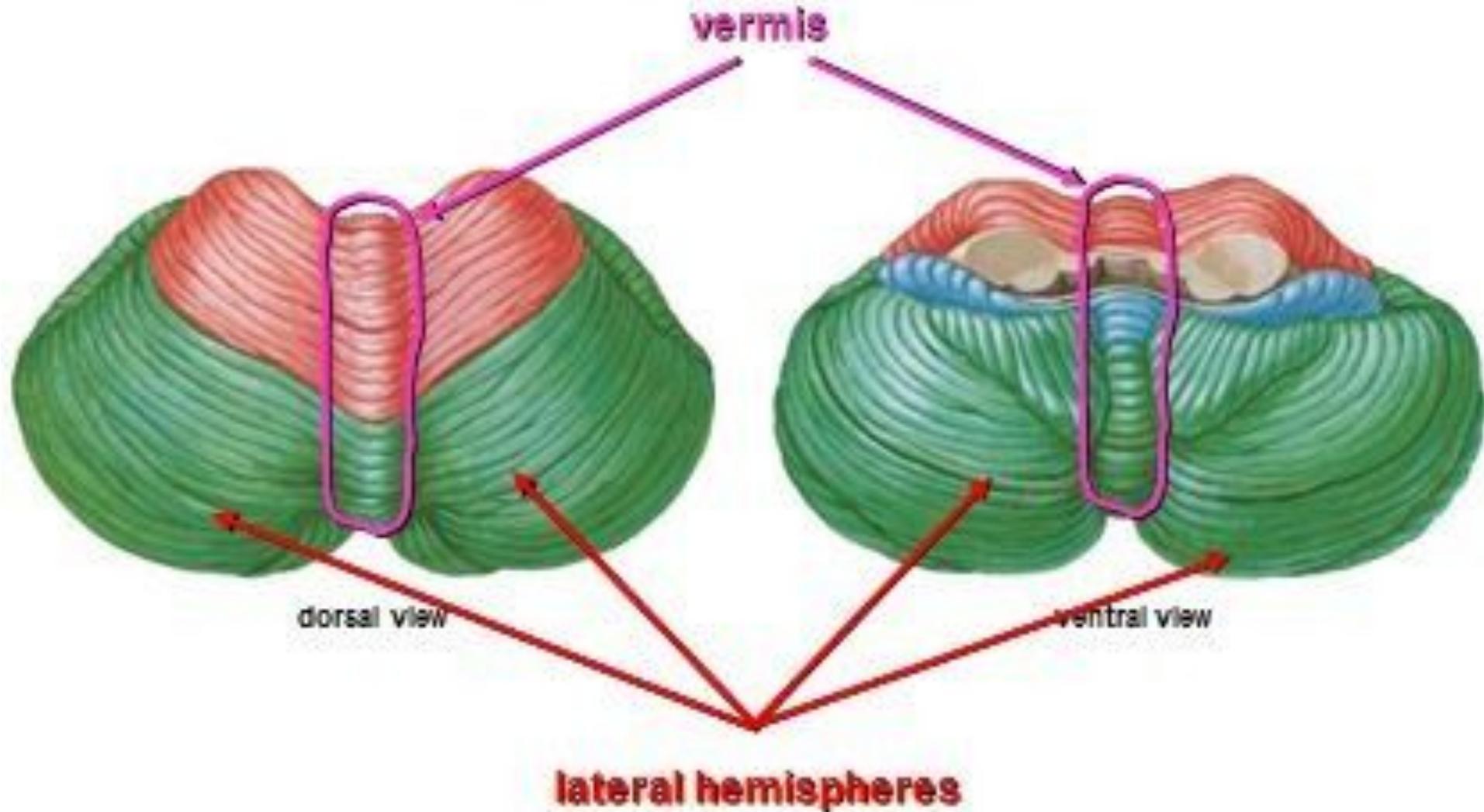
# main functions:

1. balance and equilibrium
2. spacial awareness
3. muscle tone
4. fine motor coordination
5. motor learning
6. cognitive functions



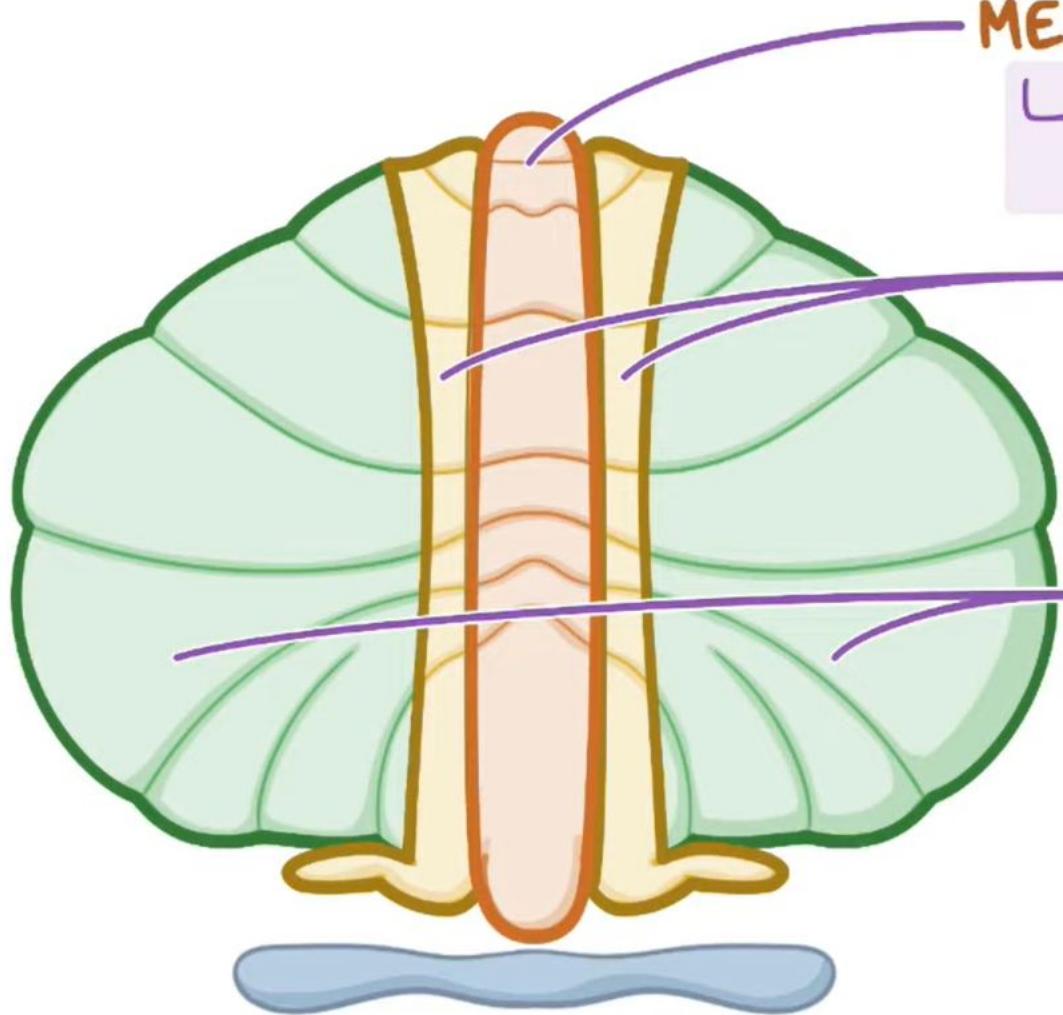
The cerebellum consists of **three** functional subdivisions. These are the **vestibulocerebellum**, the **spinocerebellum**, and the **cerebrocerebellum**.

# CEREBELLUM



3 parts

# FUNCTIONAL ZONES



## MEDIAN/VERMAL ZONE

- ADJUSTS MEDIAL DESCENDING MOTOR PATHWAYS (AXIAL MUSCULATURE)

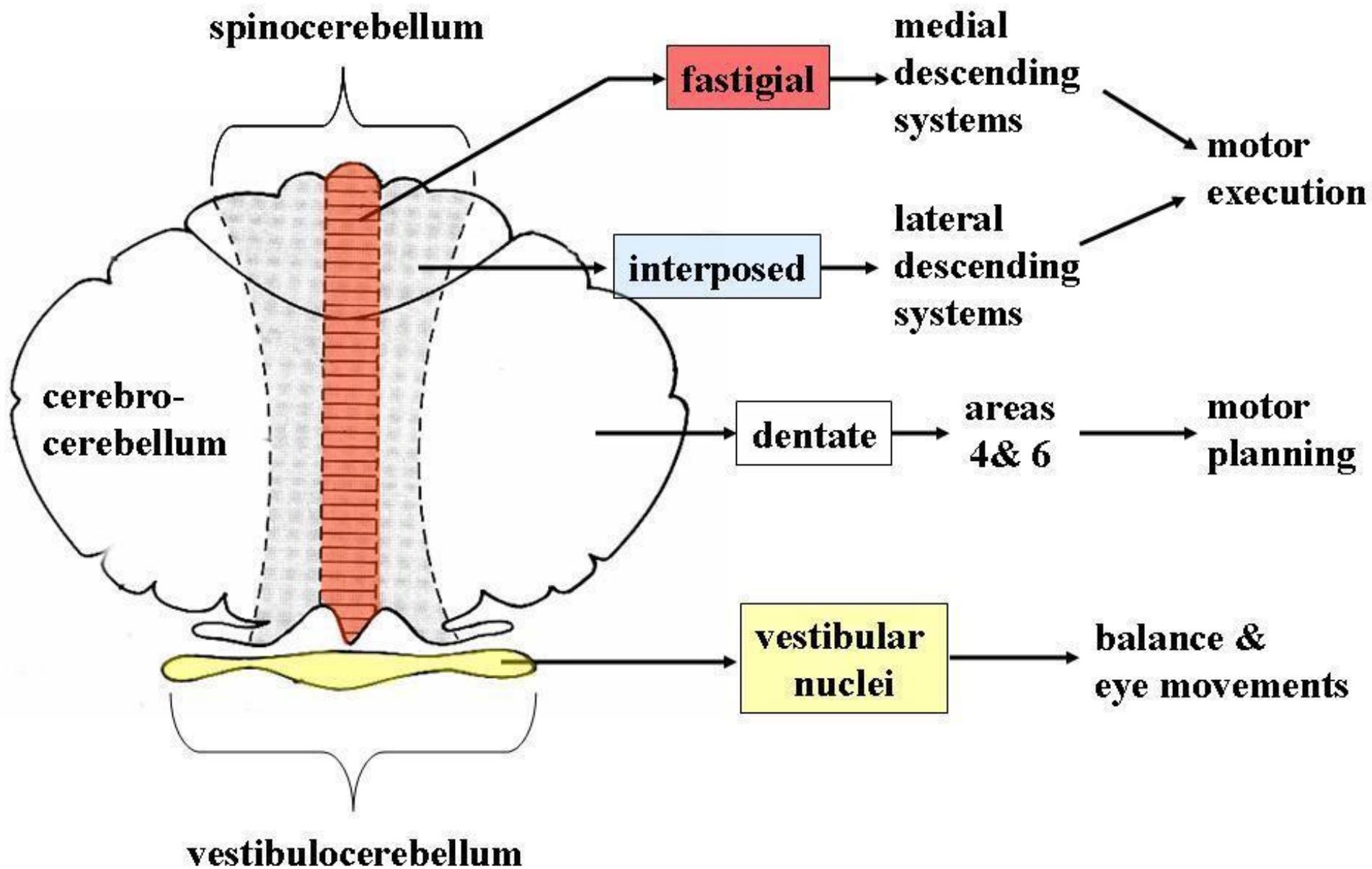
## INTERMEDIATE ZONE (PARAMEDIAN/PARAVERMAL)

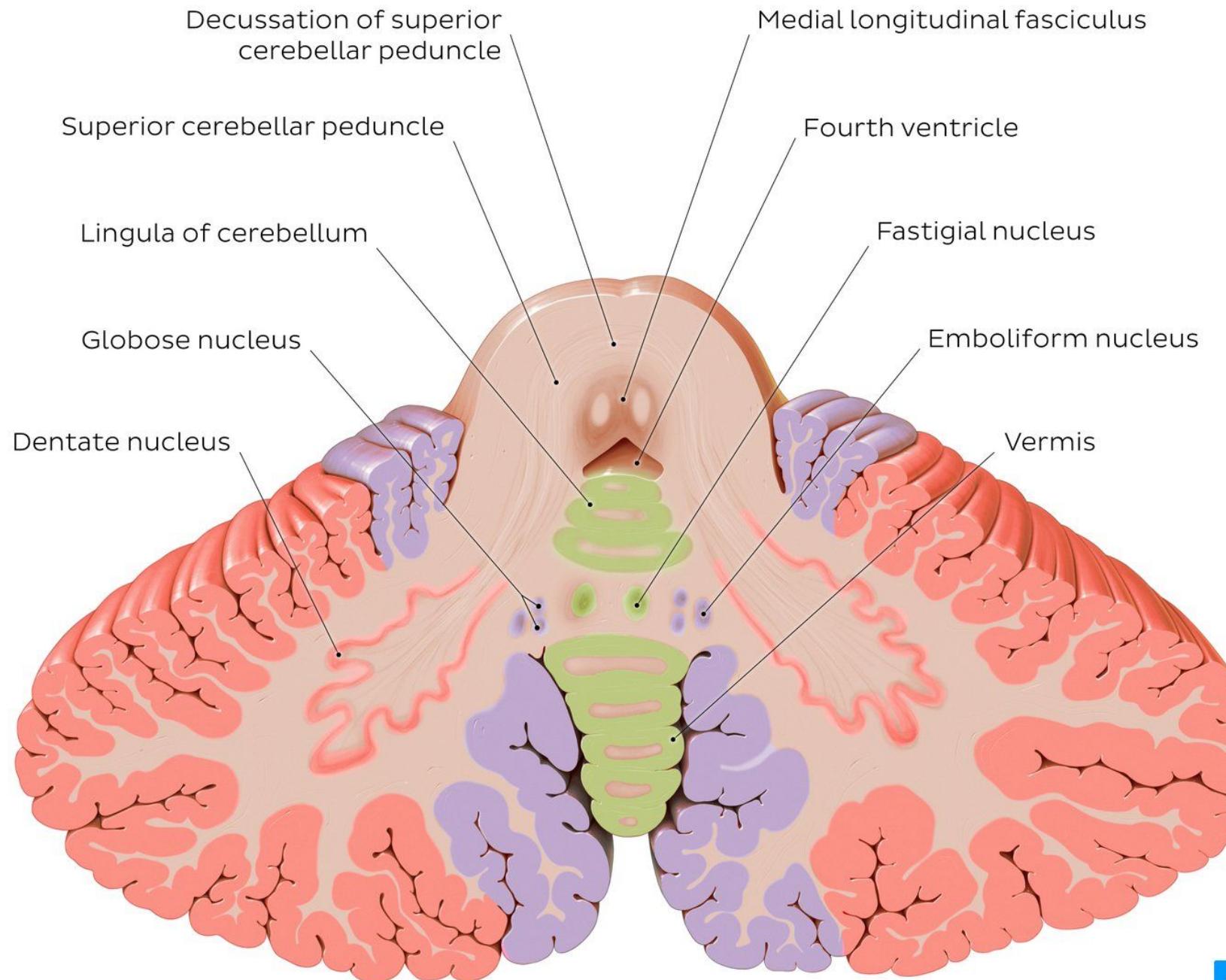
- ADJUSTS LATERAL DESCENDING MOTOR PATHWAYS (APPENDICULAR MUSCULATURE)

## LATERAL ZONE

- PLANNING & EVALUATING MOVEMENTS

# Cerebellar Output





The primary function of the **spinocerebellum** is to monitor and fine-tune limb movements. This is achieved by proprioceptive input from the dorsal column pathway of the spinal cord, the cranial trigeminal nerve, the visual and auditory systems, as well as the spinocerebellar tract. This region sends its output to the deep cerebellar nuclei. These then project to the cerebral cortex, and brainstem. This **enables the region to monitor and modify the activity of the descending motor pathways.**

The **cerebrocerebellum** receives information exclusively from the cerebral cortex, with the pontine nuclei in between, and sends its output to the thalamus, which will go on to connect with the premotor cortex and primary motor area. It will also send its output to the red nucleus. This region is primarily concerned with **planning future movements**, and also **some purely cognitive functions** such as matching verbs to nouns.

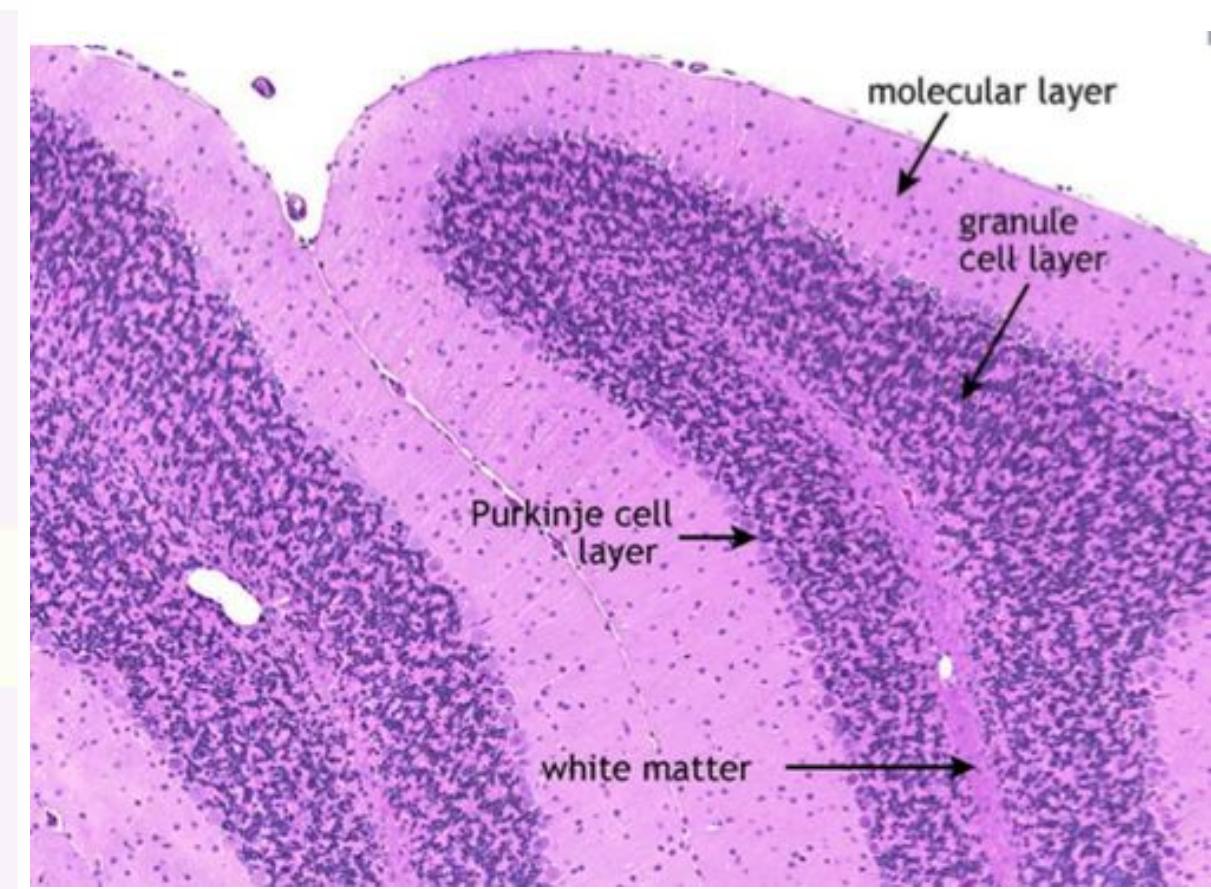
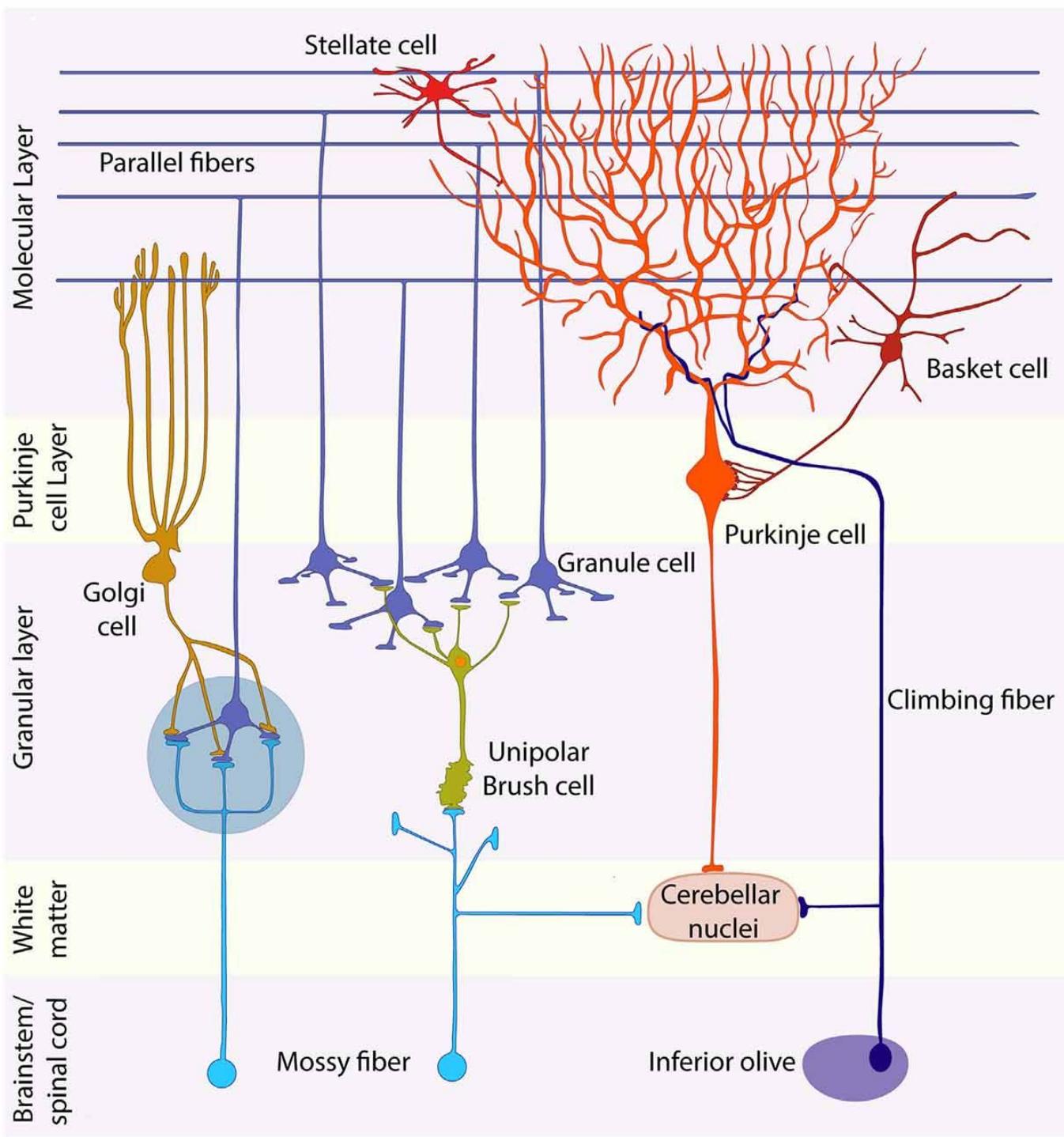
The **vestibulocerebellum** is mainly focused on **spatial awareness and balance**. It mainly receives its input from the vestibular nuclei but also from the auditory and visual sensory input. If a patient has damaged this region, the result is disturbed balance and gait.

# functions of nuclei:

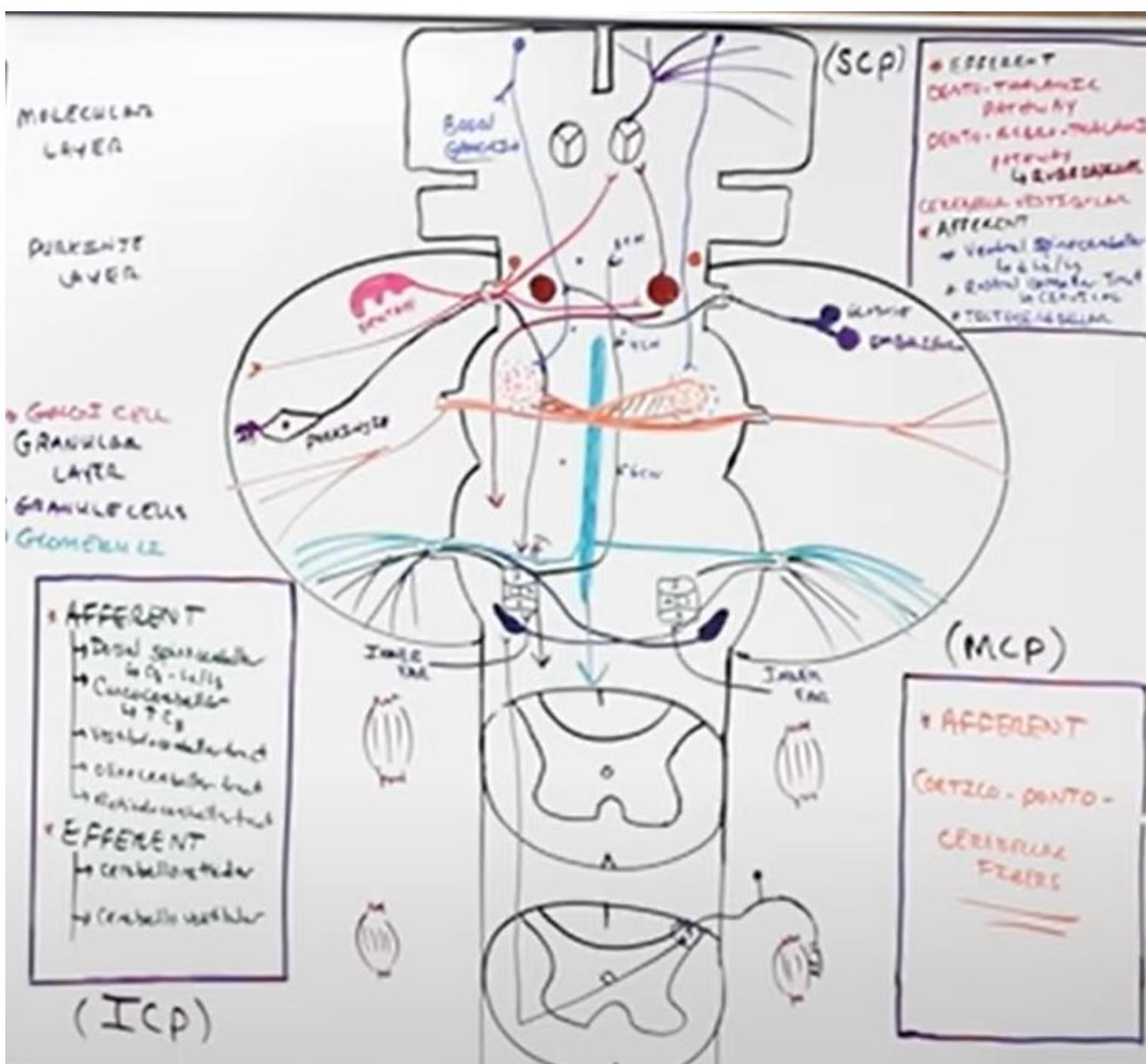
- 1) the **fastigial** nucleus: Vestibulospinal and reticulospinal tracts form **medial descending system** → involved in maintenance of balance and posture as well as muscle tone of extensor muscles
- 2) the **interposed** nuclei: Execution and modulation of movement, rubrospinal and lateral corticospinal tracts form **lateral descending system** → influence movements of distal musculature of limbs
- 3) the **dentate** nucleus: Dorsal/Motor part: Planning, initiation and timing of voluntary movement (e.g. reciprocal action of agonist and antagonist muscles of the limbs), modulation of oculomotor movement  
Ventral/nonmotor part: Associated with cognitive and visuospatial functions of cerebellum

# micro anatomy

histology



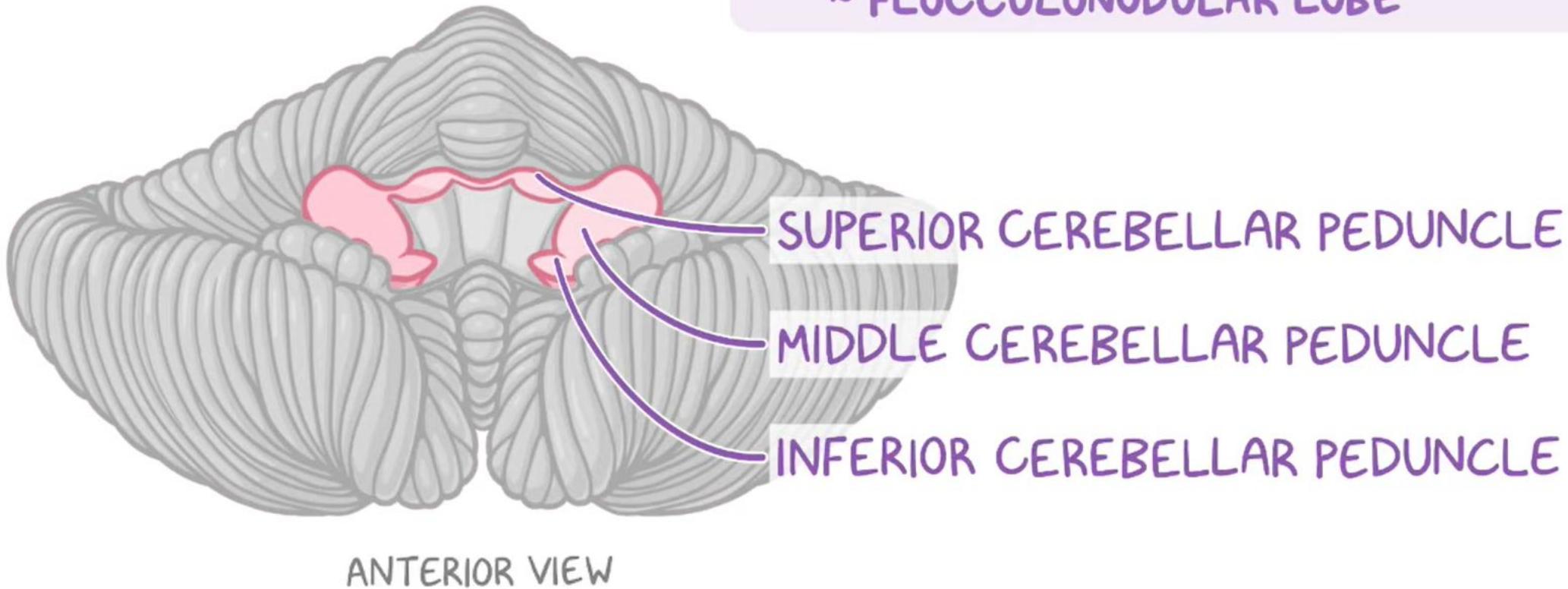
# Histology the internal cerebellar circuits



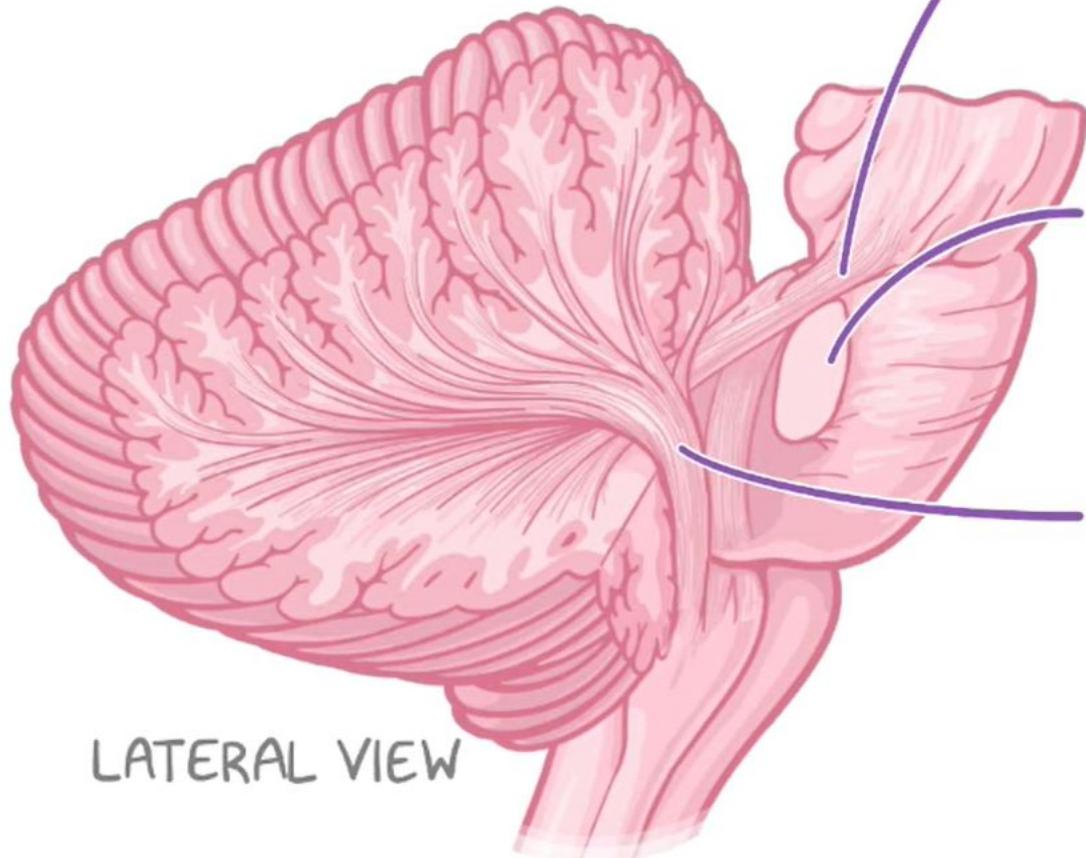
peduncles and tracts

# CEREBELLUM

- \* LOCATED in POSTERIOR CRANIAL FOSSA
- \* TWO HEMISPHERES SEPARATED by VERMIS
- \* THREE LOBES:
  - ~ ANTERIOR LOBE
  - ~ POSTERIOR LOBE
  - ~ FLOCCULONODULAR LOBE



# CEREBELLAR PEDUNCLES



LATERAL VIEW

## SUPERIOR CEREBELLAR PEDUNCLE

CONNECTS CEREBELLUM  
with MIDBRAIN

## MIDDLE CEREBELLAR PEDUNCLE (CUT)

CONNECTS CEREBELLUM  
with PONS

## INFERIOR CEREBELLAR PEDUNCLE

CONNECTS CEREBELLUM  
with MEDULLA

MAJORITY of  
AFFERENT  
SIGNALS

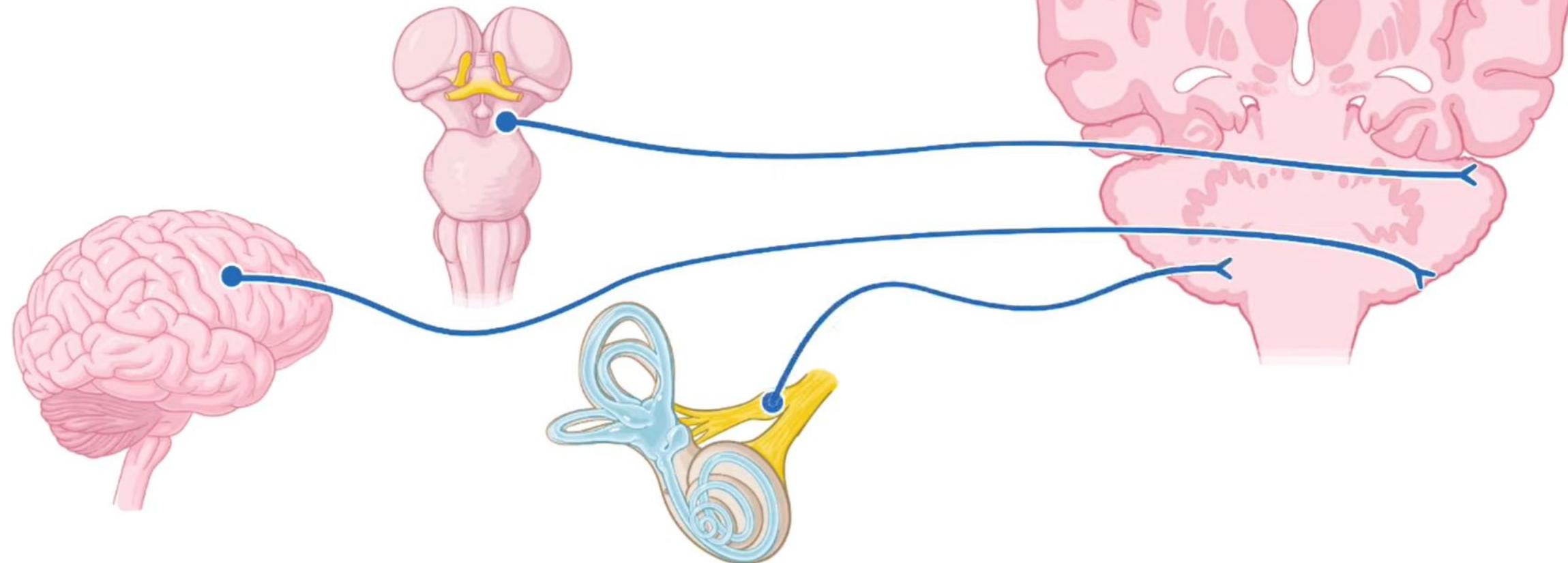
# afferent pathways

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# AFFERENT PATHWAYS

## ORIGINATE:

- ~ SPINAL CORD & BRAINSTEM
- ~ CEREBRAL CORTEX
- ~ VESTIBULAR SYSTEM

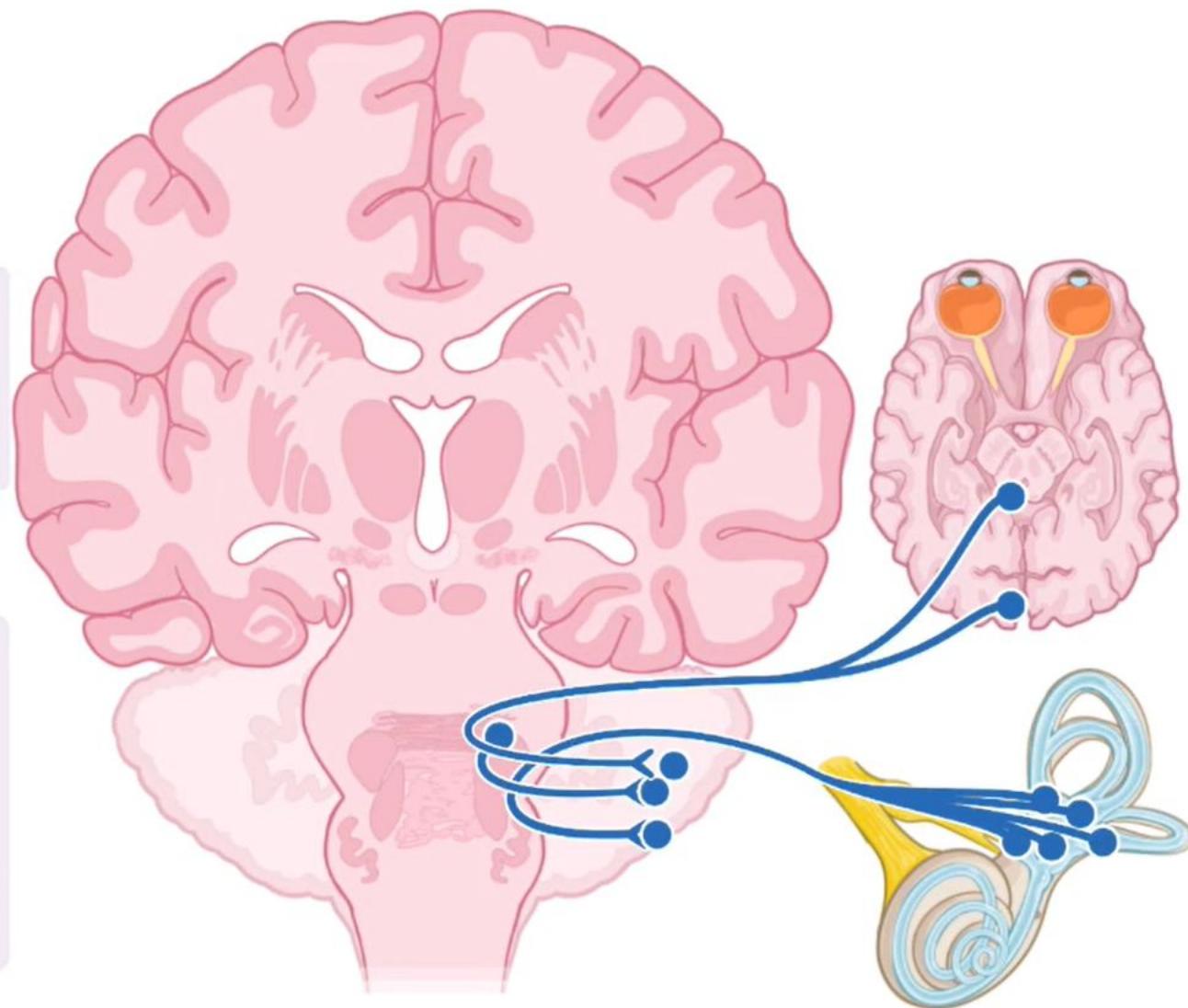


مین اللي بيكلم المخيخ؟  
المخيخ بيسمع من مين؟  
بيستقبل من مين؟

# AFFERENT PATHWAYS

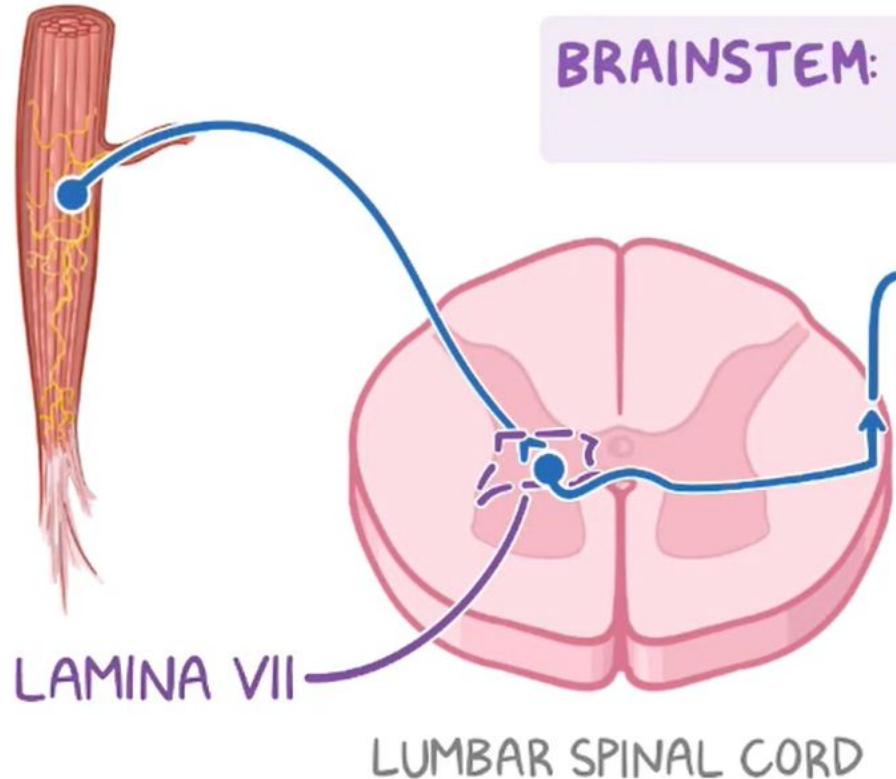
- \* SPINAL CORD → CEREBELLUM
  - ~ VENTRAL SPINOCEREBELLAR PATHWAY
  - ~ DORSAL SPINOCEREBELLAR PATHWAY
  - ~ CUNEOCEREBELLAR PATHWAY
- \* BRAIN → CEREBELLUM
  - ~ CORTICOPONTOCEREBELLAR PATHWAY
  - ~ CEREBRO-OLIVOCEREBELLAR PATHWAY
  - ~ CEREBRORETICULOCEREBELLAR PATHWAY
- \* VESTIBULOCEREBELLAR PATHWAY
  - SEMICIRCULAR CANALS
  - INNER EAR
  - SUPERIOR COLICULI
  - PRIMARY VISUAL CORTEX

↳ HELPS MAINTAIN BALANCE, POSTURE, BODY POSITION, & COORDINATE EYE MOVEMENTS

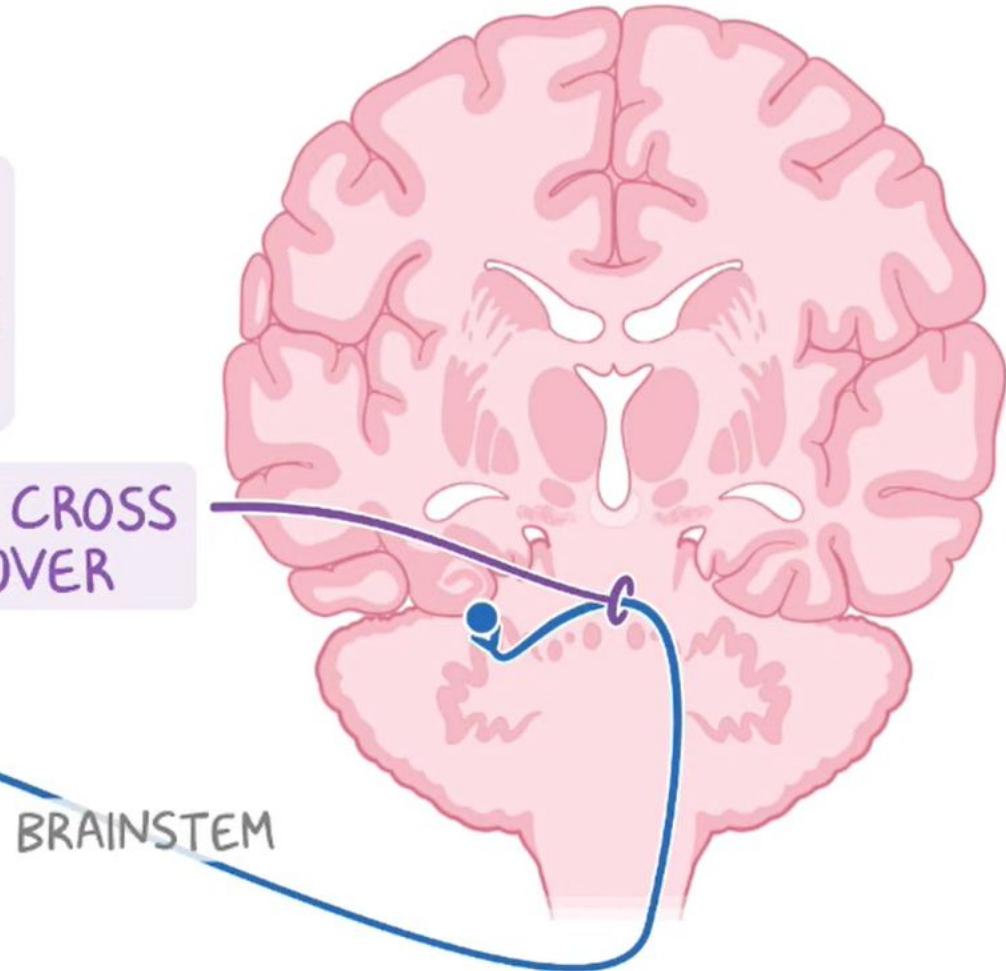


# VENTRAL/ANTERIOR SPINOCEREBELLAR PATHWAY

CARRIES PROPRIOCEPTIVE INFORMATION from MUSCLE SPINDLES, GOLGI TENDON ORGANS, & JOINT RECEPTORS of LOWER EXTREMITIES



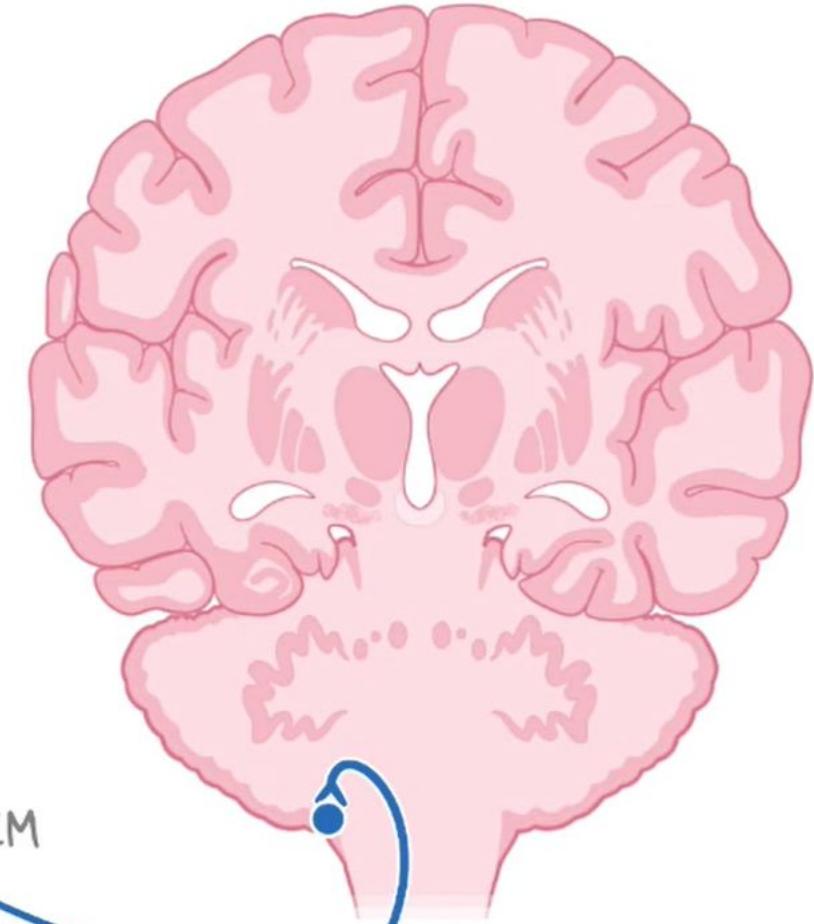
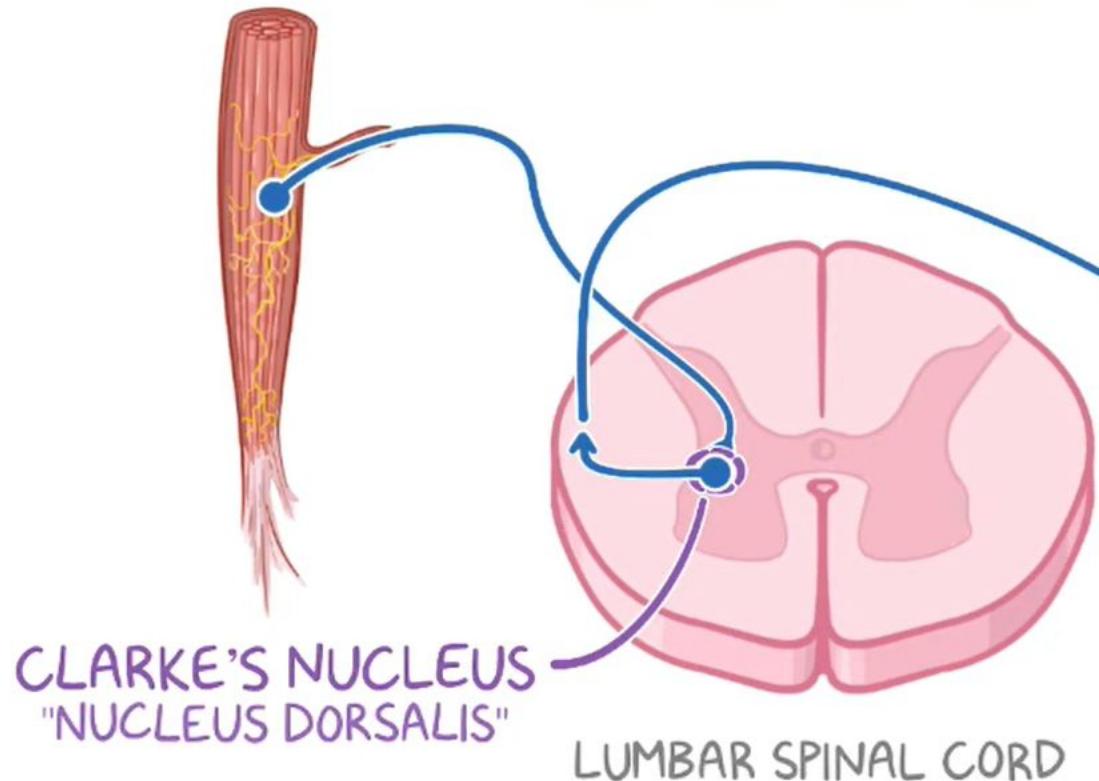
BRAINSTEM: AXONS CROSS BACK OVER



CEREBELLUM: ENTERS THROUGH SUPERIOR CEREBELLAR PEDUNCLE  
TERMINATES: IPSILATERAL VERMAL & PARAVERMAL CORTEX

# DORSAL/POSTERIOR SPINOCEREBELLAR PATHWAY

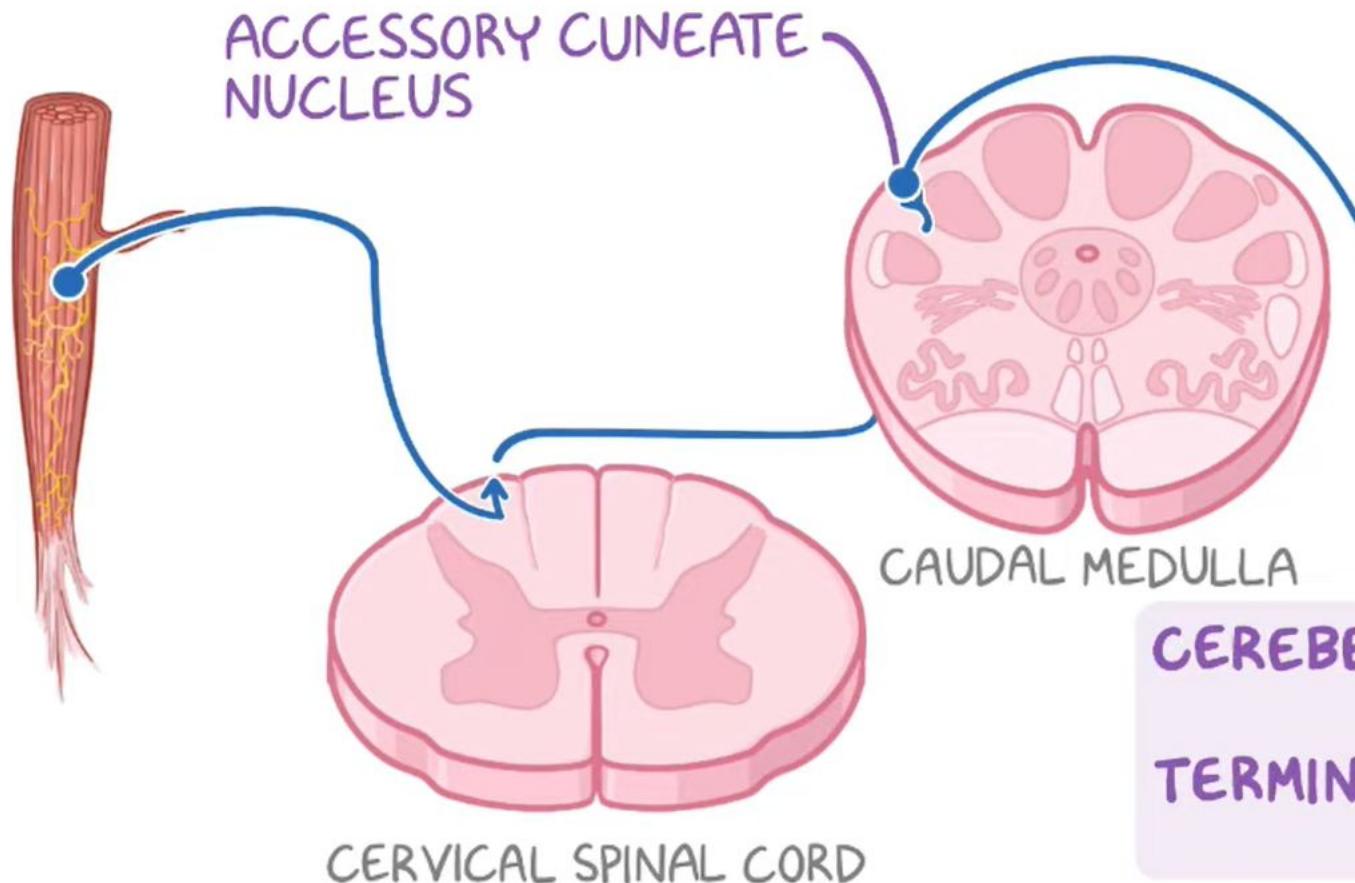
CARRIES PROPRIOCEPTIVE INFORMATION from MUSCLE SPINDLES, GOLGI TENDON ORGANS, & JOINT RECEPTORS of TRUNK & LOWER EXTREMITIES



CEREBELLUM: ENTERS THROUGH INFERIOR CEREBELLAR PEDUNCLE  
TERMINATES: IPSILATERAL CEREBELLAR CORTEX

# CUNEOCEREBELLAR PATHWAY

↳ CARRIES PROPRIOCEPTIVE INFORMATION from MUSCLE SPINDLES, GOLGI TENDON ORGANS, & JOINT RECEPTORS within UPPER LIMB & THORAX



CEREBELLUM: ENTERS THROUGH INFERIOR CEREBELLAR PEDUNCLE  
TERMINATES: IPSILATERAL CEREBELLAR CORTEX

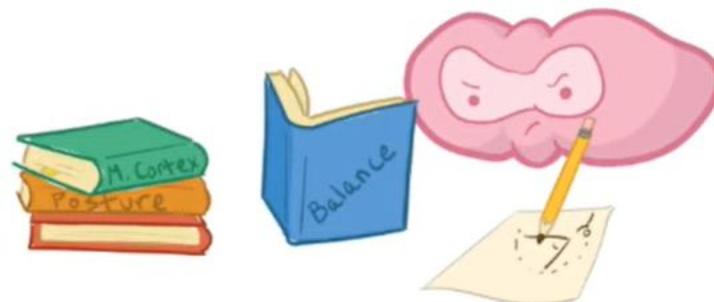
# AFFERENT PATHWAYS from CEREBRAL CORTEX



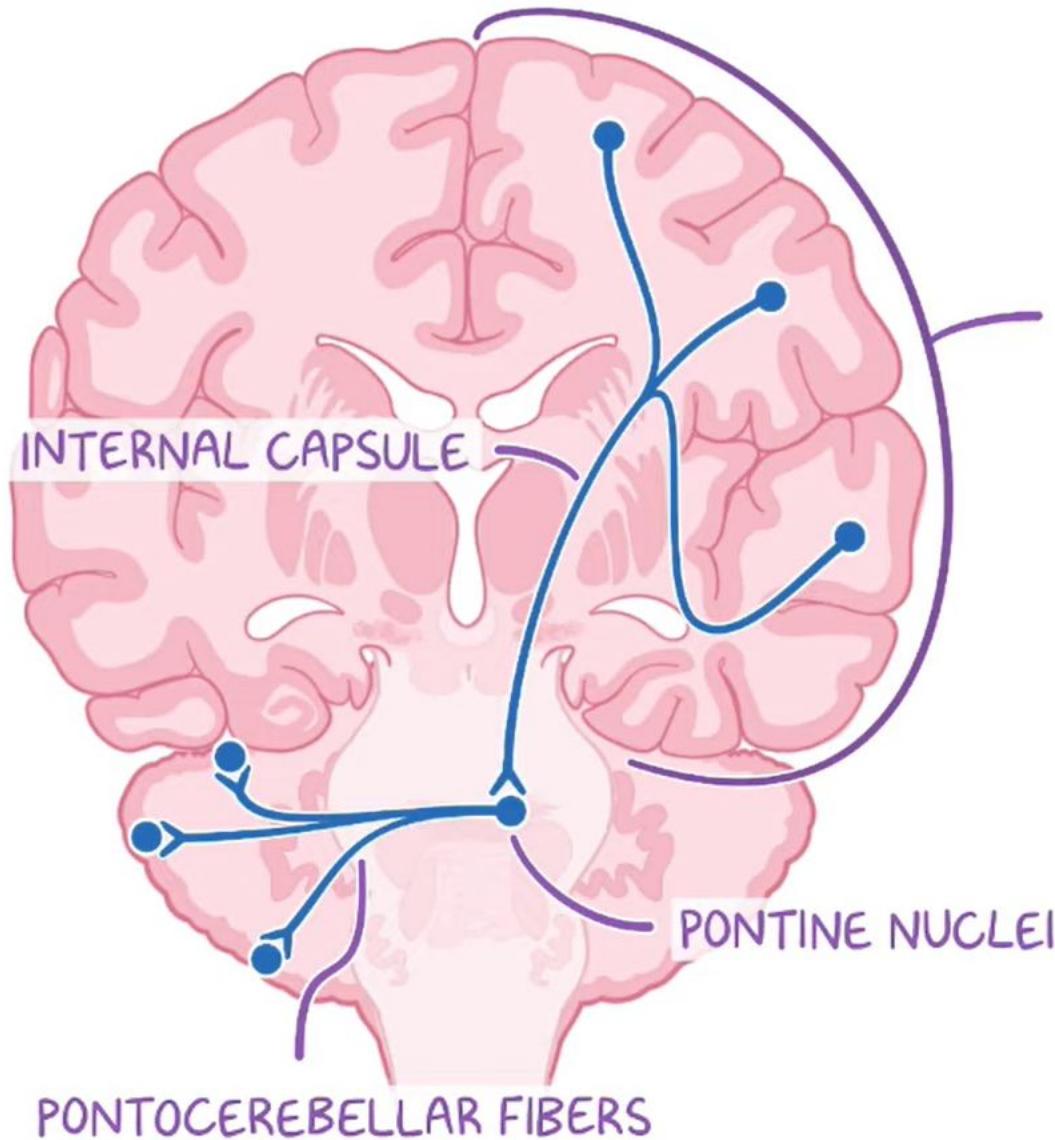
ORIGINATE in CEREBRAL CORTEX

SIGNAL through BRAINSTEM

CEREBELLUM



# CORTICOPONTOCEREBELLAR PATHWAY



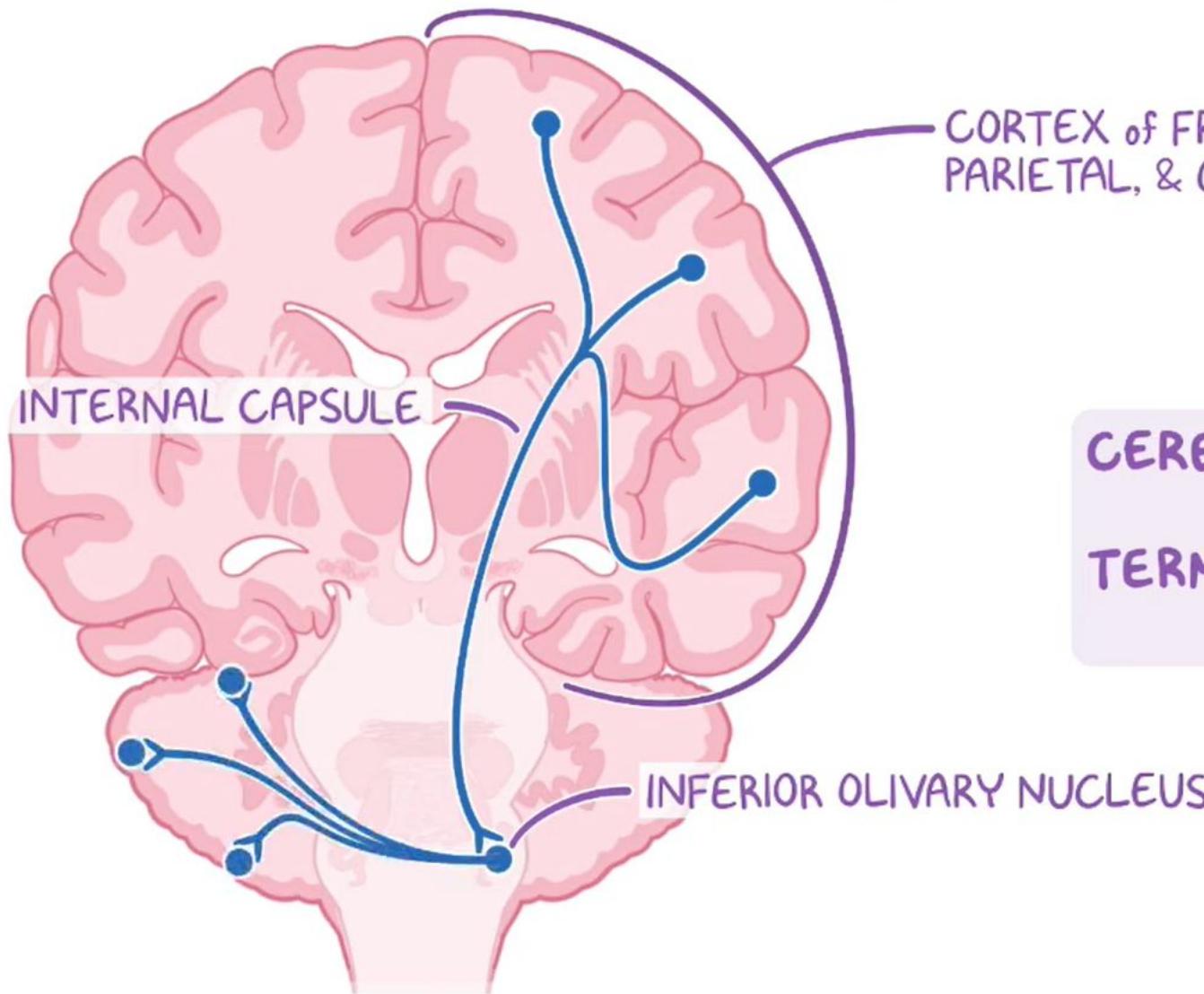
RELAYS MOTOR COMMANDS of  
CEREBRAL CORTEX

CORTEX of FRONTAL, TEMPORAL,  
PARIETAL, & OCCIPITAL LOBES

CEREBELLUM: ENTERS via MIDDLE  
CEREBELLAR PEDUNCLE

TERMINATES: CONTRALATERAL  
CEREBELLAR CORTEX

# CEREBRO-OLIVOCEREBELLAR PATHWAY



CORTEX of FRONTAL, TEMPORAL,  
PIRIETAL, & OCCIPITAL LOBES

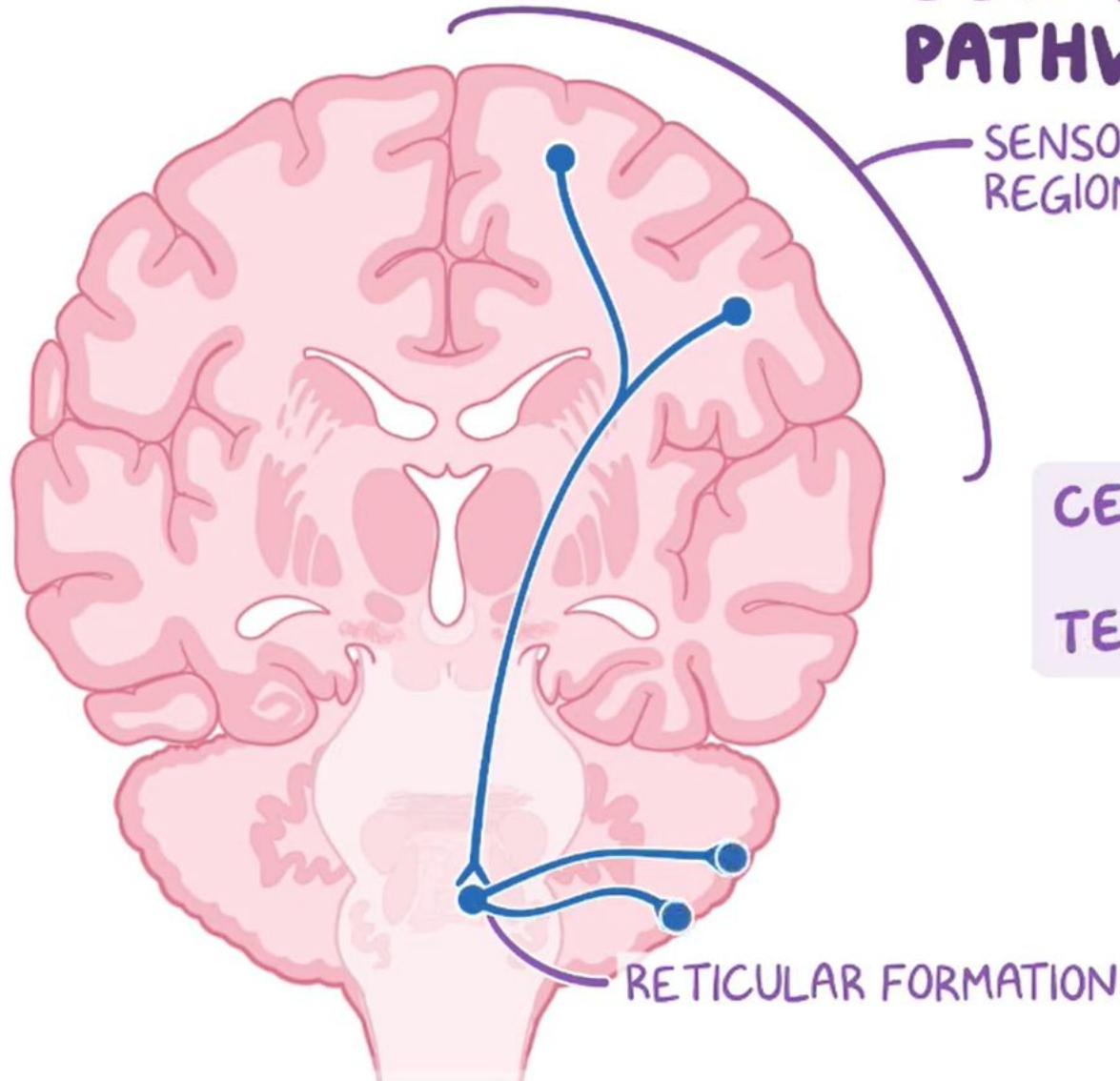
INTERNAL CAPSULE

INFERIOR OLIVARY NUCLEUS

CEREBELLUM: ENTERS via INFERIOR  
CEREBELLAR PEDUNCLE

TERMINATES: CONTRALATERAL  
CEREBELLAR CORTEX

# CEREBRORETICULOCEREBELLAR PATHWAY

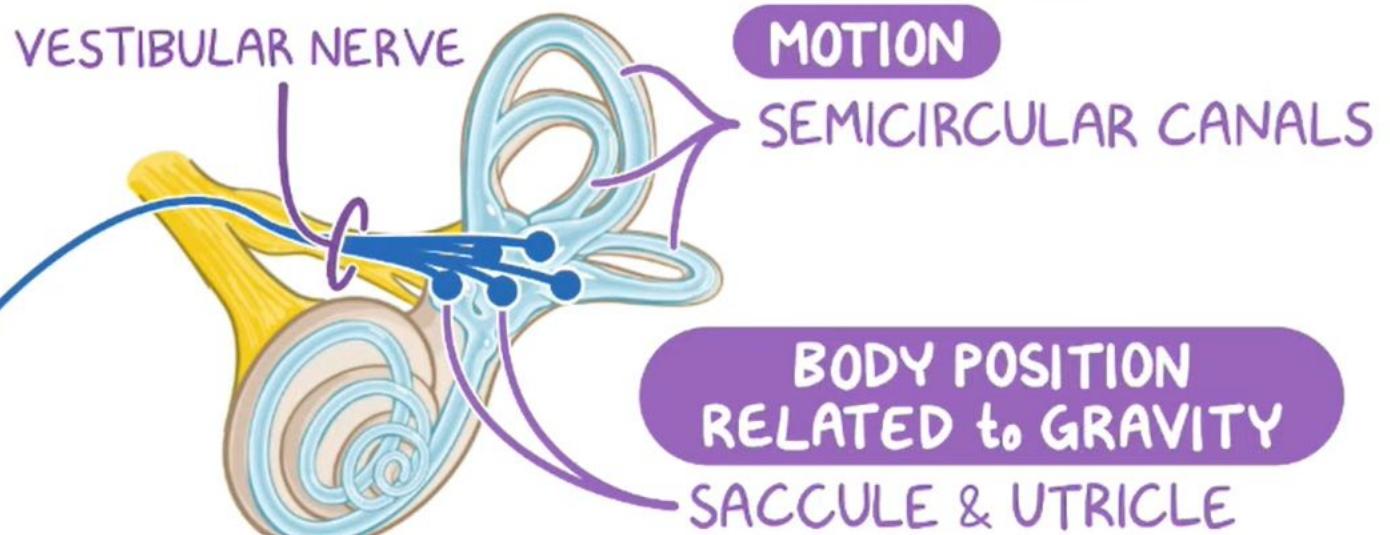
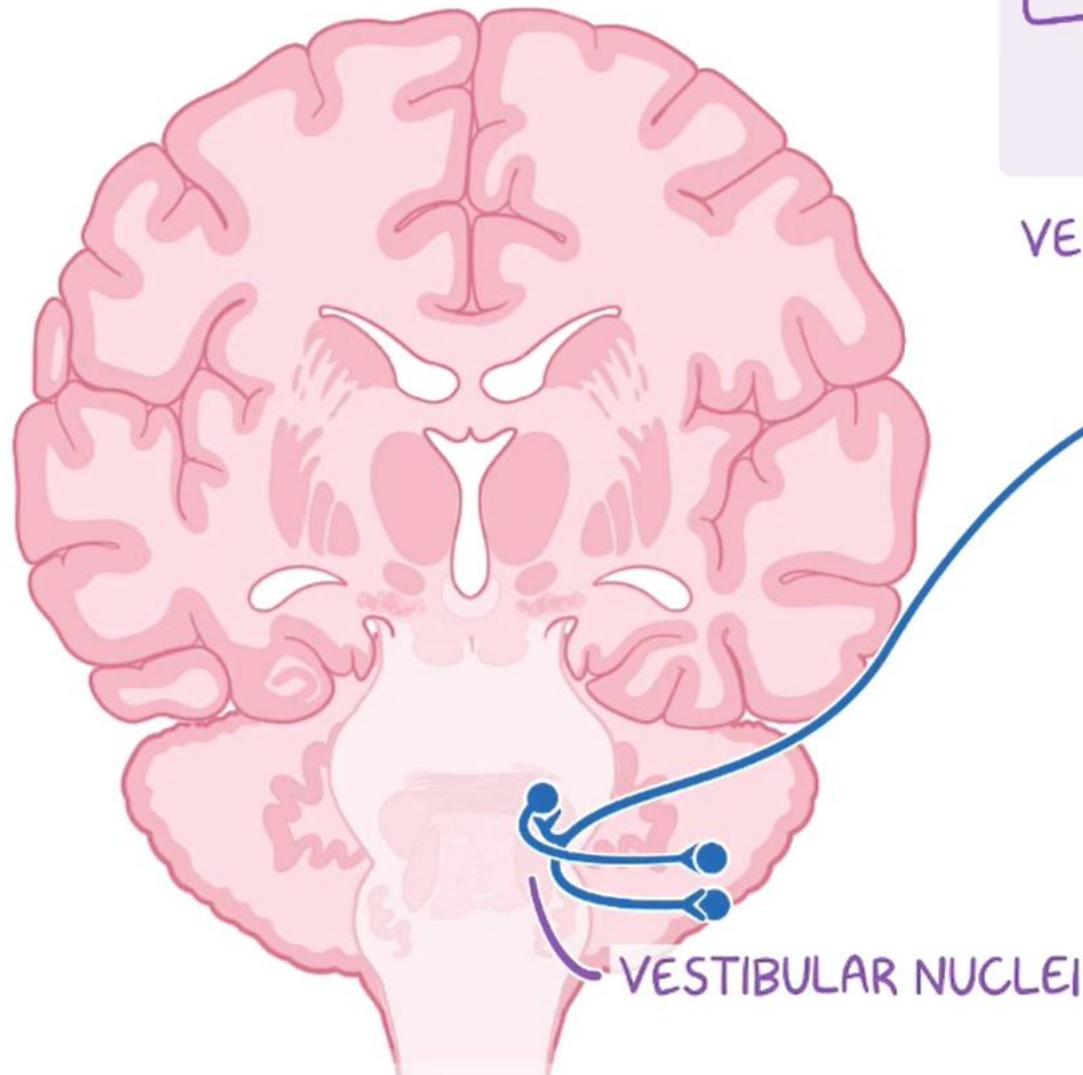


SENSORIMOTOR CORTICAL  
REGIONS in PARIETAL LOBE

CEREBELLUM: TRAVEL THROUGH MIDDLE &  
INFERIOR CEREBELLAR PEDUNCLE  
TERMINATES: IPSILATERAL CEREBELLAR CORTEX

# VESTIBULOCEREBELLAR PATHWAY

PLAYS a KEY ROLE in MAINTENANCE of BALANCE, POSTURE, BODY POSITION, & COORDINATION of EYE MOVEMENTS



## CEREBELLUM:

- ~ SIGNAL STRAIGHT through INFERIOR CEREBELLAR PEDUNCLE or
- ~ SYNAPSE in VESTIBULAR NUCLEI

## TERMINATES:

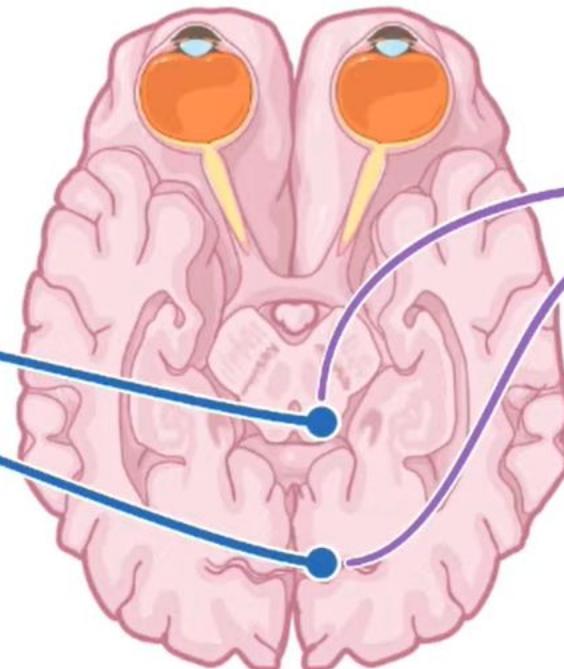
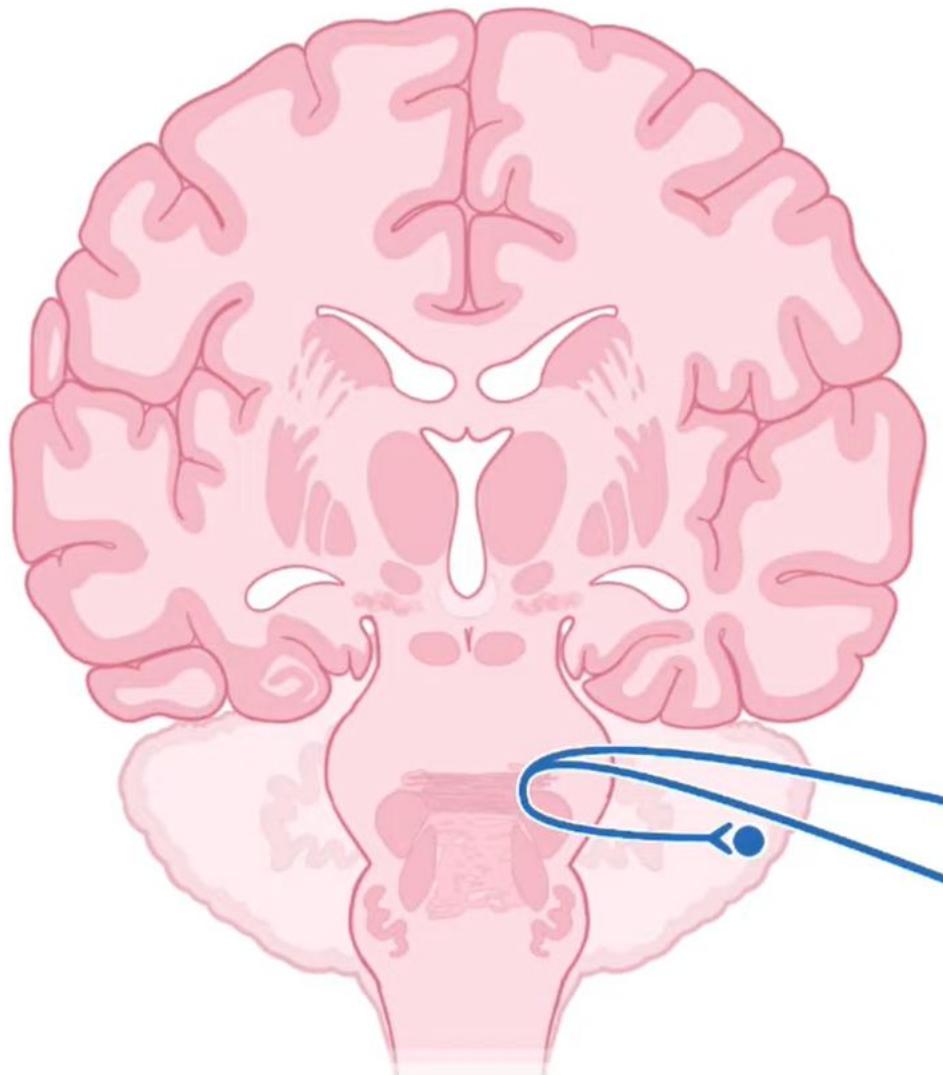
- ~ IPSILATERAL FLOCCULONODULAR LOBE

# VESTIBULOCEREBELLAR PATHWAY

PLAYS a KEY ROLE in MAINTENANCE of BALANCE, POSTURE, BODY POSITION, & COORDINATION of EYE MOVEMENTS

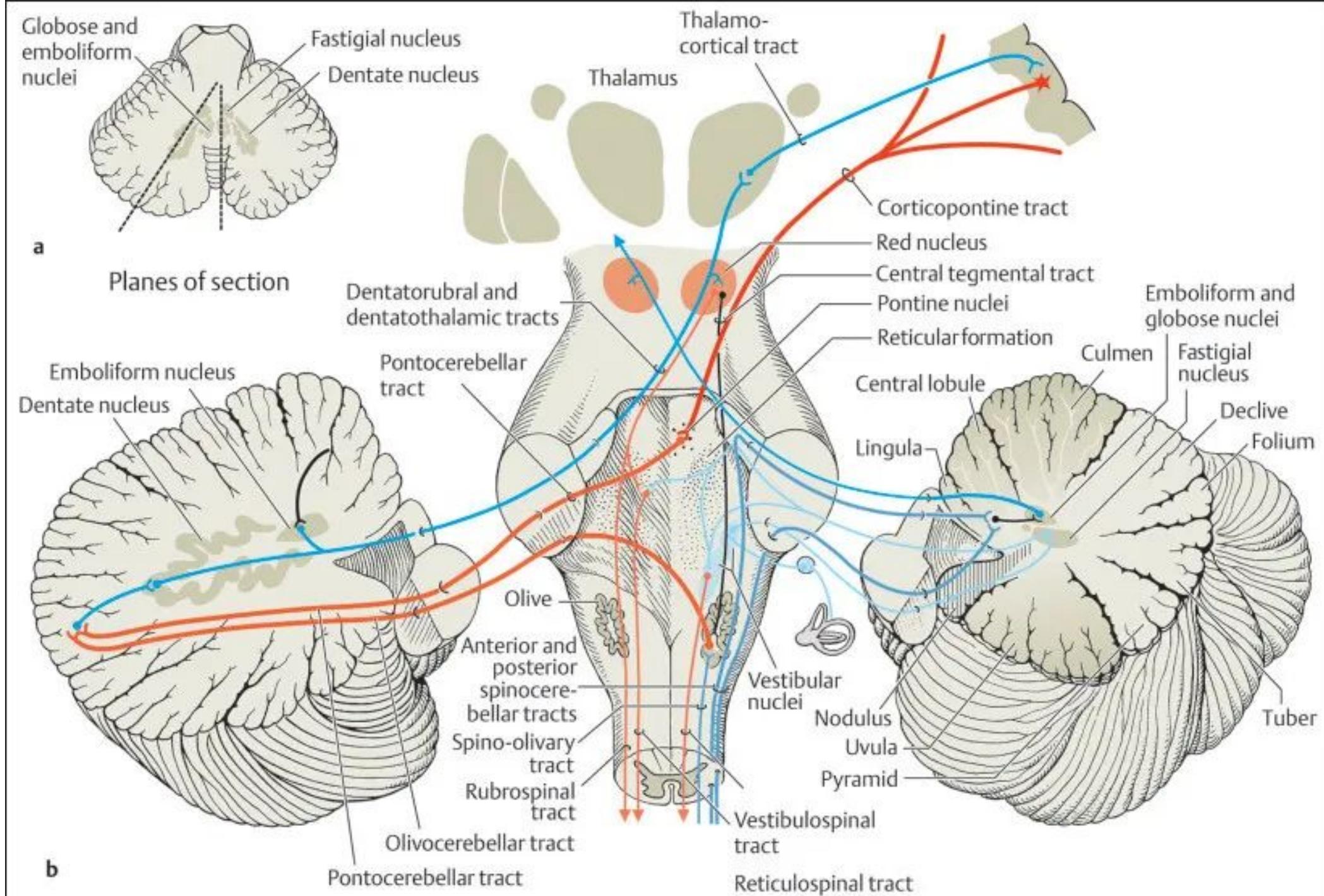
CEREBELLUM: TRAVEL THROUGH SUPERIOR CEREBELLAR PEDUNCLE

TERMINATES: IPSILATERAL FLOCCULONODULAR LOBE



VISUAL INPUT

SUPERIOR COLICULUS  
PRIMARY VISUAL CORTEX



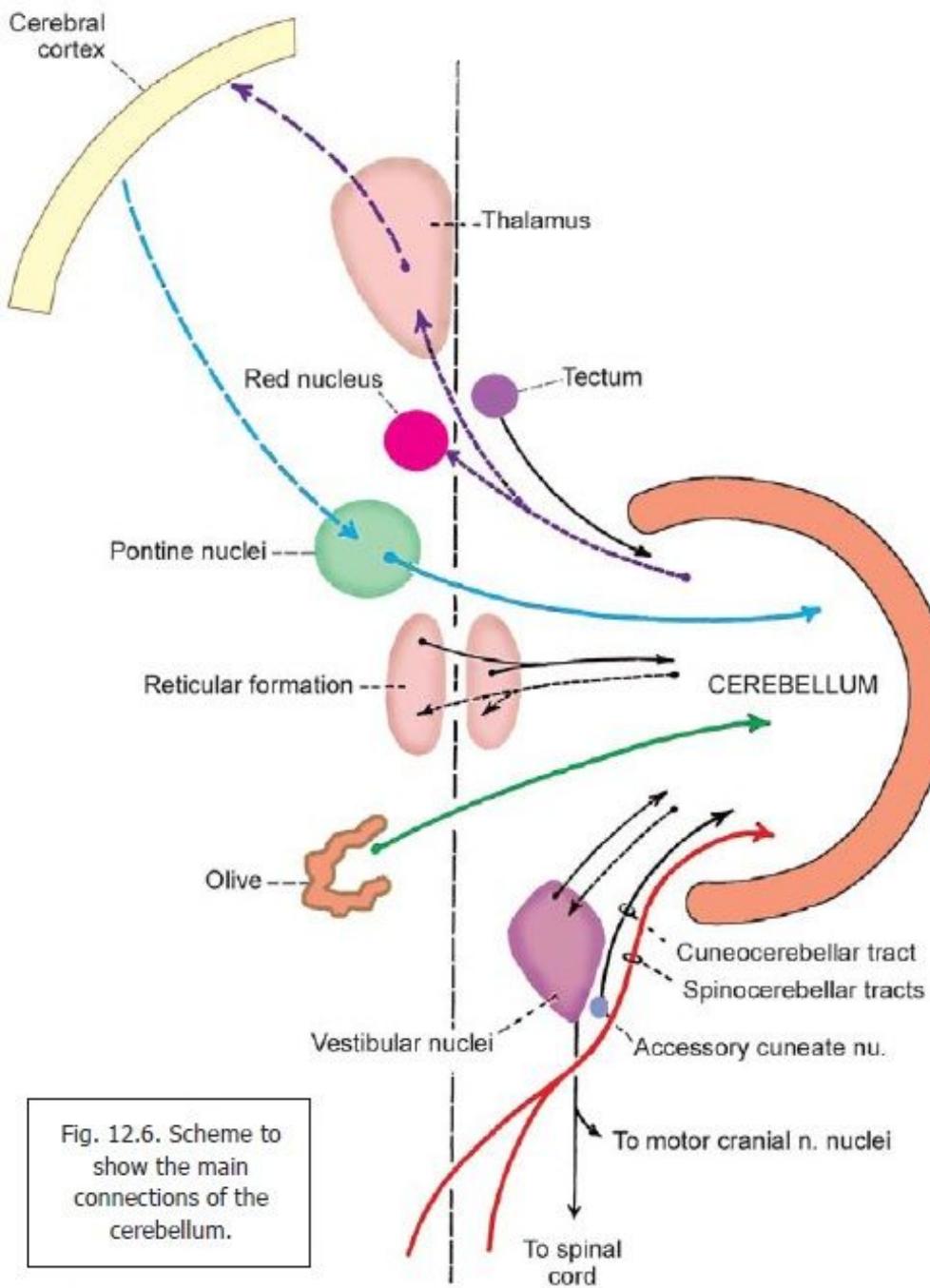
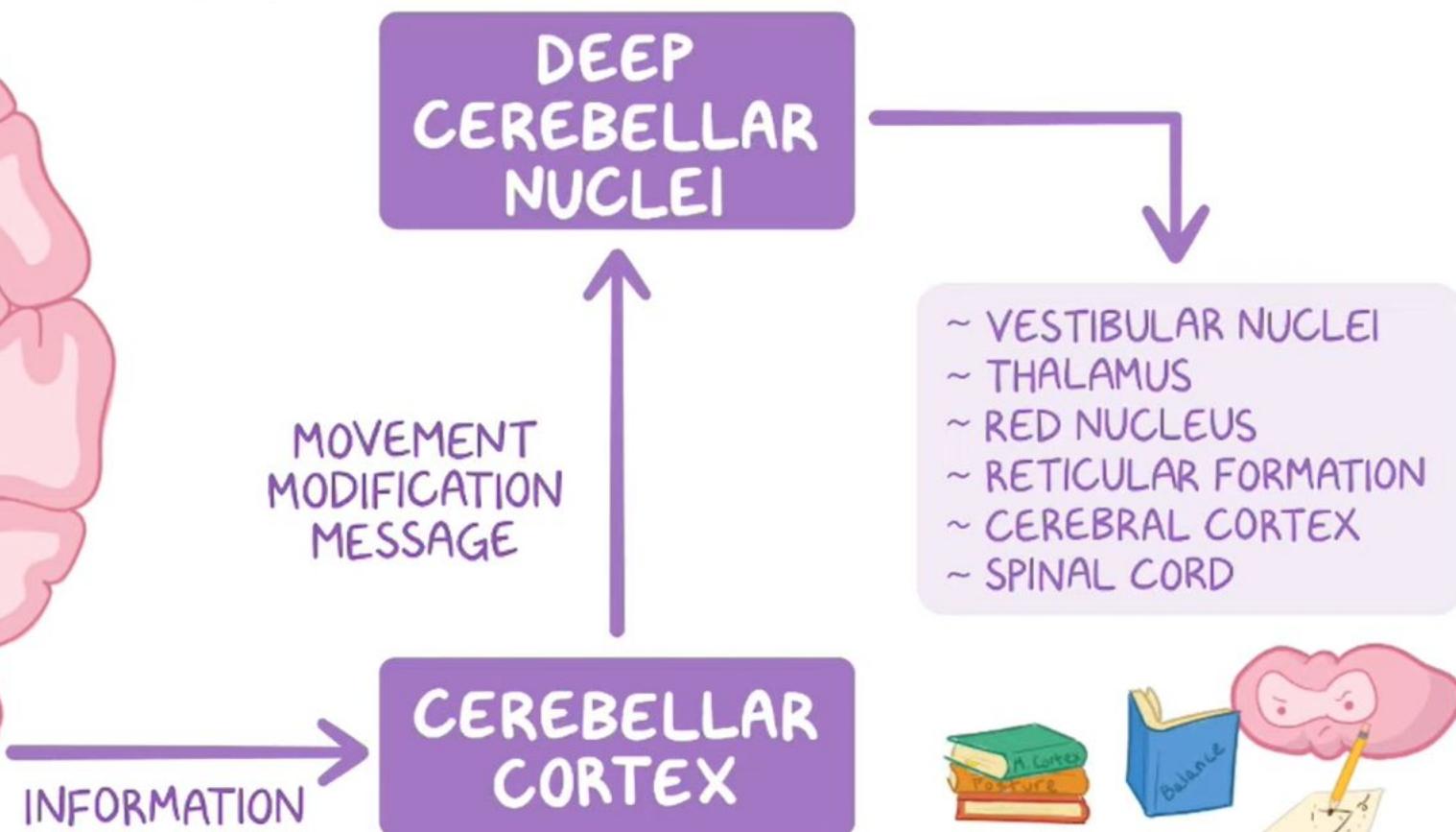
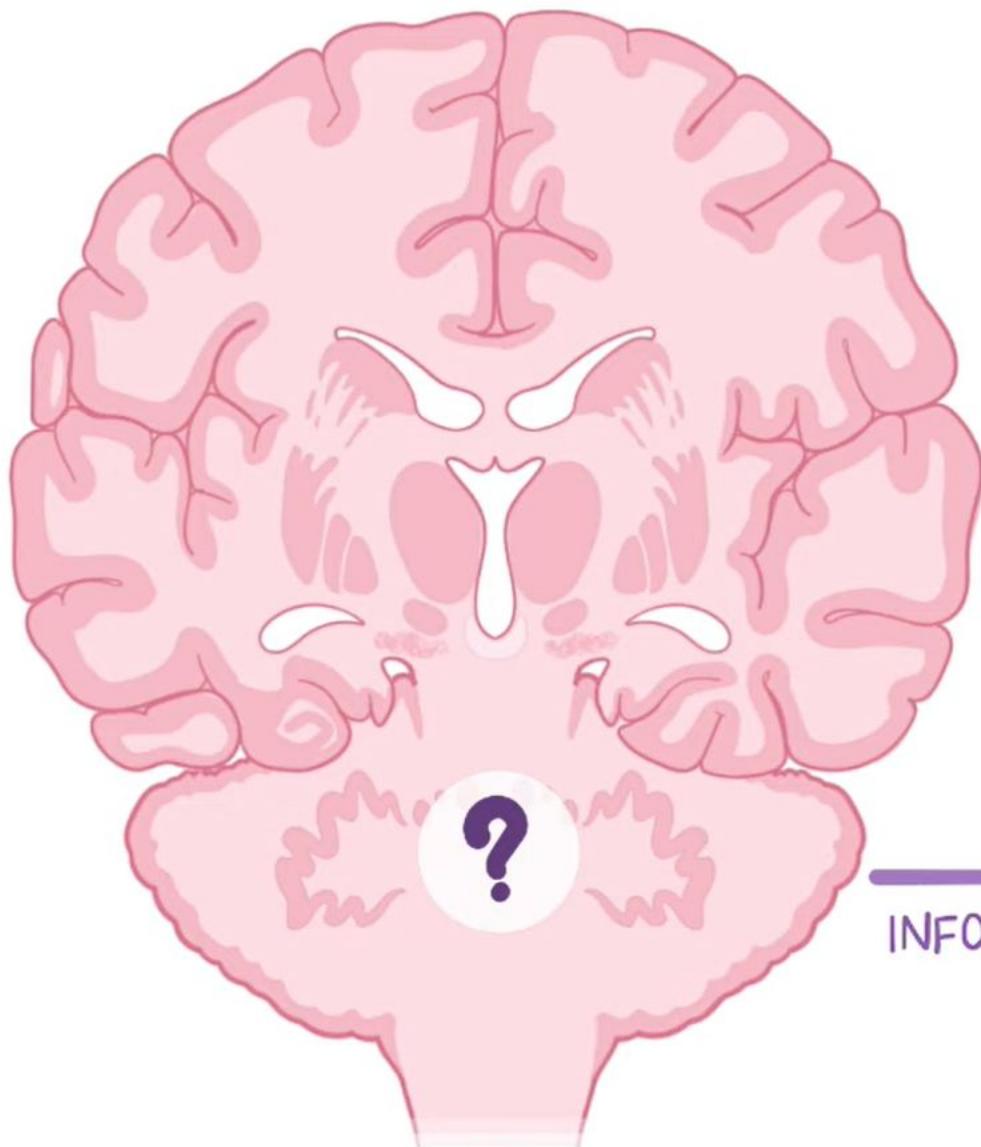
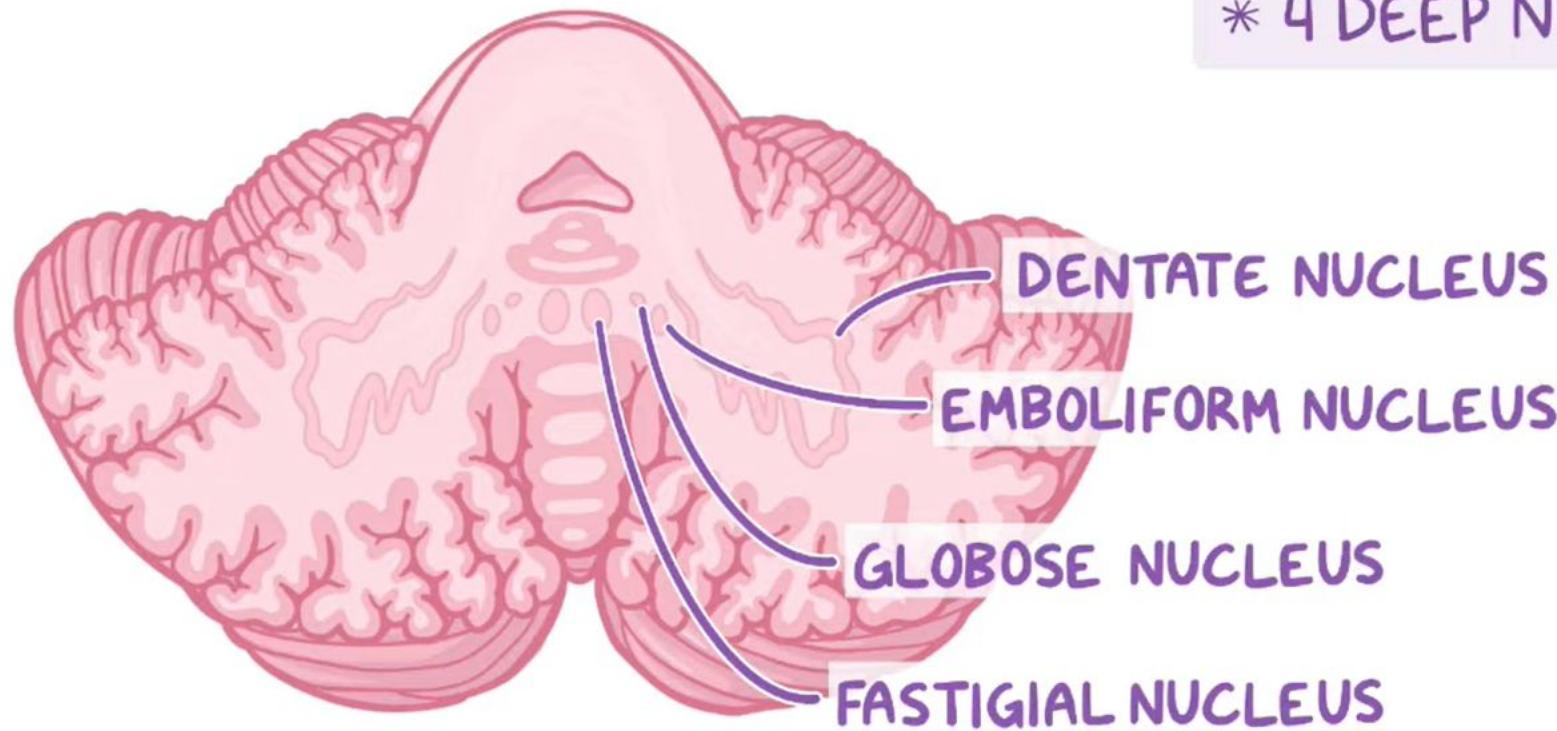


Fig. 12.6. Scheme to show the main connections of the cerebellum.

\* CONTINUOUS ROLE in MAINTAINING POSTURE, BALANCE, & MODIFYING, ADJUSTING, & COORDINATING MOVEMENT



# CEREBELLUM



TRANSVERSE SECTION

- \* GRAY MATTER FOLDS w/ WHITE MATTER WITHIN → FOLIA
- \* 4 DEEP NUCLEI:

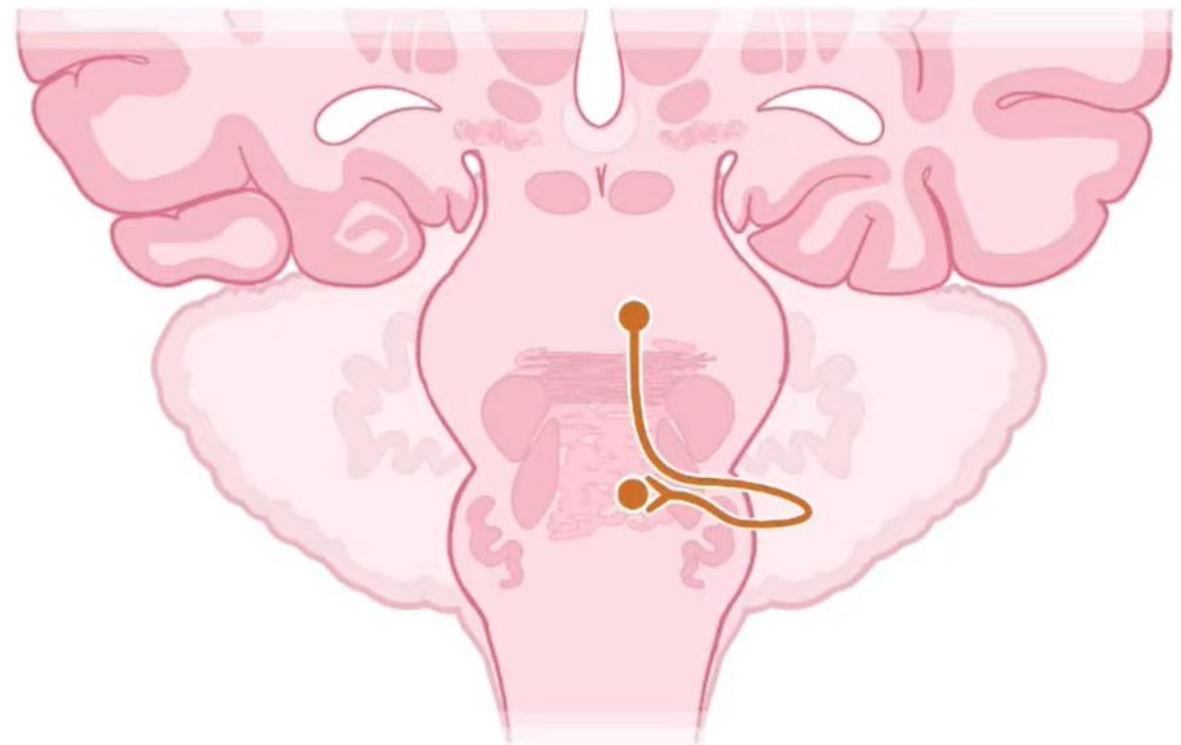
# efferent pathways

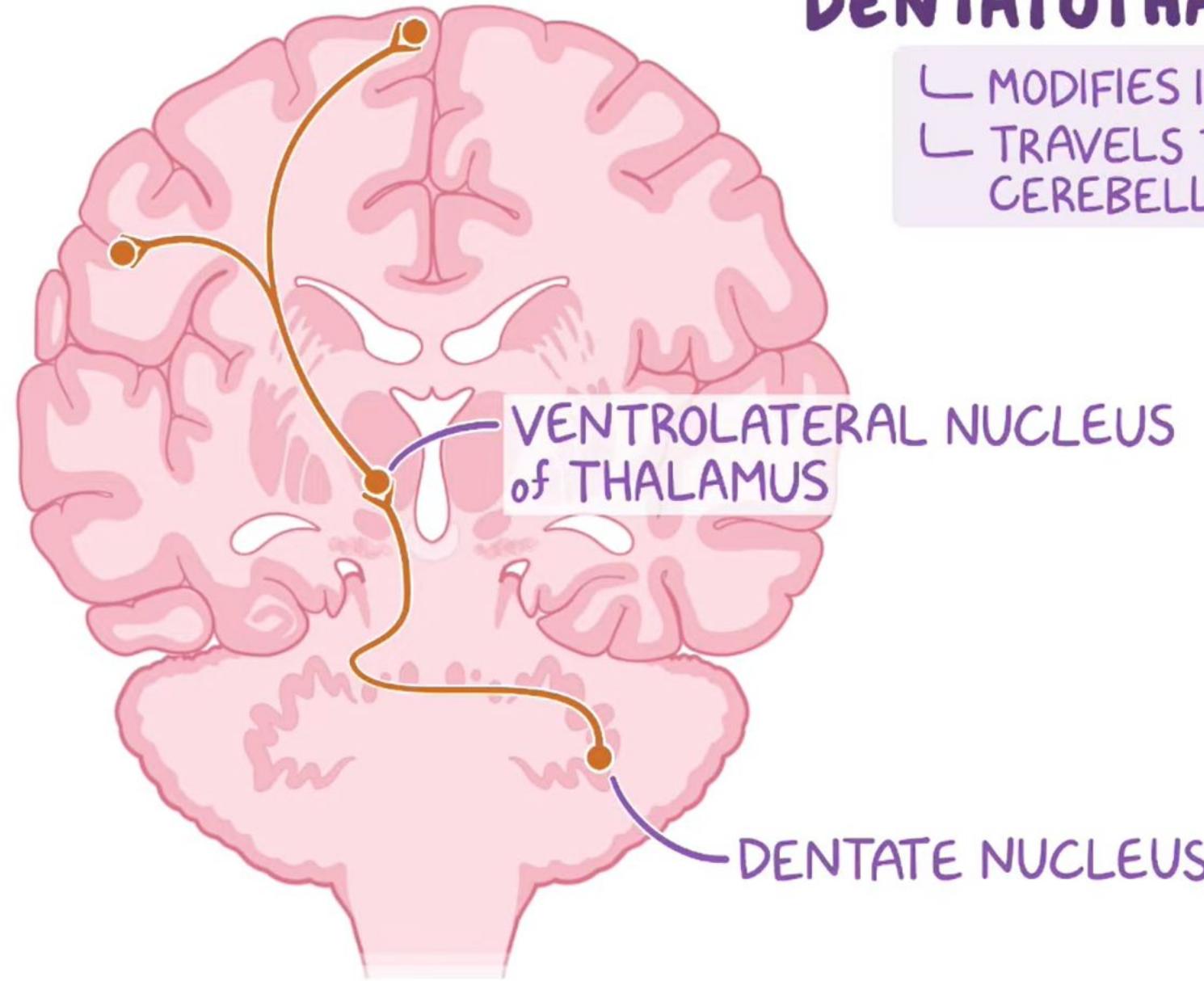
طالع من المخيخ

eff=exit

# EFFERENT PATHWAYS

- ~ FASTIGIAL VESTIBULAR PATHWAY
- ~ DENTATOTHALAMIC PATHWAY
- ~ GLOBOSE-EMBOLIFORM-RUBRAL PATHWAY
- ~ FASTIGIAL RETICULAR PATHWAY





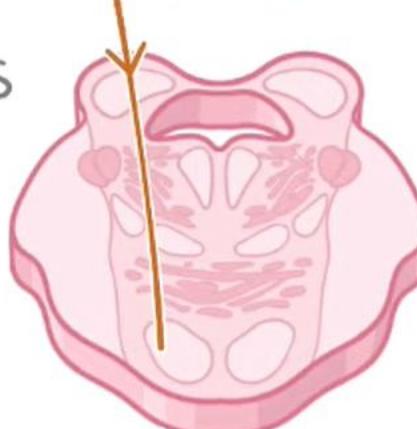
## DENTATOTHALAMIC PATHWAY

- └ MODIFIES IPSILATERAL MOTOR ACTIVITY
- └ TRAVELS THROUGH IPSILATERAL SUPERIOR CEREBELLAR PEDUNCLE

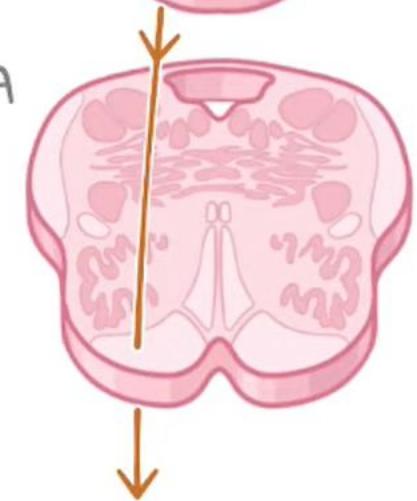
ROSTRAL MIDBRAIN



MID PONS



ROSTRAL MEDULLA



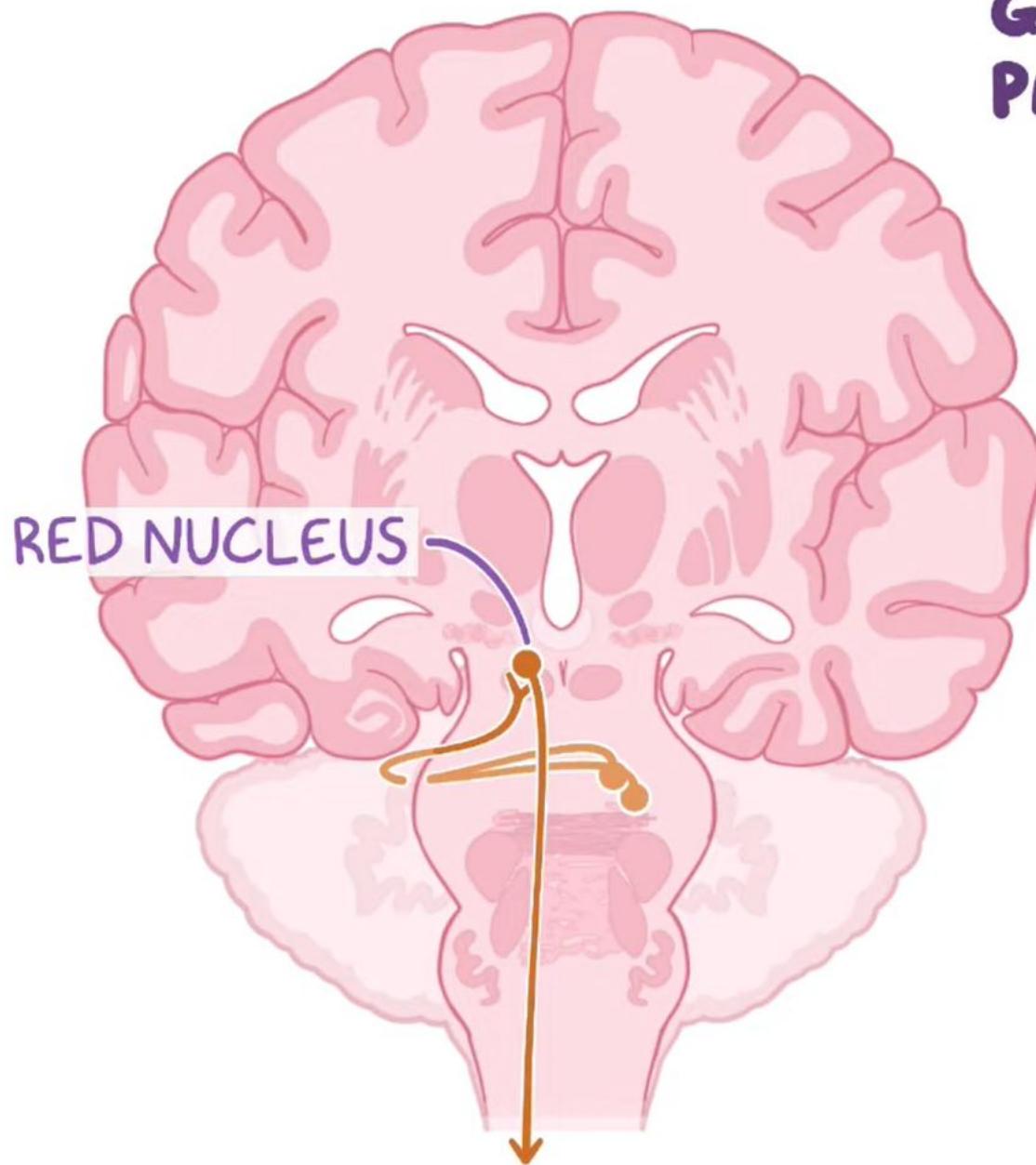
## DENTATOTHALAMIC PATHWAY

- └ MODIFIES IPSILATERAL MOTOR ACTIVITY
- └ TRAVELS THROUGH IPSILATERAL SUPERIOR CEREBELLAR PEDUNCLE

\* INFORMATION RELAYED to  
**CORTICOSPINAL TRACT**

- └ INFLUENCES & MODULATES MOTOR ACTIVITY of DESCENDING MOTOR PATHWAYS

## GLOBOSE-EMBOLIFORM-RUBRAL PATHWAY



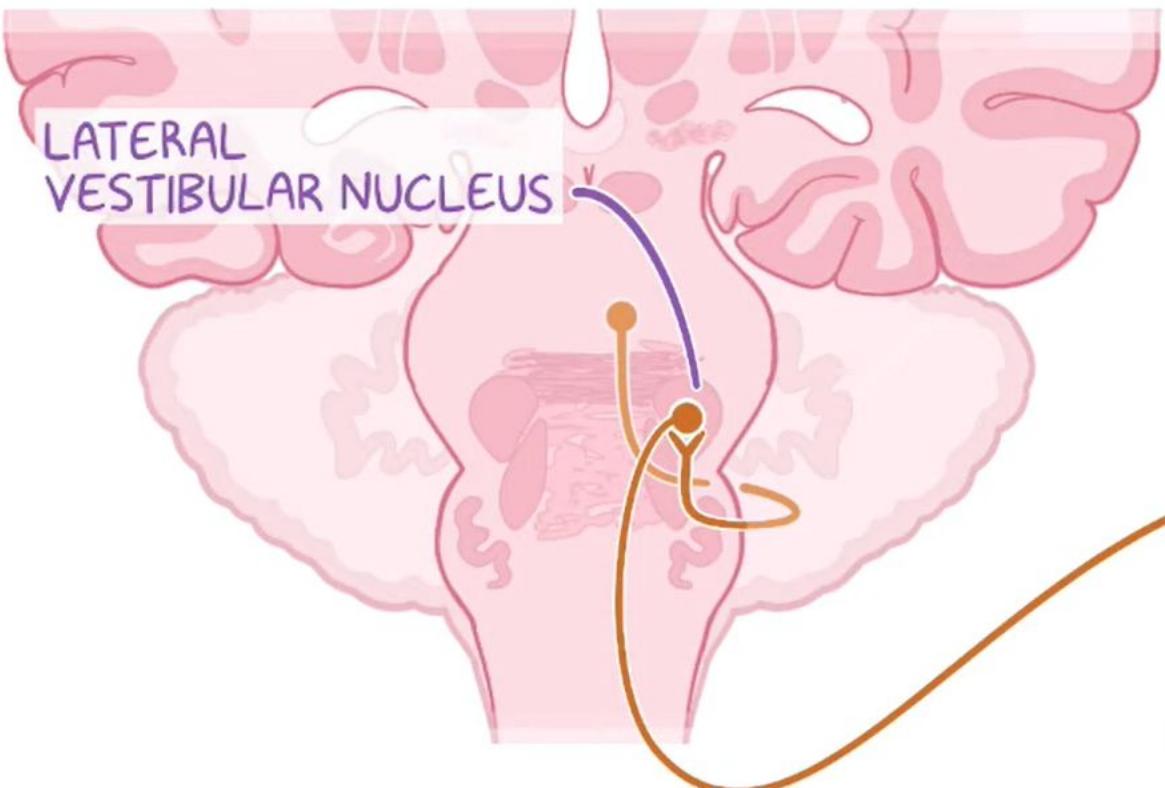
- MODIFIES IPSILATERAL MOTOR ACTIVITY
- TRAVELS THROUGH IPSILATERAL SUPERIOR CEREBELLAR PEDUNCLE
  - CONTRALATERAL RED NUCLEUS

\* INFLUENCES RUBROSPINAL TRACT

- ACTS on PROXIMAL FLEXOR MUSCULATURE of UPPER LIMB

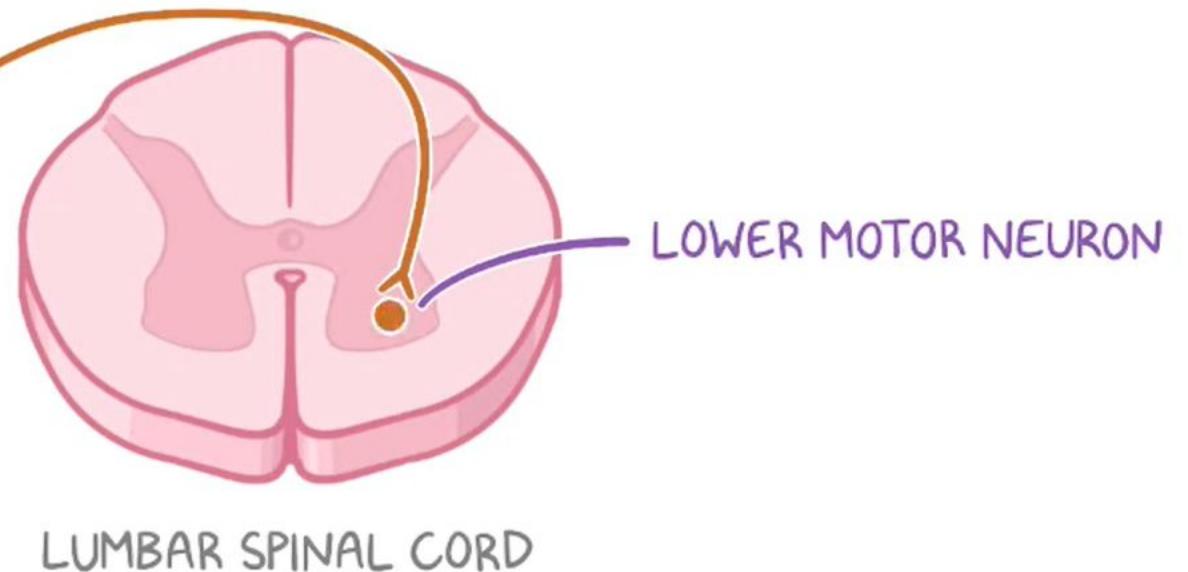
# FASTIGIAL VESTIBULAR PATHWAY

- REGULATING EXTENSOR MUSCLE TONE
- TRAVELS THROUGH INFERIOR CEREBELLAR PEDUNCLE



\* FORMS VESTIBULOSPINAL TRACT

- SIGNALS to MOTOR NEURONS of SPINAL CORD & HELPS MAINTAIN POSTURE



LUMBAR SPINAL CORD

ROSTRAL MIDBRAIN

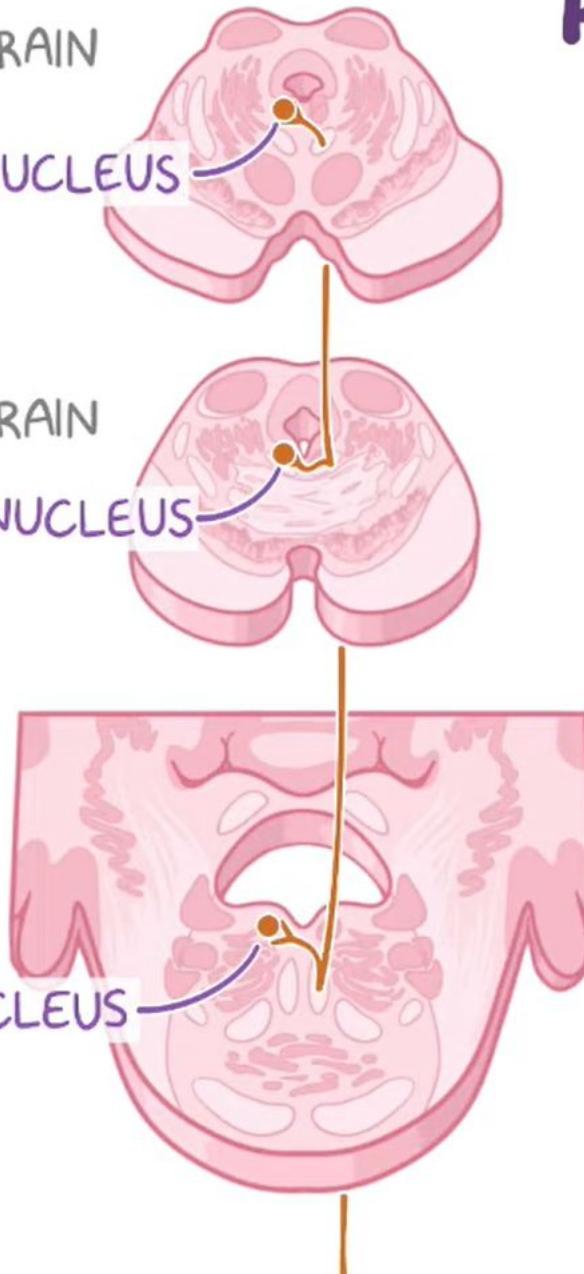
OCULOMOTOR NUCLEUS

CAUDAL MIDBRAIN

TROCHLEAR NUCLEUS

CAUDAL PONS

ABDUCENS NUCLEUS

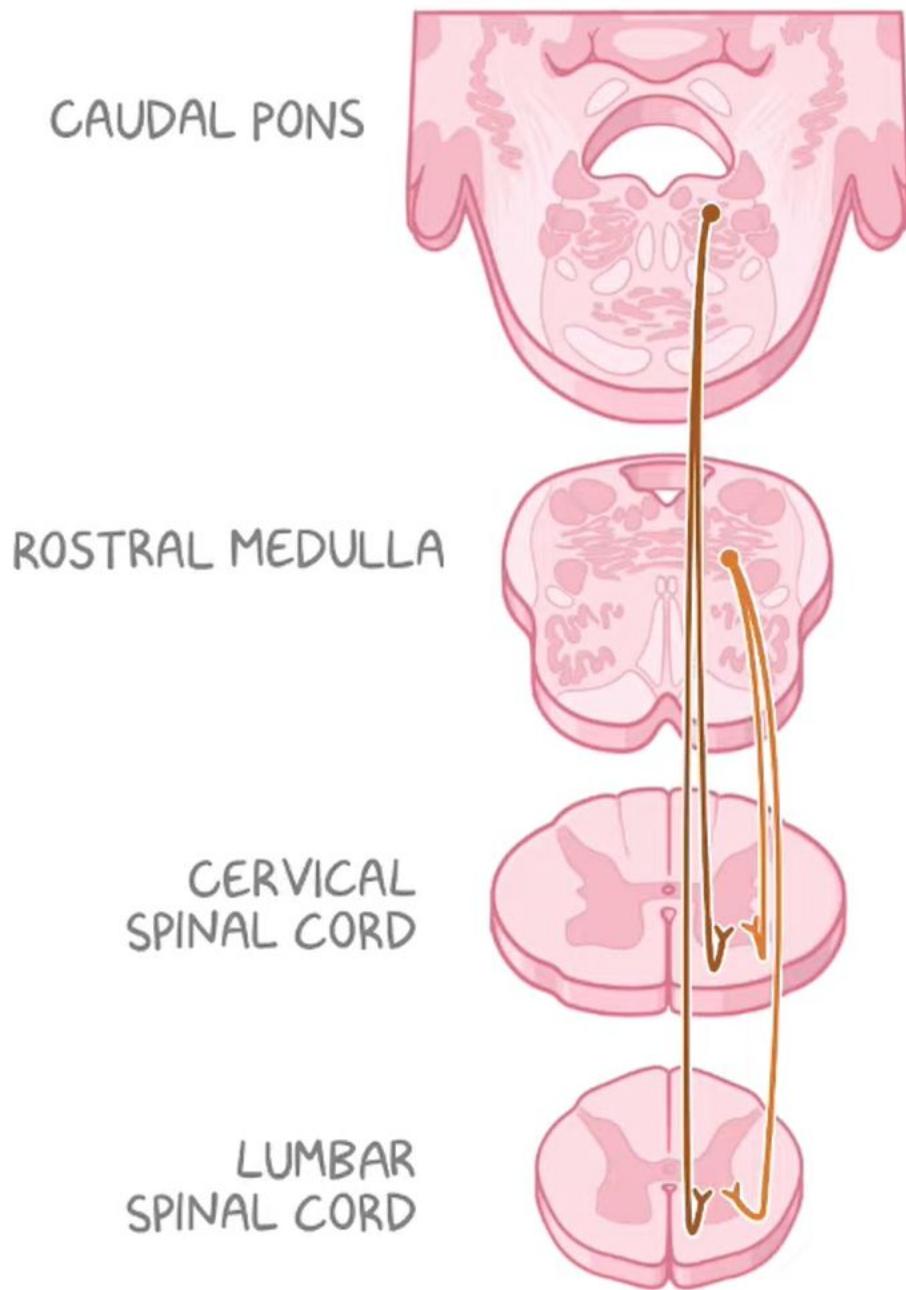


## FASTIGIAL VESTIBULAR PATHWAY

- └ REGULATING EXTENSOR MUSCLE TONE
- └ TRAVELS THROUGH INFERIOR CEREBELLAR PEDUNCLE

\* CONTRIBUTES to MEDIAL LONGITUDINAL FASCICULUS

- └ TRANSMITS INFORMATION to MOTOR NUCLEI of CN III, CN IV, & CN VI to MODIFY & CONTROL MOVEMENTS of the EYE



## FASTIGIAL RETICULAR PATHWAY

↳ TRAVELS THROUGH INFERIOR CEREBELLAR PEDUNCLE

\* MODULATORY INFORMATION to  
**MEDIAL & LATERAL RETICULOSPINAL TRACT**  
↳ REGULATION of MUSCLE TONE & POSTURE

نَعَمْ







View (b)

