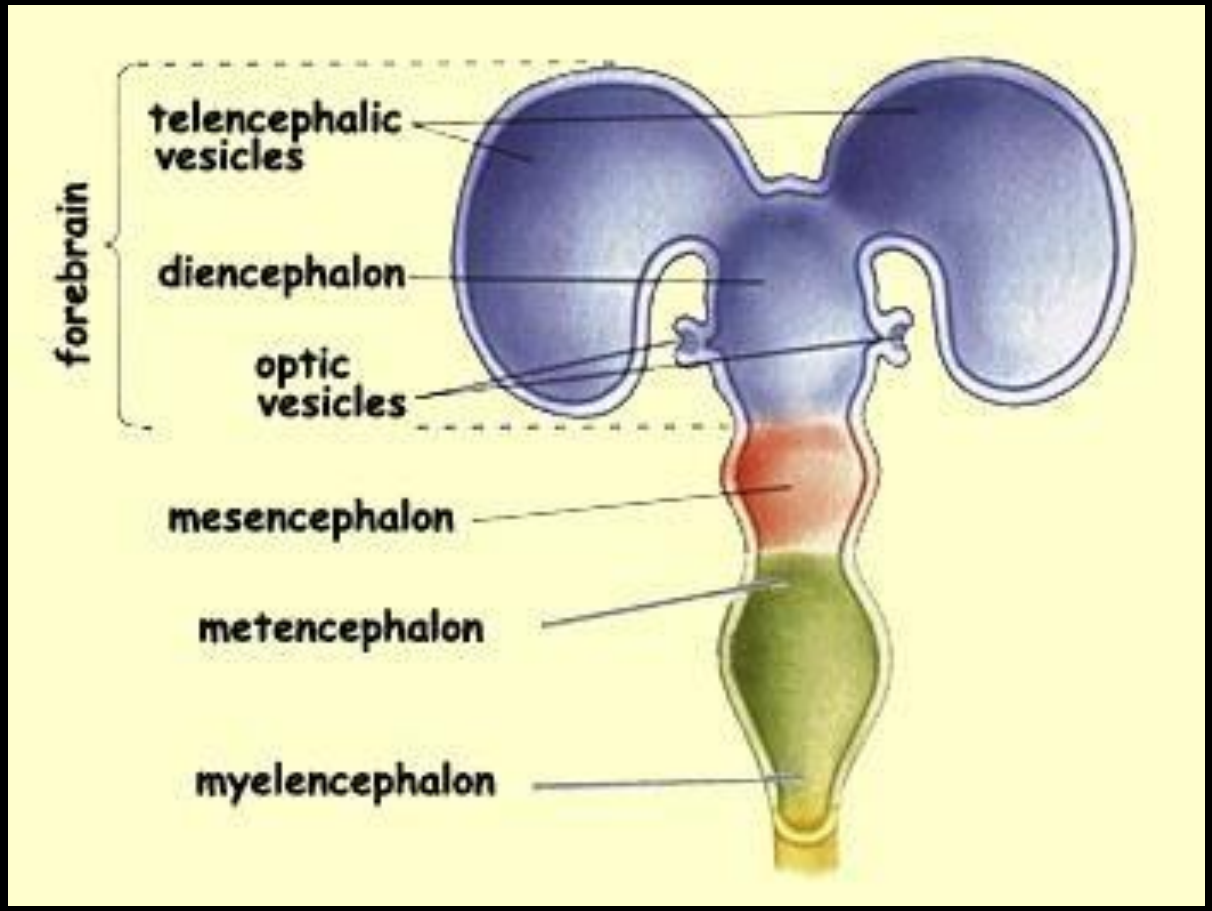
Anatomy & Function of the BRAINSTEM & CEREBELLUM

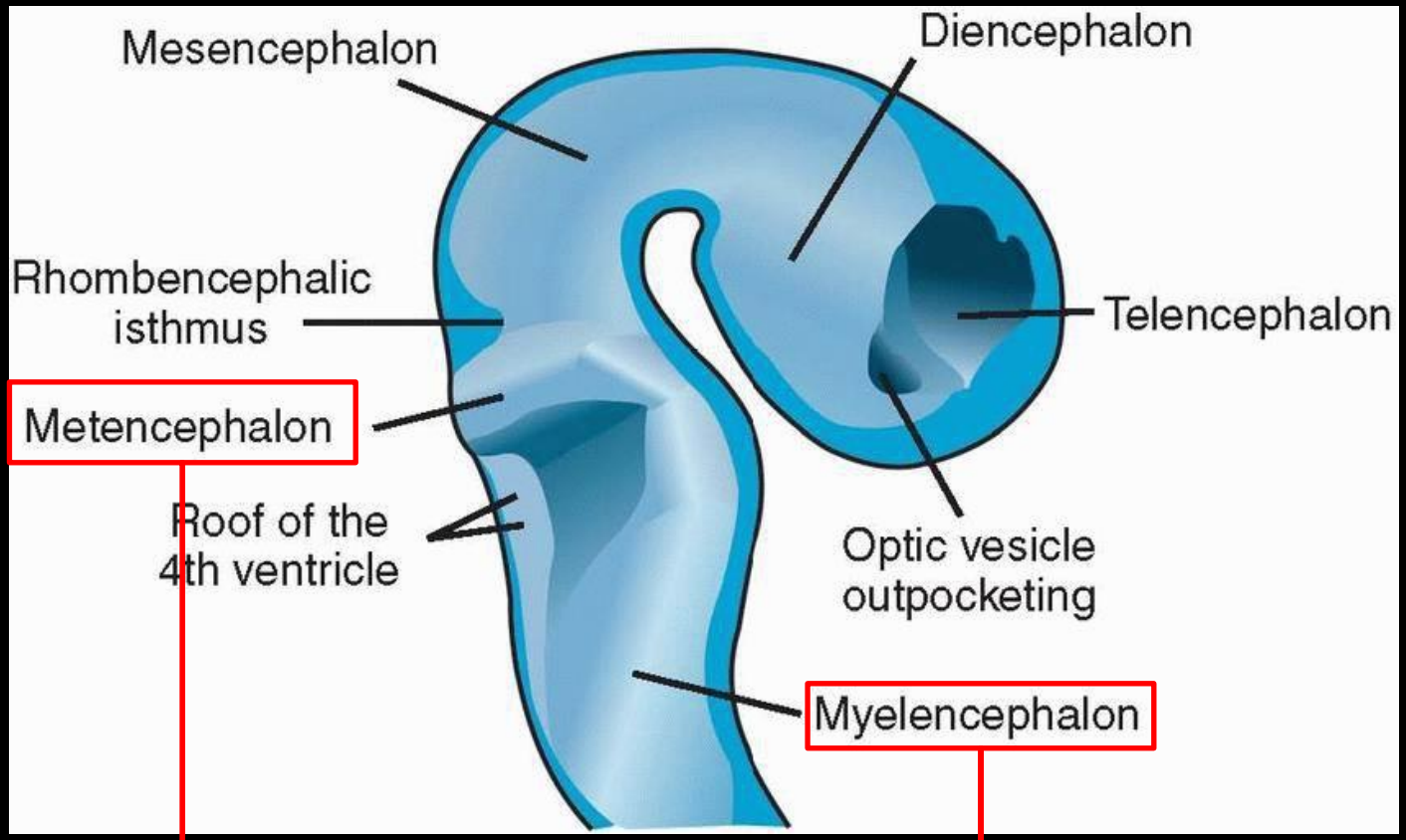
Embryology



5w of gestation

http://thebrain.mcgill.ca/flash/a/a_09/a_09_cr/a_09_cr_dev/a_09_cr_dev.html

Embryology



Cerebellum

Medulla Oblongata

Langman's Medical Embryology

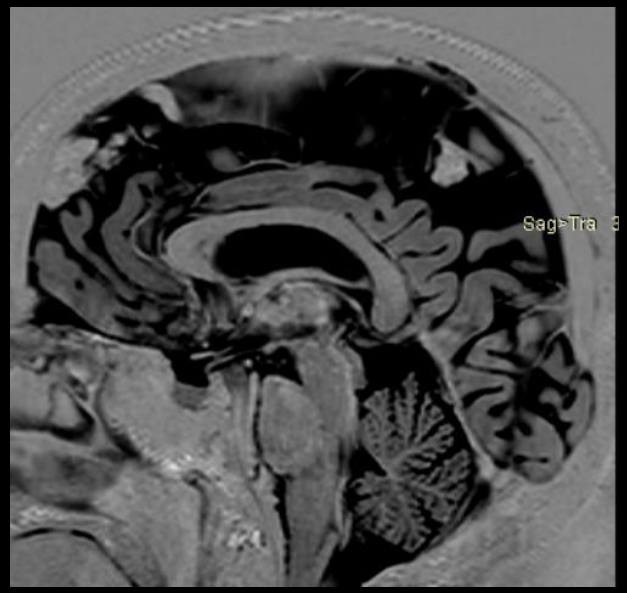
Embryology

Cerebellum forms at 7 months of gestation

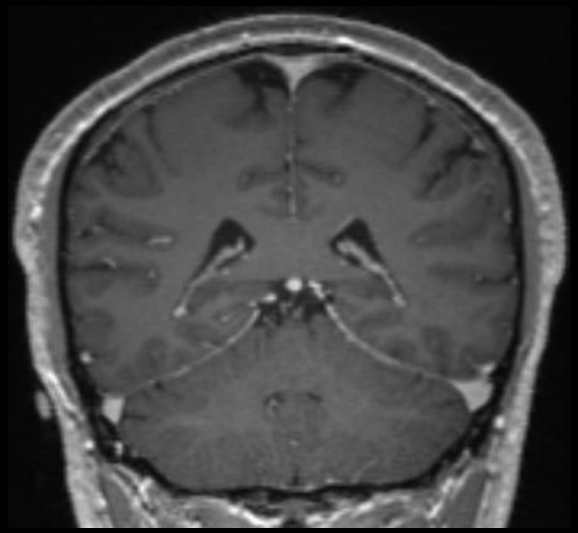
http://www.kidsintransitiontoschool.org/meet-your-cerebellum-the-link-between-movement-and-learning/

CEREBELLUM

- ✓ Cerebellum ➔ "Little brain"
- ✓ Up to 10% of brain volume
- ✓ More than 50% of brain neurons



- ✓ Anterior ➔ brainstem and 4. ventricle
- ✓ Surrounded by tentorium
- ✓ Connects to brainstem



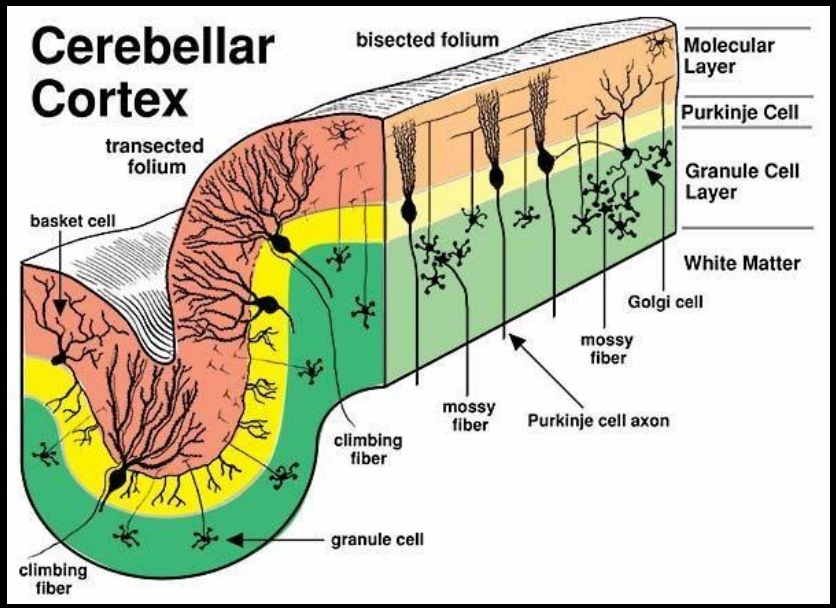
CEREBELLUM

- ✓ Cerebellar cortex has 3 layers (vs 6 layers of cerebral cortex)
- ✓ Cerebellar white matter is called "Arbor Vitae" "Tree of life"

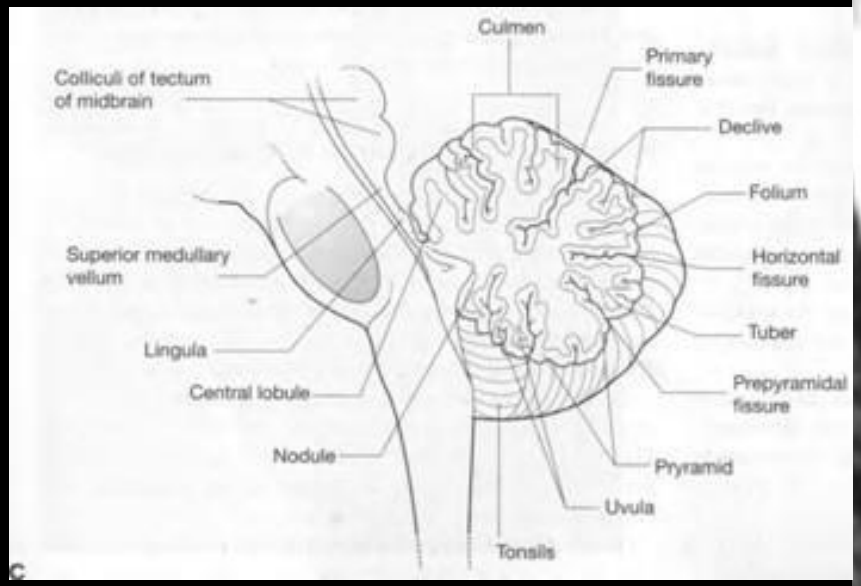
Cerebellar Cortex

- ✓ Cerebellar cortex has 3 layers

1. Molecular layer
   - Stellate cells
   - Basket cells
2. Purkinje Cell layer
3. Granular layer
   - Granule cells
   - Unipolar brush cells
   - Golgi cells



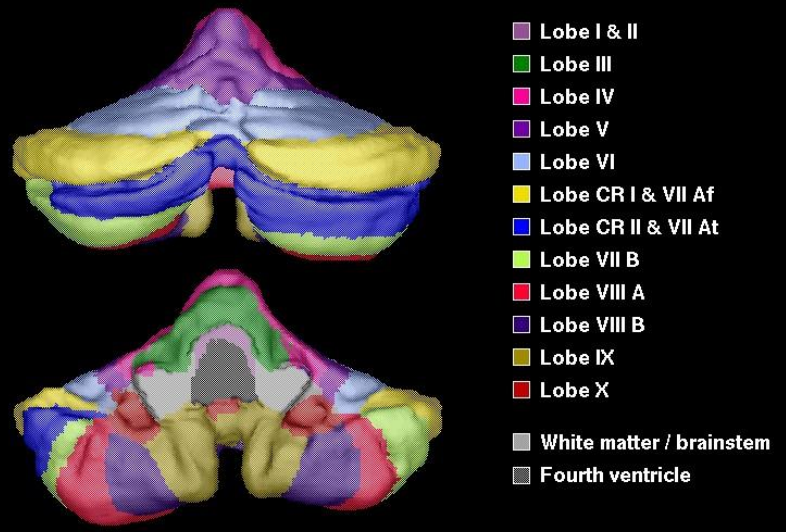
Cerebellar Vermis



Cerebellar Lobules

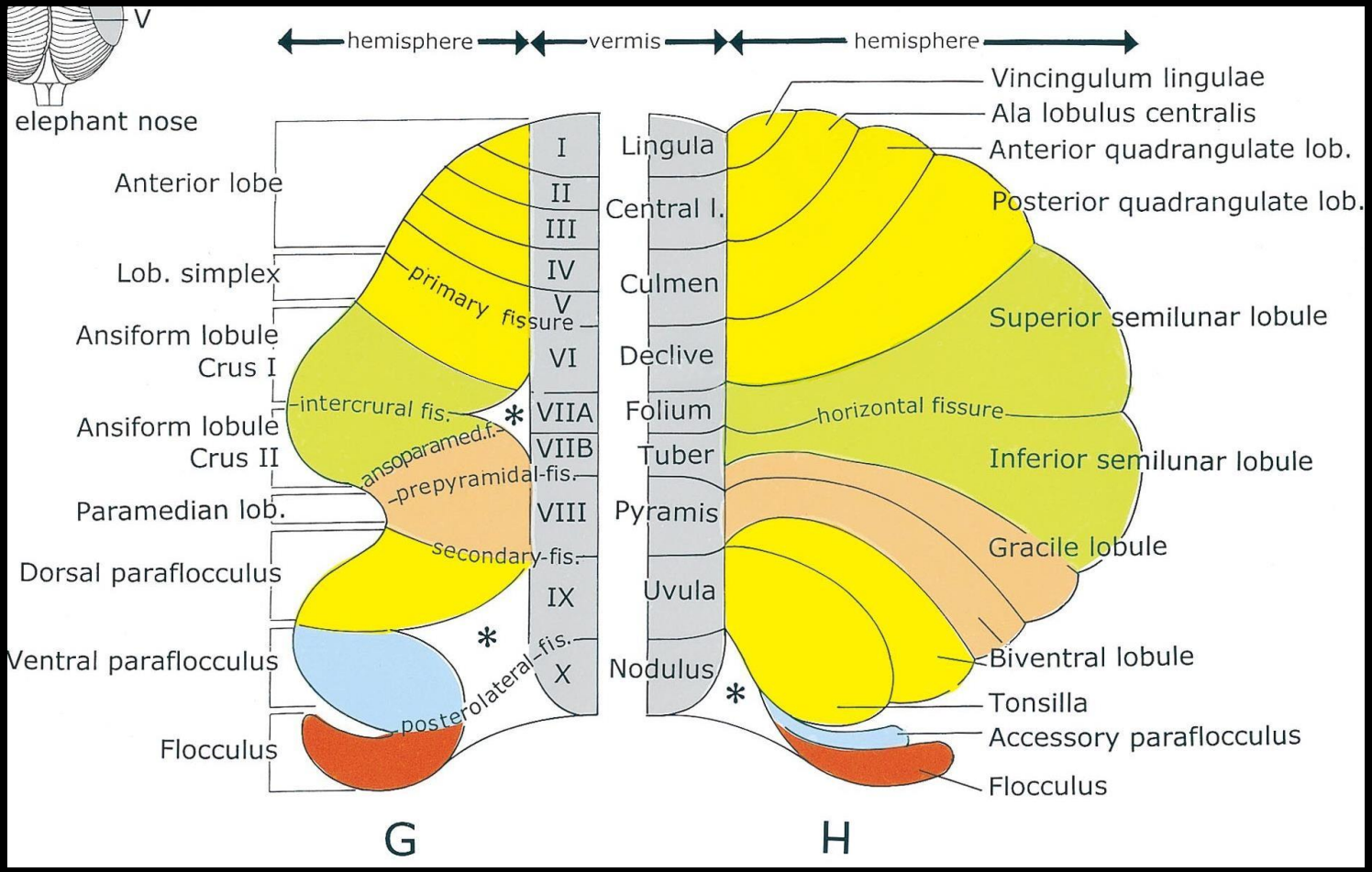
Larsell's classification

- ✓ Cerebellum has 10 lobules
- ✓ Lobules are expressed I-X
- ✓ Extensions from vermis



http://www.edoctoronline.com/medical-atlas.asp?c=4&id=21803

Cerebellar Lobules



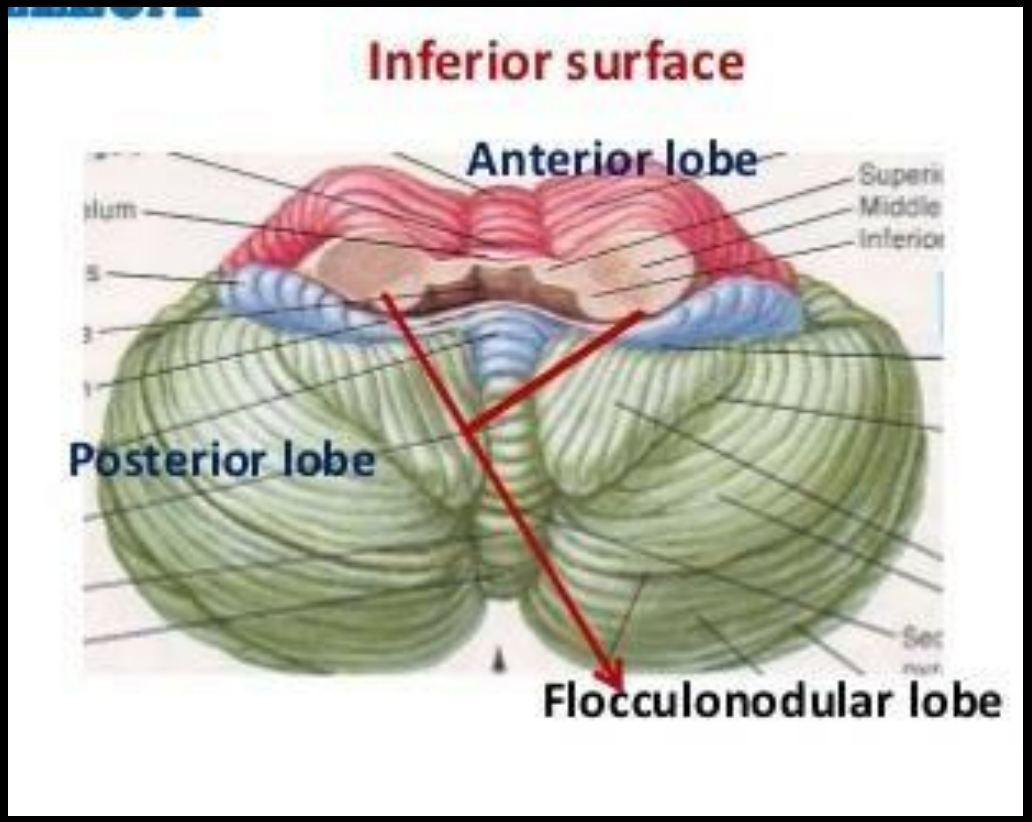
Larsell's classification

Voogd L et al, Trends Neurosci, 1998

Cerebellum:

Gross Morphological Divisions

- ✓ Anterior Lobe
- ✓ Posterior lobe
- ✓ Flocculonodular lobe



http://http://www.slideshare.net/ananthatiger/anatomy-of-cerebellum

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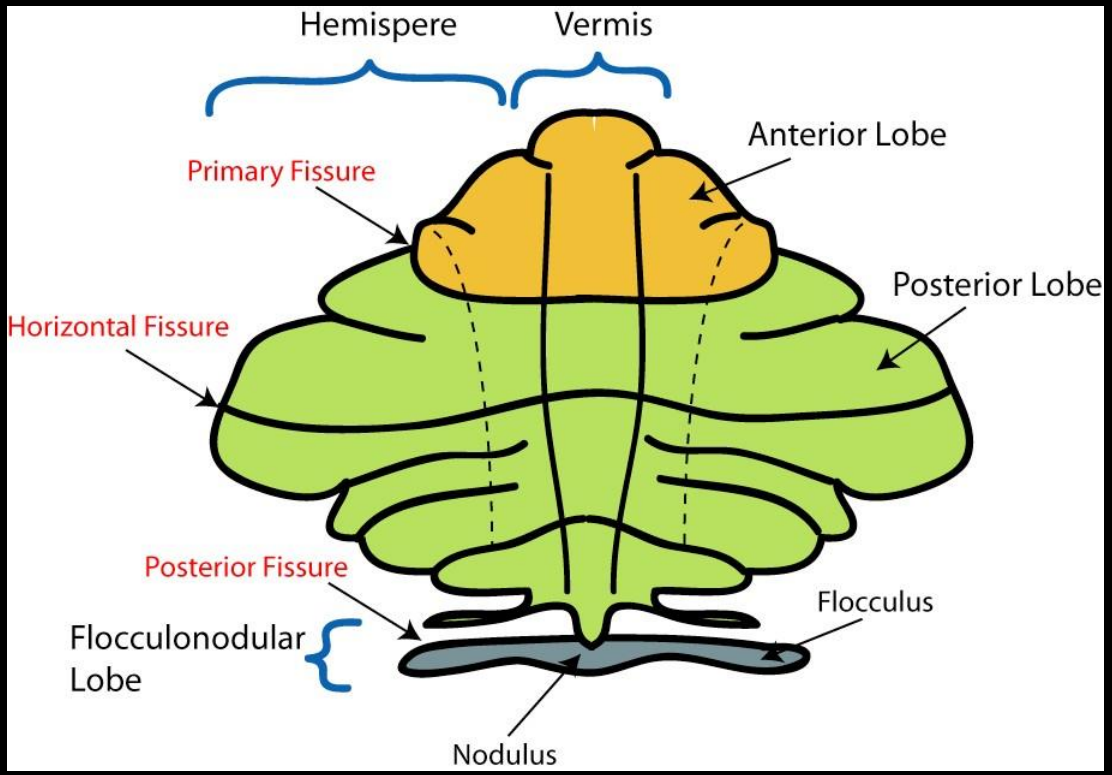

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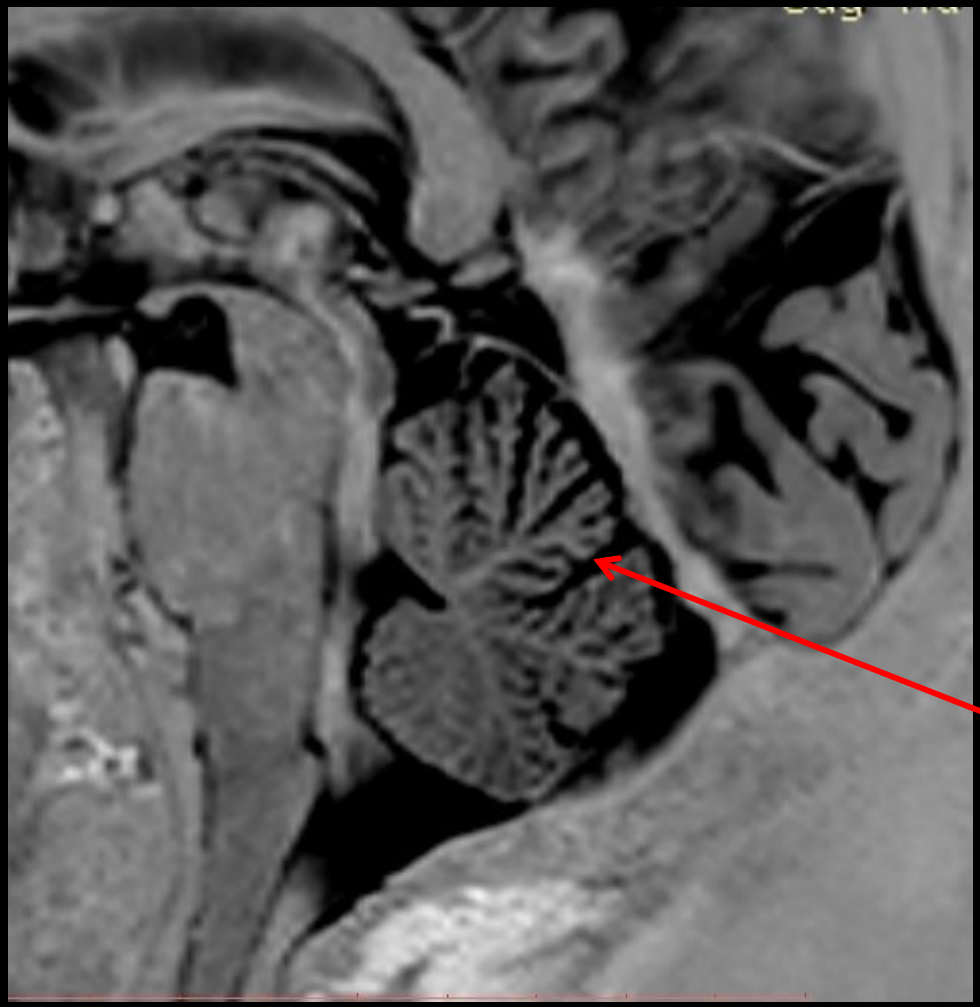
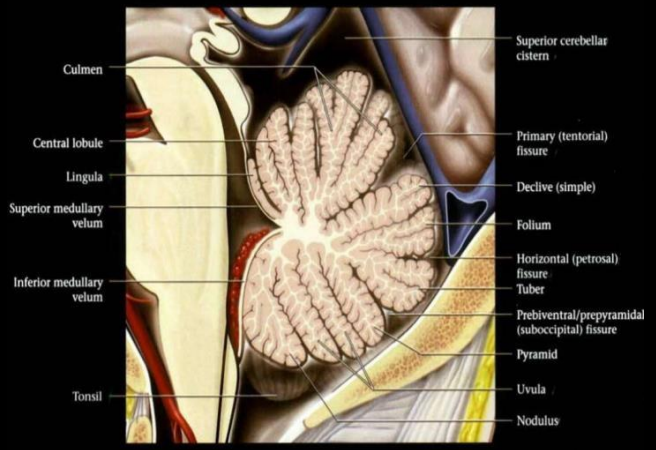
Cerebellum:

Gross Morphological Divisions



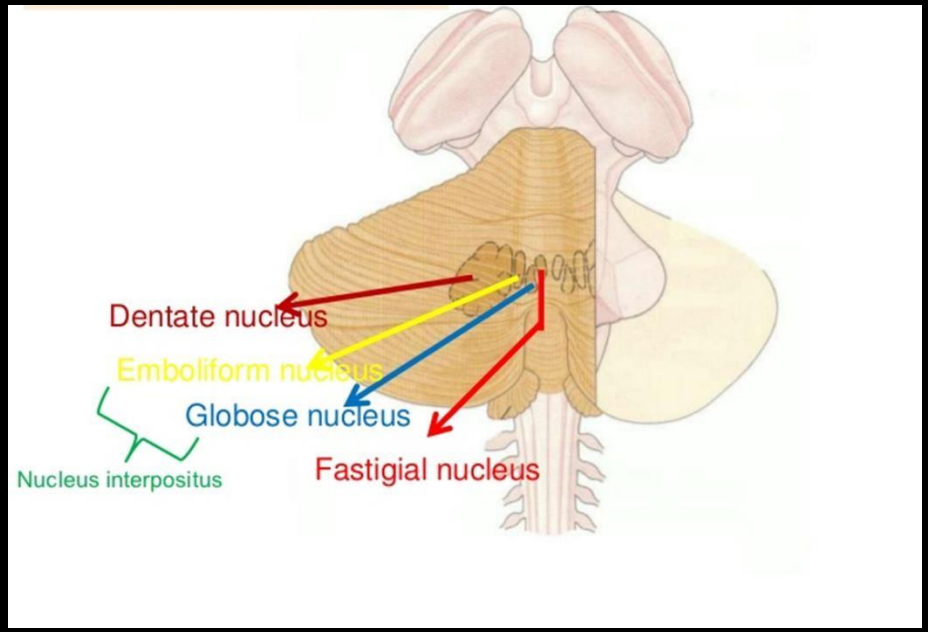


Primary fissure

http://http://www.slideshare.net/ananthatiger/anatomy-of-cerebellum

Deep Cerebellar Nuclei

- ✓ Dentate nucleus
- ✓ Emboliform nuclues
- ✓ Globose nucleus
- ✓ Fastigial nuclues

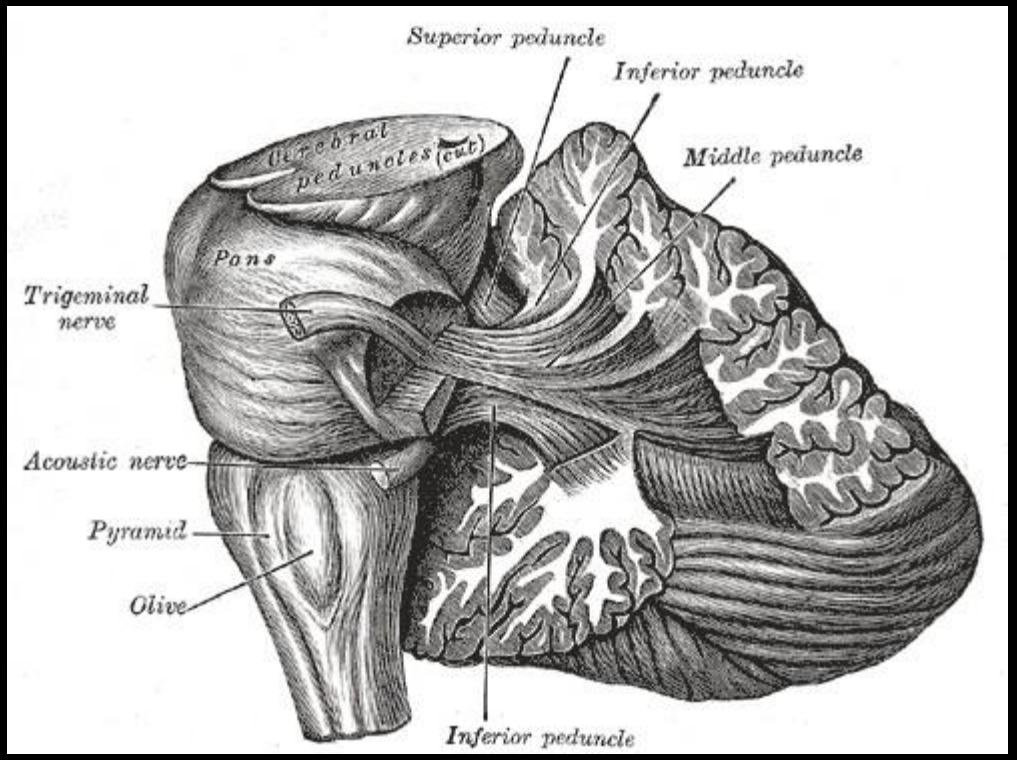


Emboliform nuclues & Globose nucleus ➔ Nuclues Interpositum

http://http://www.slideshare.net/ananthatiger/anatomy-of-cerebellum

Cerebellar Peduncles

- ✓ Superior
- ✓ Middle
- ✓ Inferior

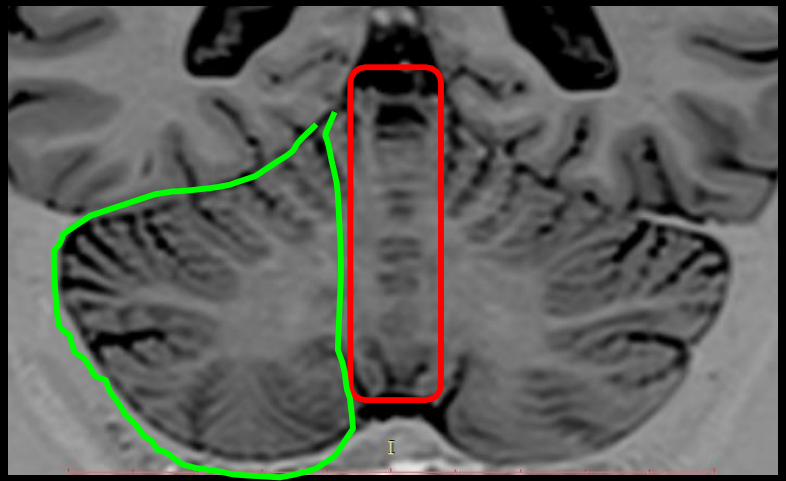


https://en.wikipedia.org/wiki/Superior_cerebellar_peduncle#/media/File:Gray705.png

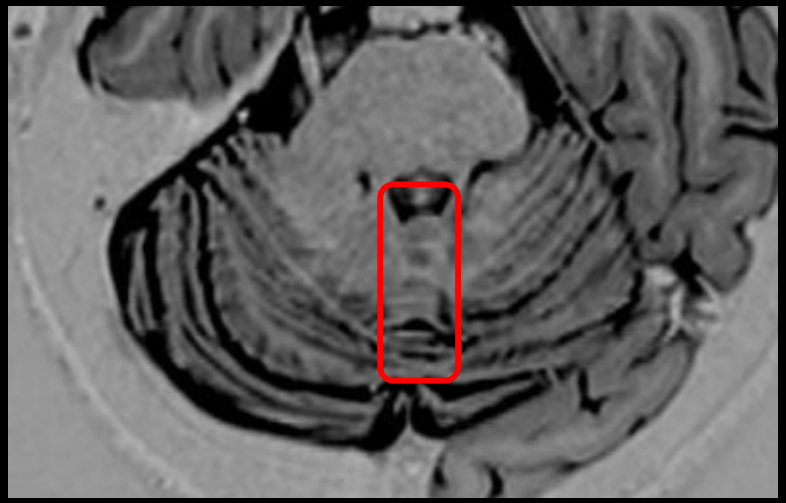
Cerebellar Peduncles

- ✓ Superior cerebellar peduncle ➔ Midbrain
- ✓ Middle cerebellar peduncle ➔ Pons
- ✓ Inferior cerebellar peduncle ➔ Medulla Oblongata

Cerebellum: Radiological Anatomy

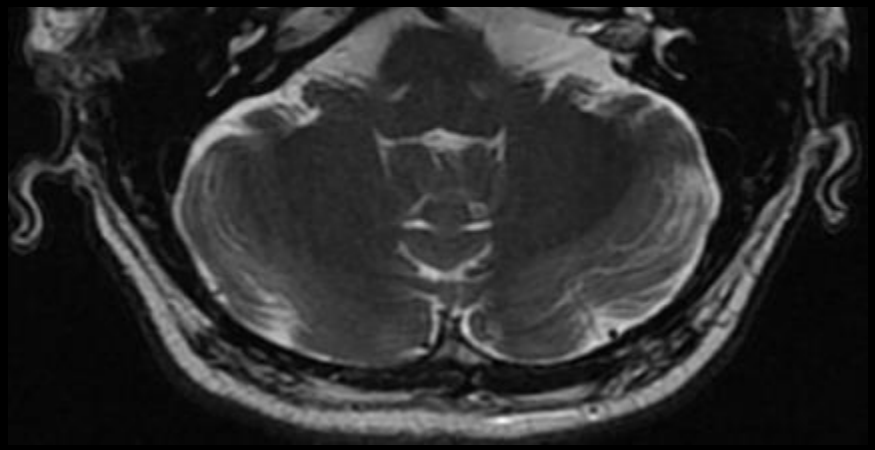


Vermis

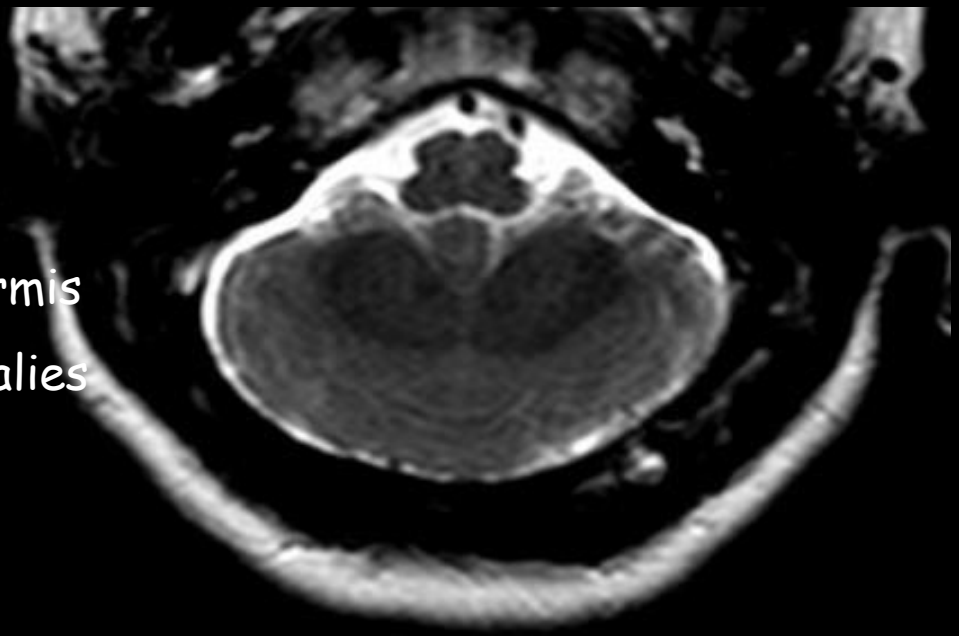


Cerebellar hemispheres

Normal

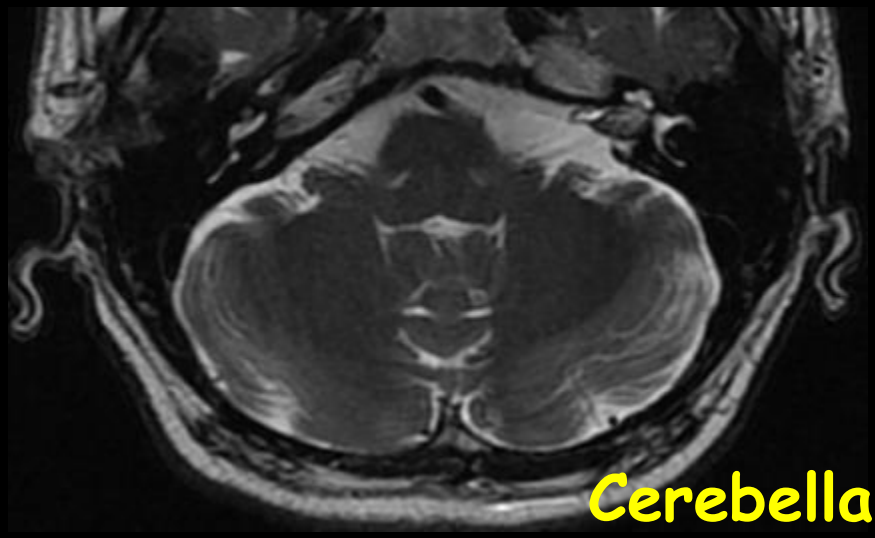


Rhombencephalosynapsis

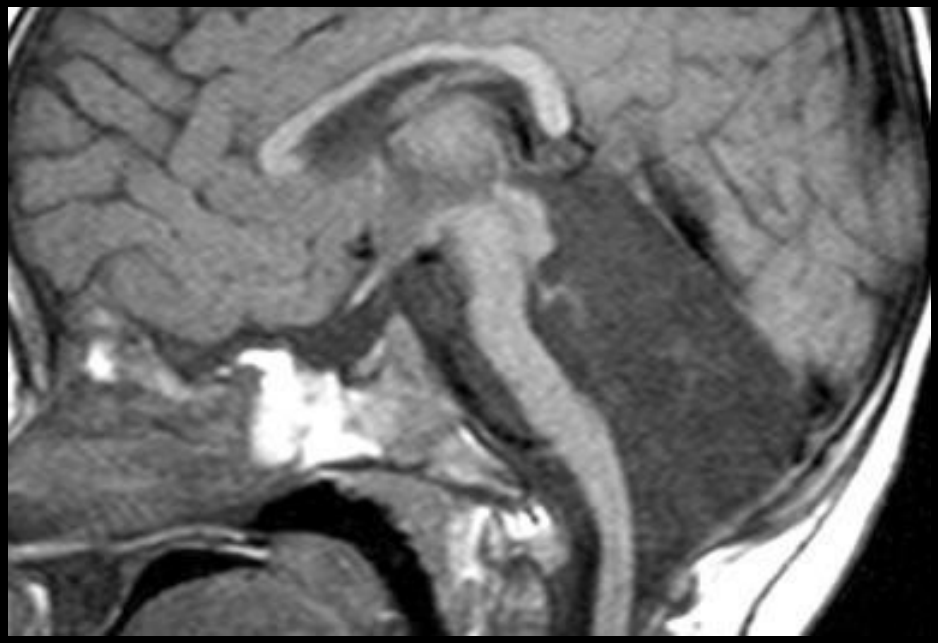


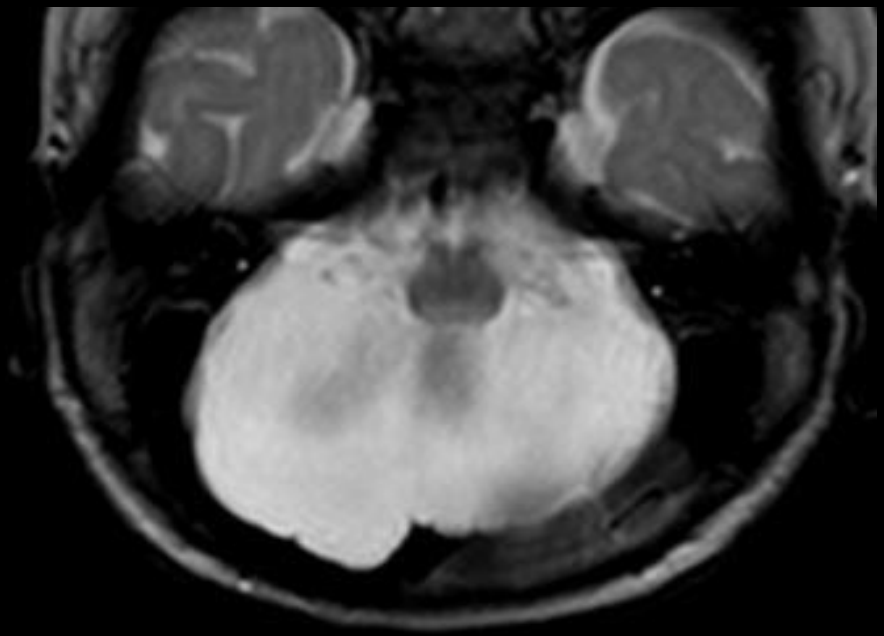
- Fusion of both cerebellar hemispheres
- Complete or partial agenesis of the vermis
- May be associated with cerebral anomalies

Normal

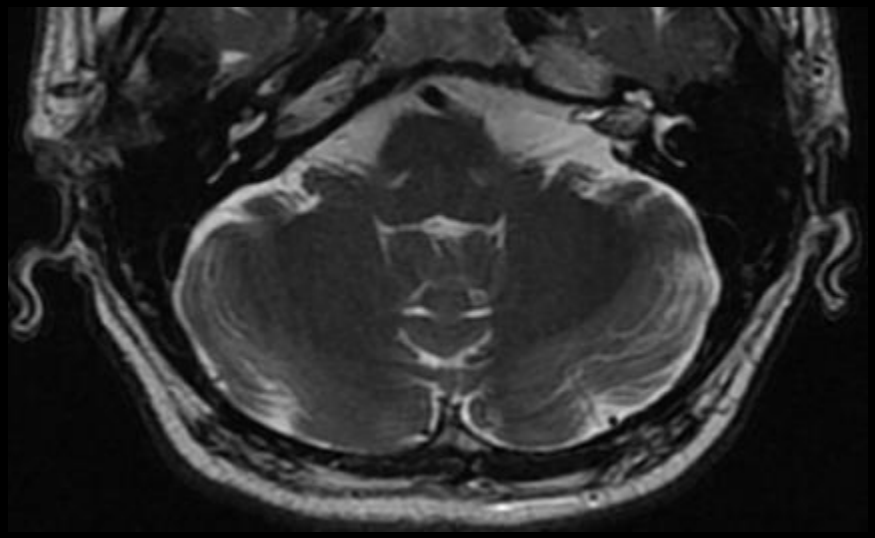


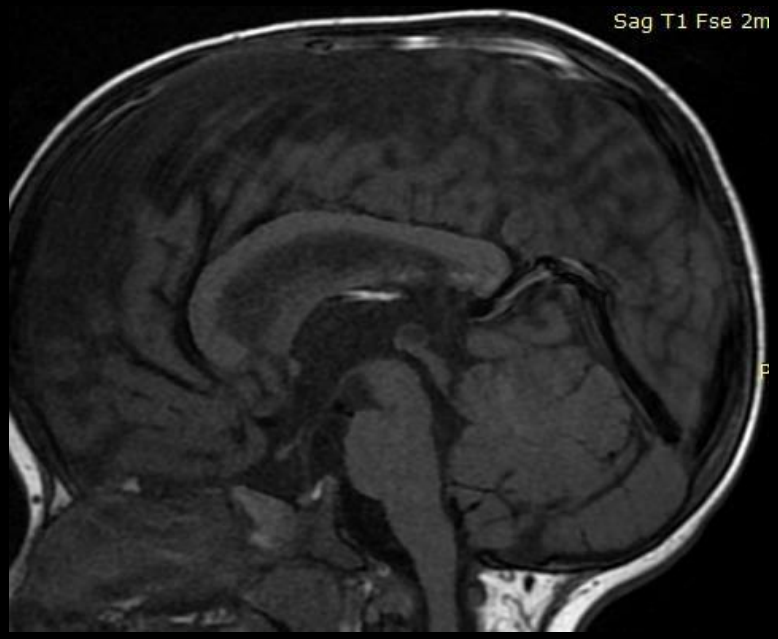
Cerebellar agenesis



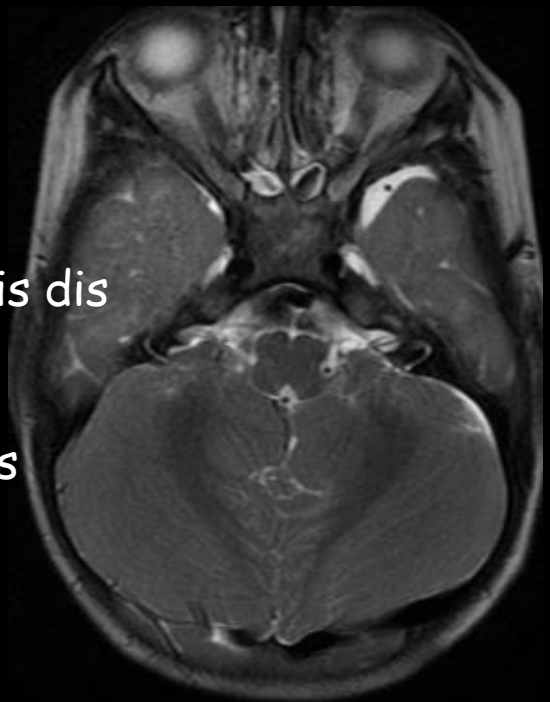


Normal



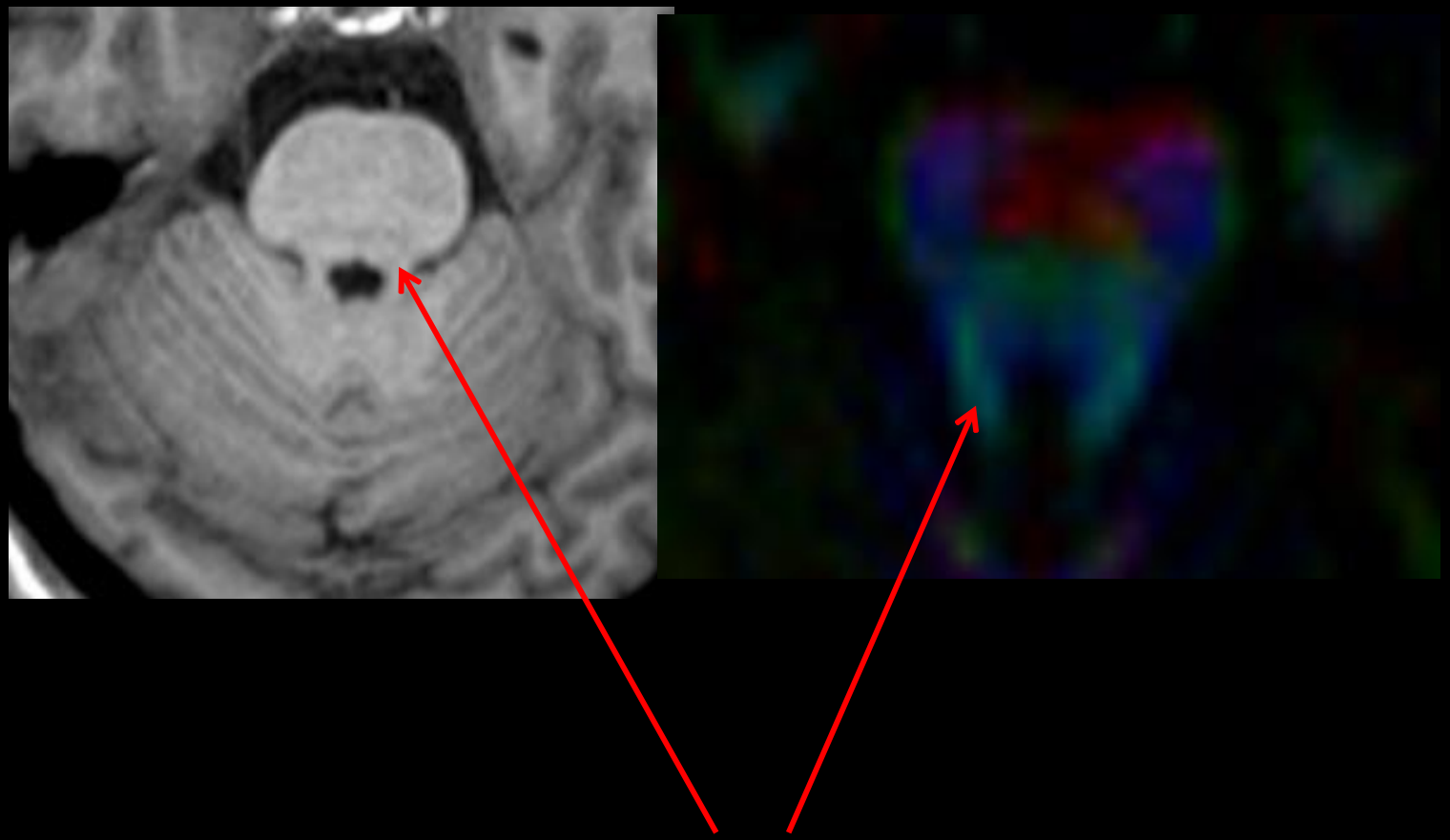


Macrocerebellum



- Rare
- May be associated with syndromes /Neurometabolis dis
- Thickening of the cerebellar cortex
- Muscular hypotonia, ataxia, eye movement disorders
- Optic atrophy may be associated

Cerebellum: Radiological Anatomy

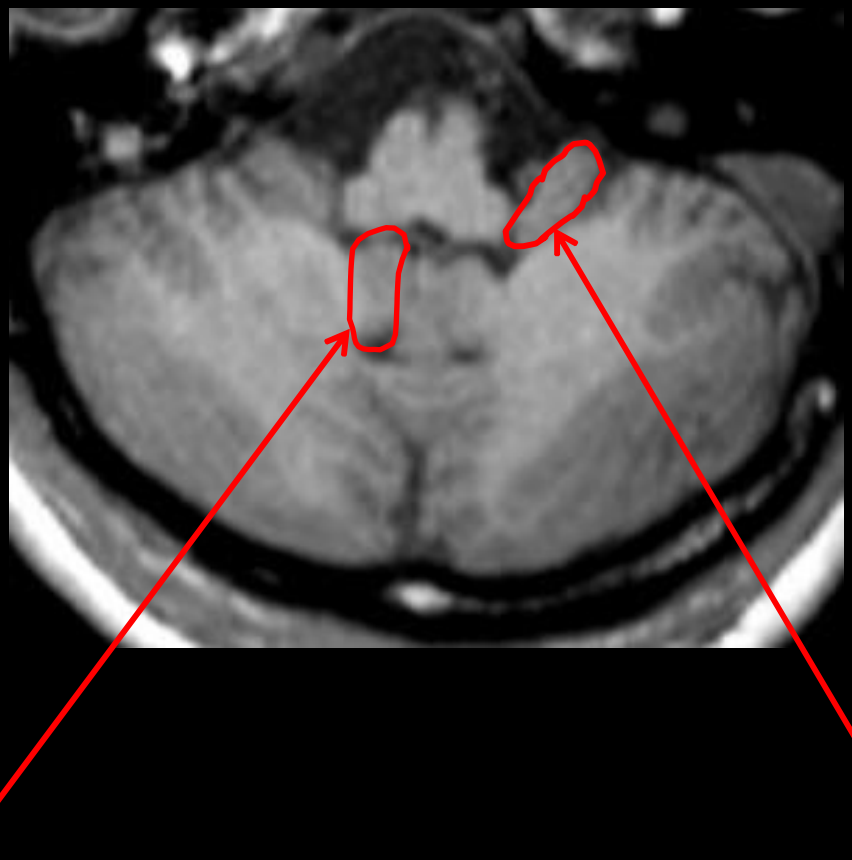


Superior cerebellar peduncle

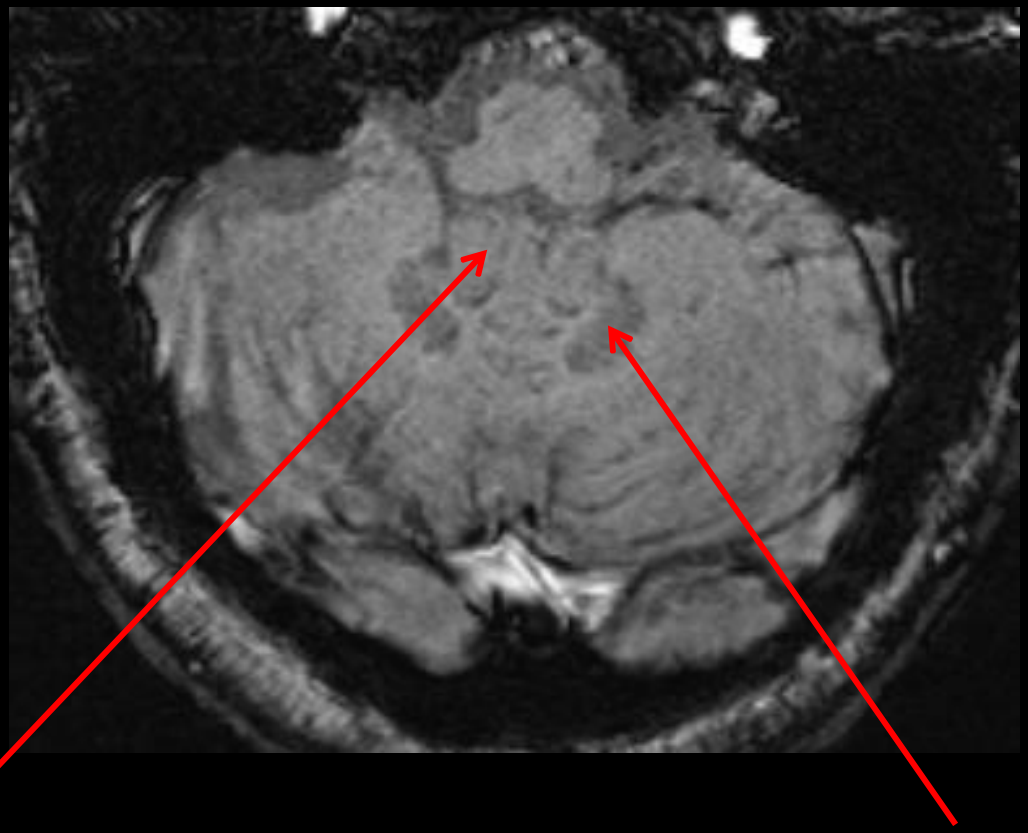
Cerebellum: Radiological Anatomy

Middle cerebellar peduncle

Cerebellum: Radiological Anatomy



Cerebellum: Radiological Anatomy



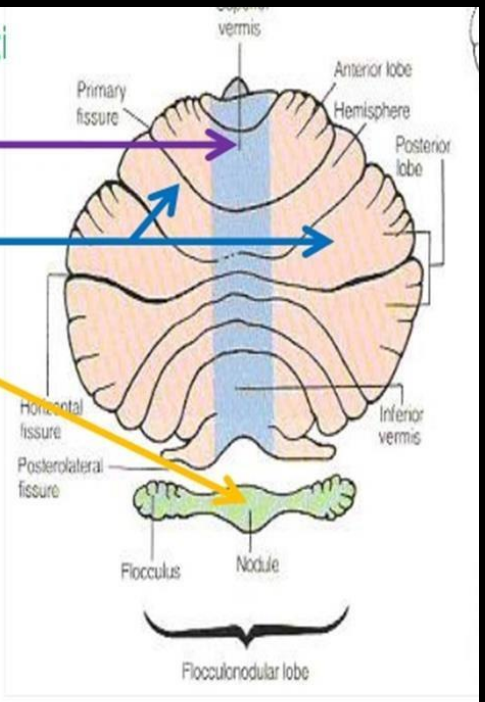
Cerebellar tonsil

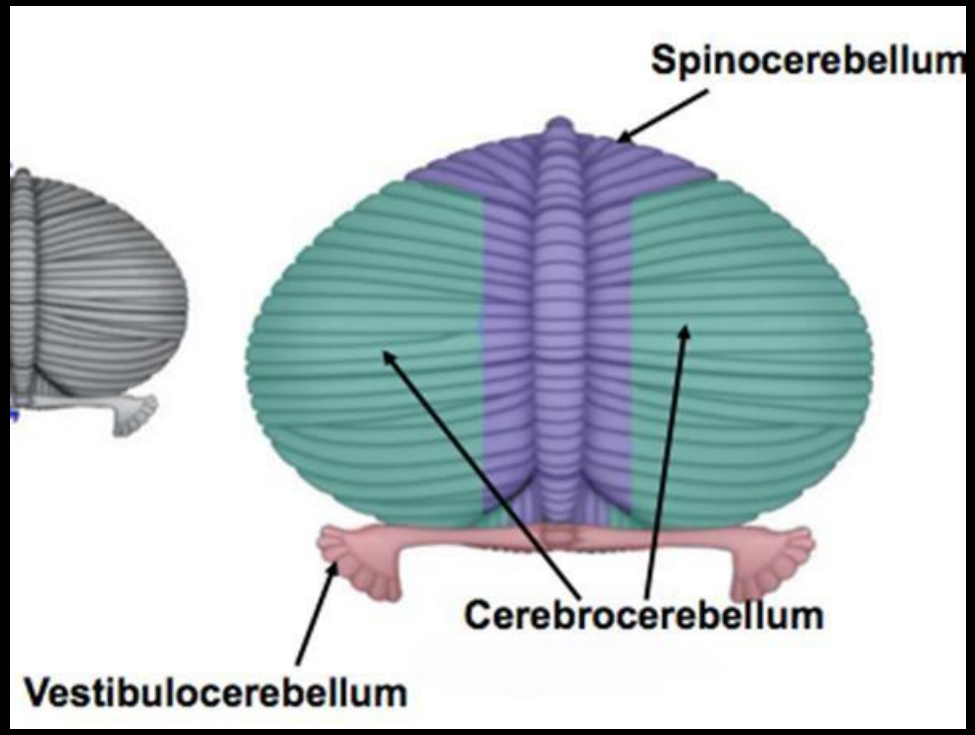
Dentate nucleus

Cerebellum: Functional Anatomy

Functional(Evolutionary)

- Paleocerebellum
- Neocerebellum
- Archicerebellum





http://www.slideshare.net/ananthatiger/anatomy-of-cerebellum

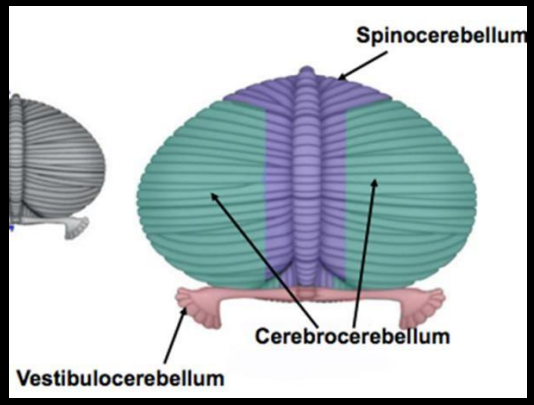
Cerebellum: Functional Anatomy

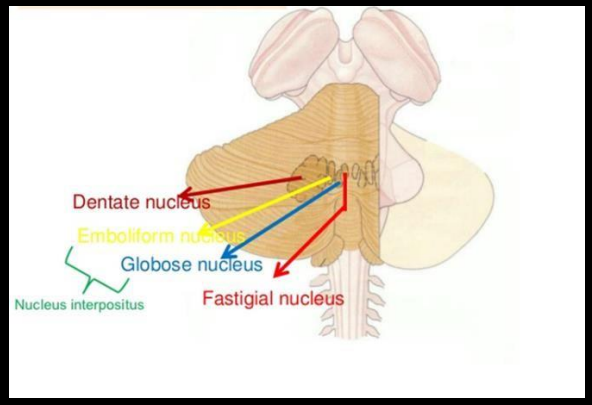
1. Vestibulocerebellum (*Archicerebellum*)

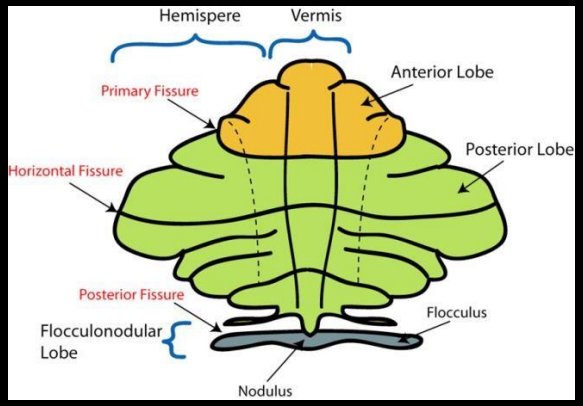
Flocculonodular Lobe + Fastigial Nuclei

Balance and gait

Postural maintenance





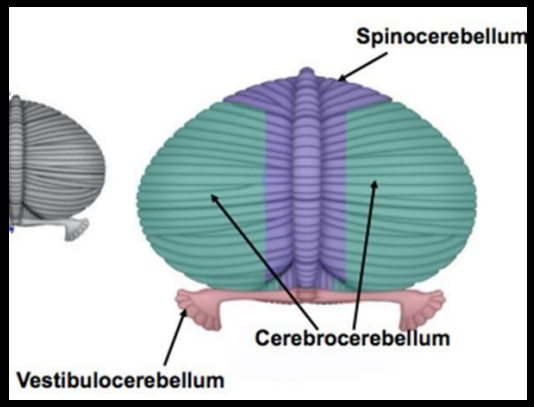


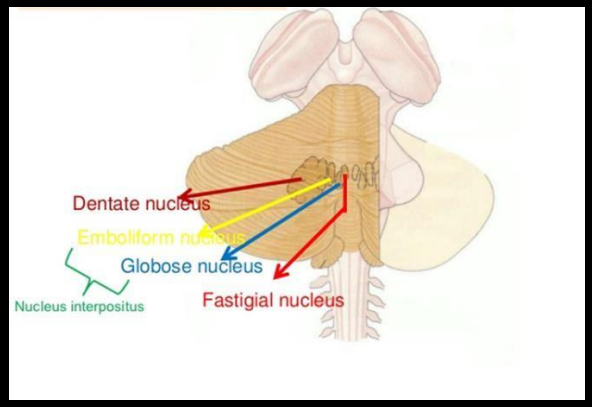
Cerebellum: Functional Anatomy

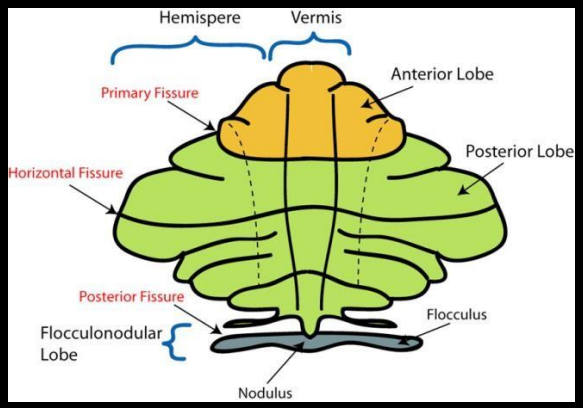
2. Spinocerebellum (*Paleocerebellum*)

Vermis + Globose & Emboliform Nuclei

Coordinating body and limb movements
Proprioception
Adjusting the "future movement"





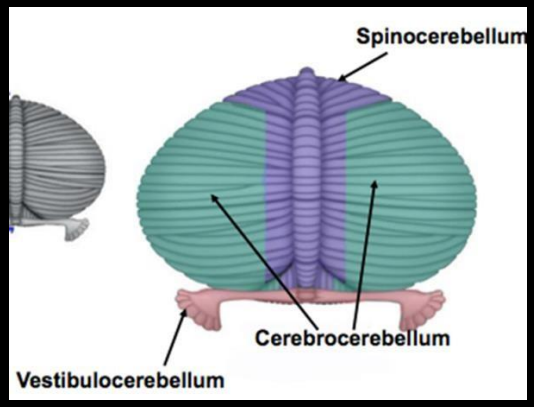


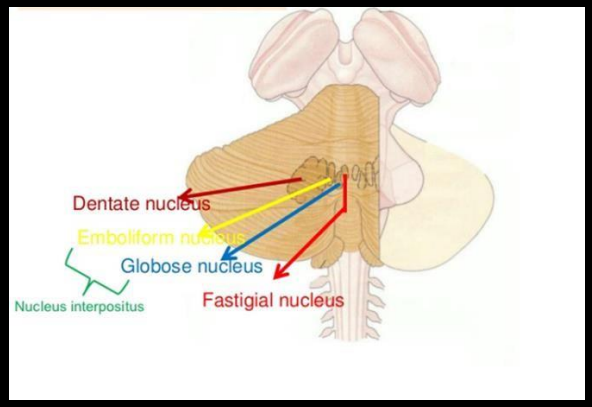
Cerebellum: Functional Anatomy

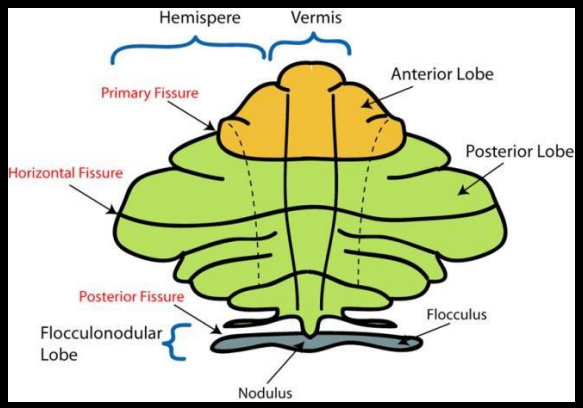
3. Cerebrocerebellum (*Neocerebellum*)

Cerebellar hemispheres + Dentate Nuclei

Cognitive functions
Evaluation of sensory information
Muscle coordination

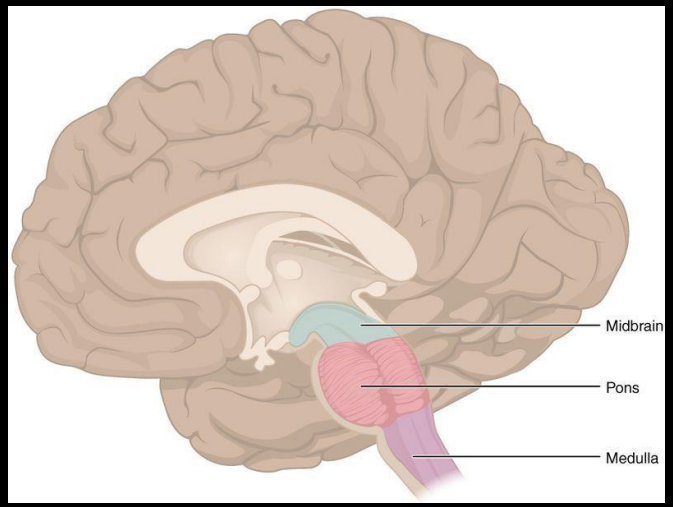






BRAINSTEM

- ✓ Located between the spinal cord & cerebrum
- ✓ Central gray matter surrounded by white matter fibres
- ✓ Contains the cranial nerve nuclei (10 pairs)
- ✓ Lots of connections to other parts the CNS
- ✓ Has many motor and sensory nuclei



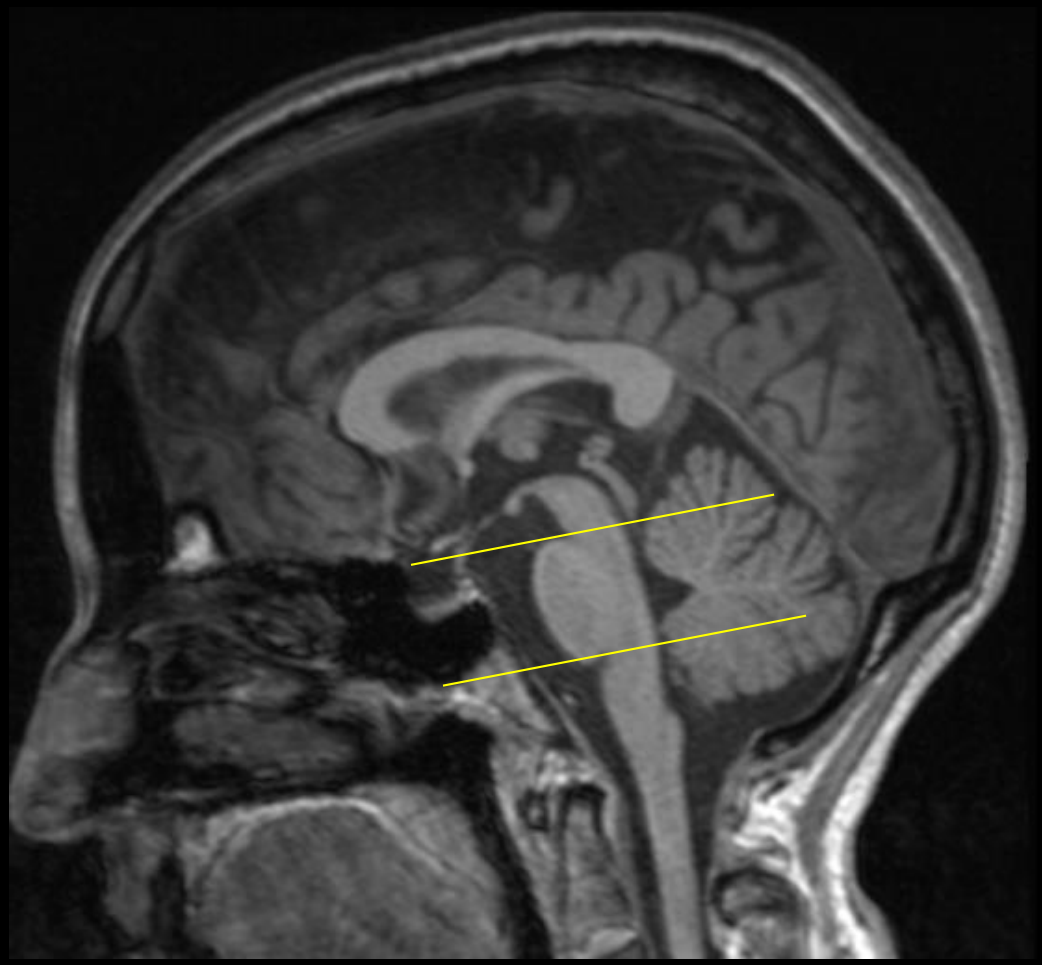
https://en.wikipedia.org/wiki/Brainstem#/media/File:1311_Brain_Stem.jpg

BRAINSTEM

Midbrain

Pons

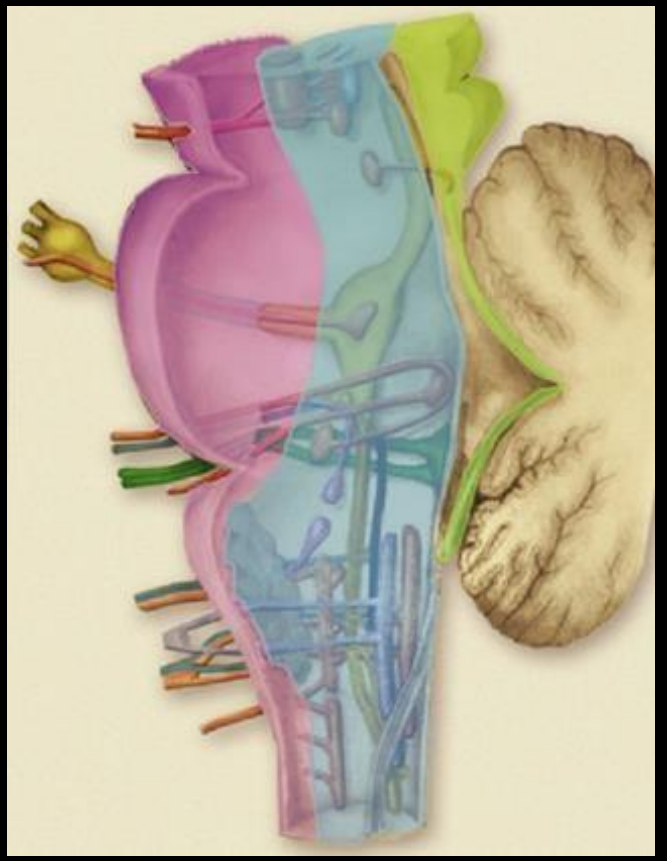
Medulla Oblongata



BRAINSTEM

Internal structure organized by 3 laminae:

- Tectum
- Tegmentum
- Basis



Fernandez-Gil MA, et al. Seminars in US, CT and MRI, 2010

BRAINSTEM

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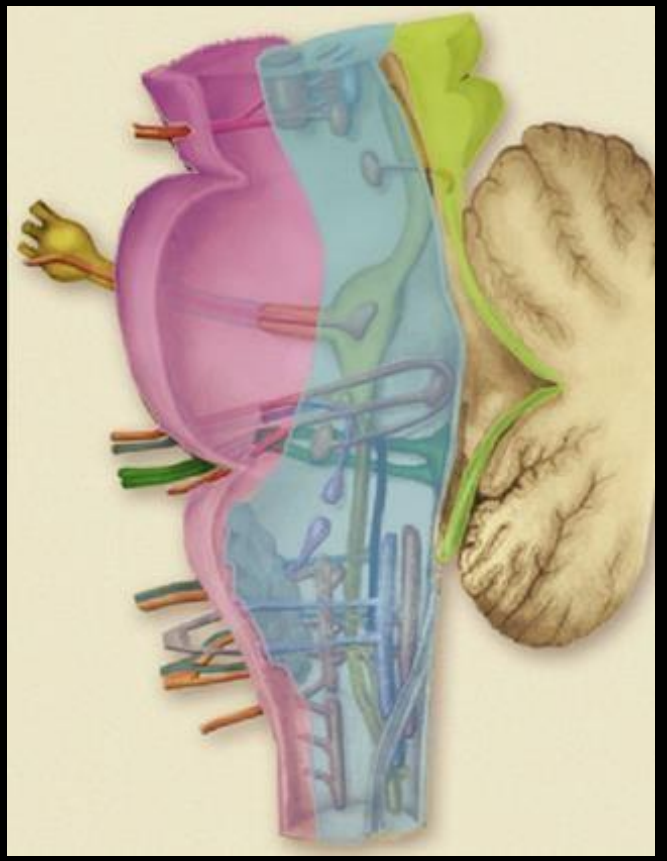
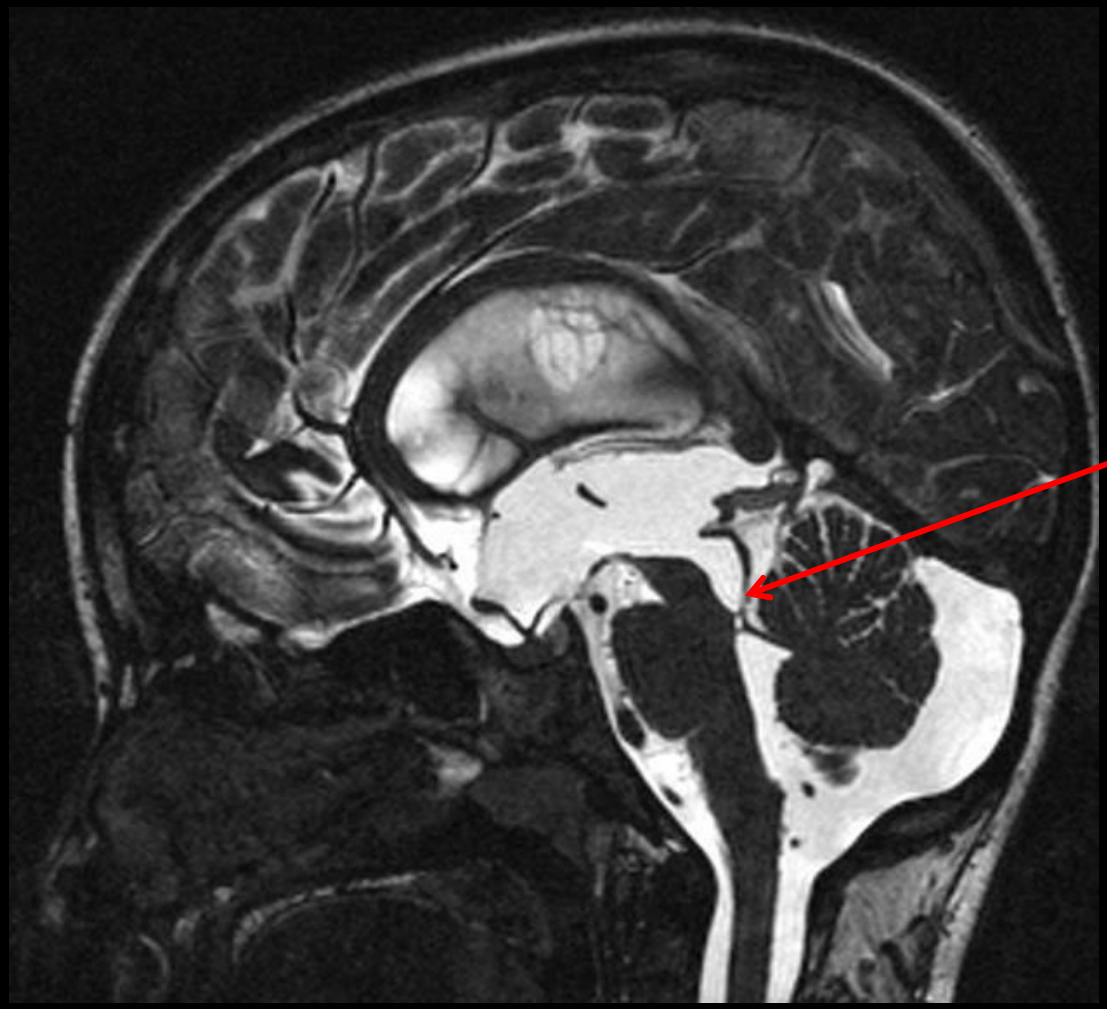


Tectum:

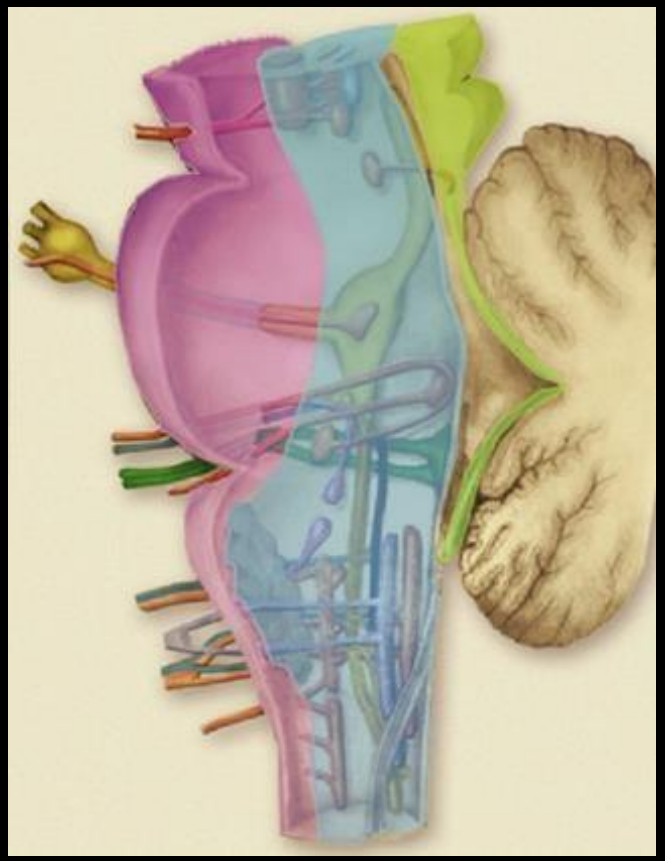
- ✓ Quadrigeminal plate
- ✓ Sup. Medullary velum
- ✓ Inf. Medullary velum

Fernandez-Gil MA, et al. Seminars in US, CT and MRI, 2010


Sup. Medullary velum

BRAINSTEM

Internal structure organized by 3 laminae:



Tegmentum (2 layers):

✓ Dorsal layer

Somatomotory & sensory cranial nerve nuclei

✓ Ventral layer

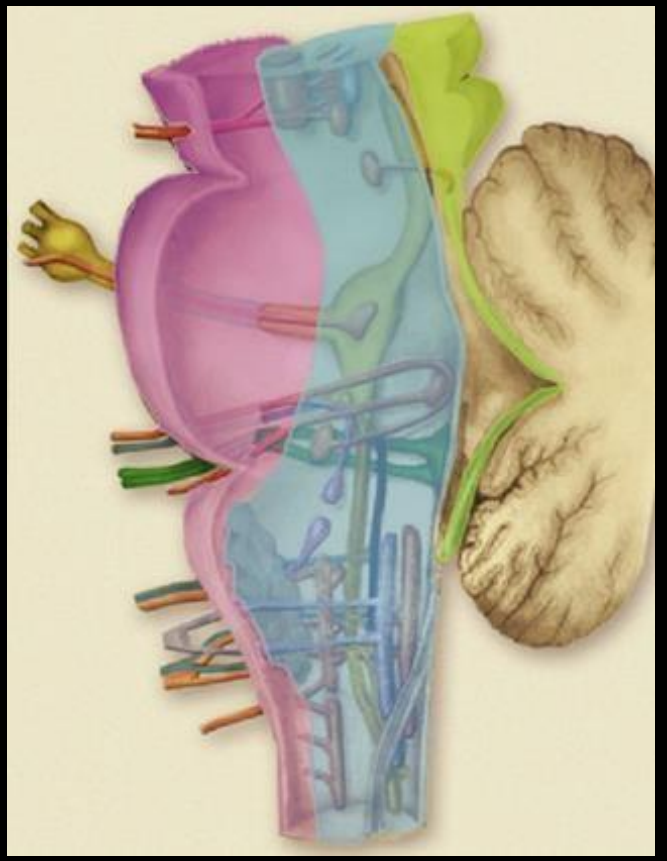
Supplementary nuclei, substantia nigra

Red nucleus, inferior olivary nucleus

Fernandez-Gil MA, et al. Seminars in US, CT and MRI, 2010

BRAINSTEM

Internal structure organized by 3 laminae:



Basis:

- ✓ Pyramidal tracts
- ✓ Pontine nuclei

Fernandez-Gil MA, et al. Seminars in US, CT and MRI, 2010

The Midbrain

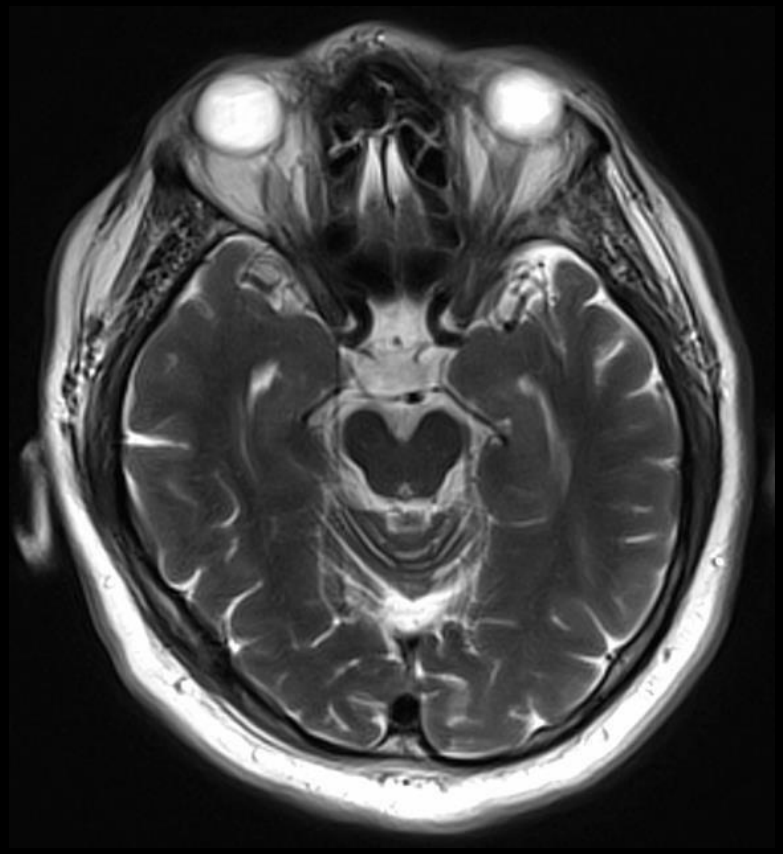
Located between the diencephalon and pons

The midbrain contains:

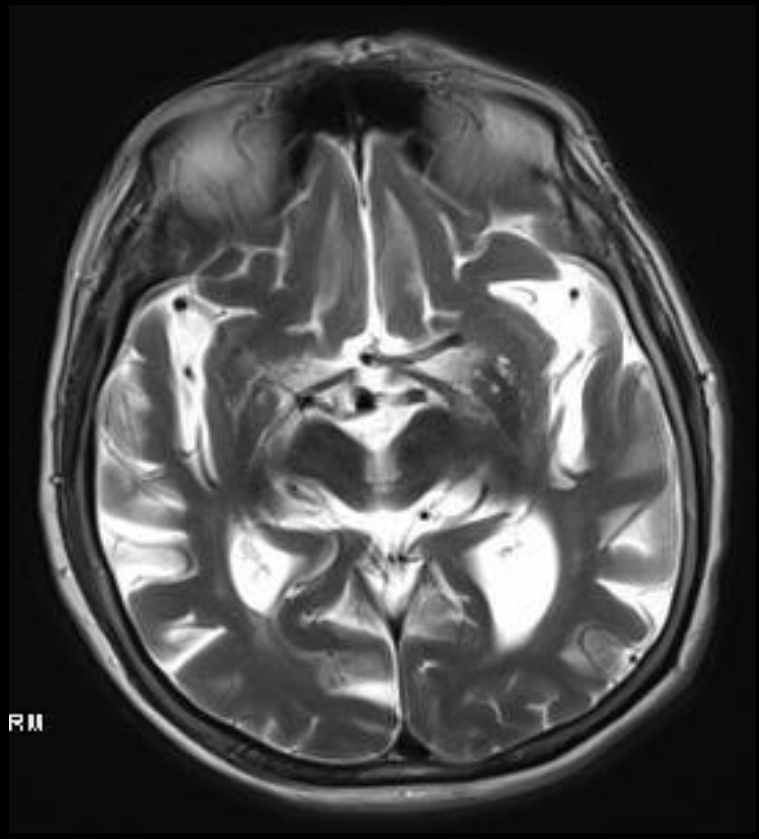
- Cerebral peduncles
- Tectum
- Nuclei of 3rd and 4th cranial nerves
- Reticular formation
- Substantia nigra
- Red nucleus
- Central tegmental tracts
- etc…

The Midbrain

The Midbrain

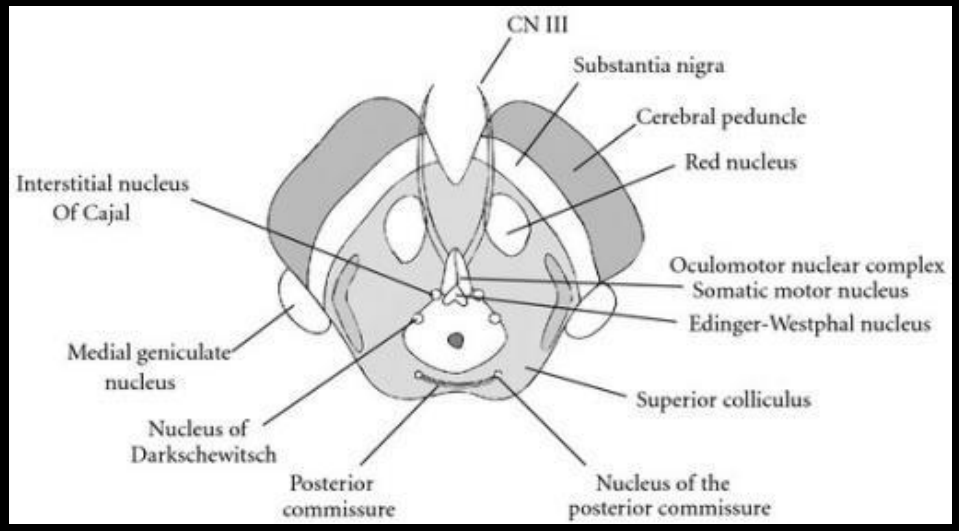


Normal



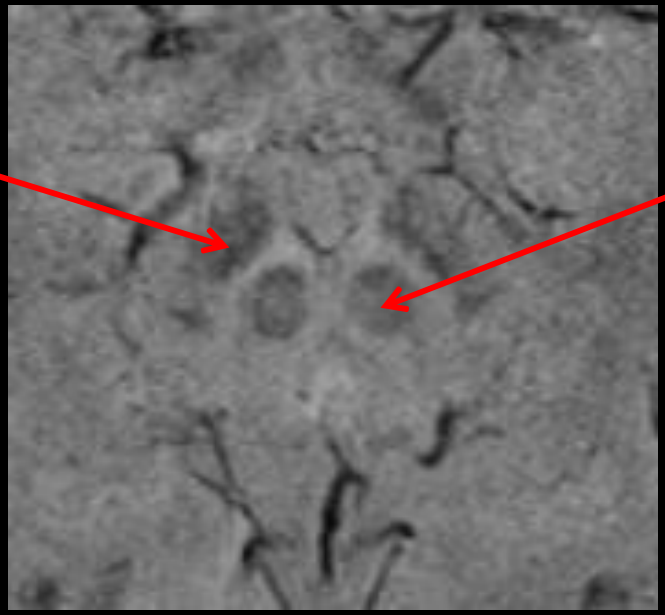
Progressive Supranuclear Palsy

The Midbrain



Substantia nigra

- ✓ Motor function
- ✓ Emotion

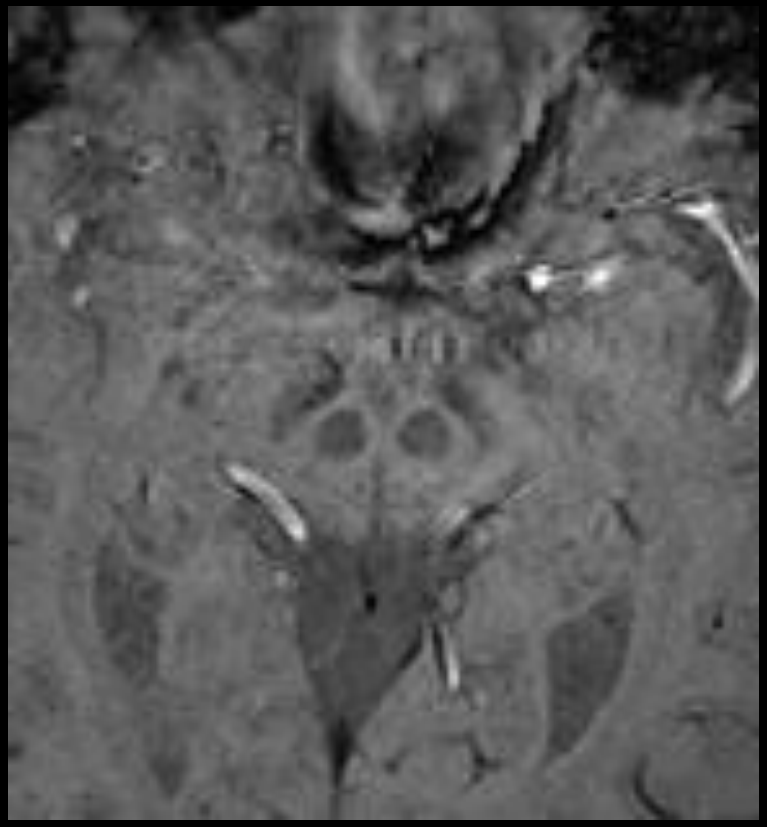


Red nucleus

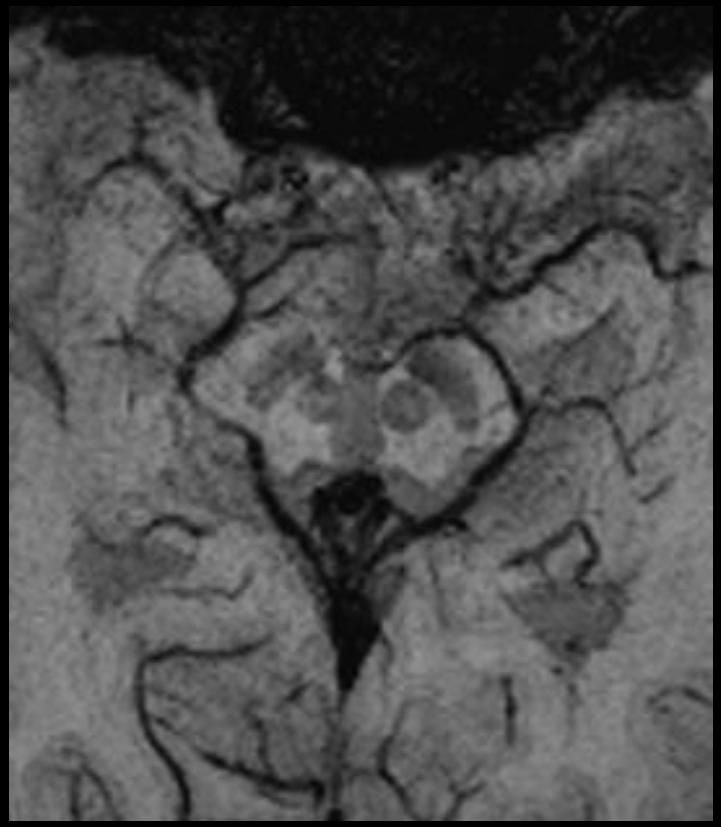
- ✓ Motor function

SWI

Parkinson's diesase



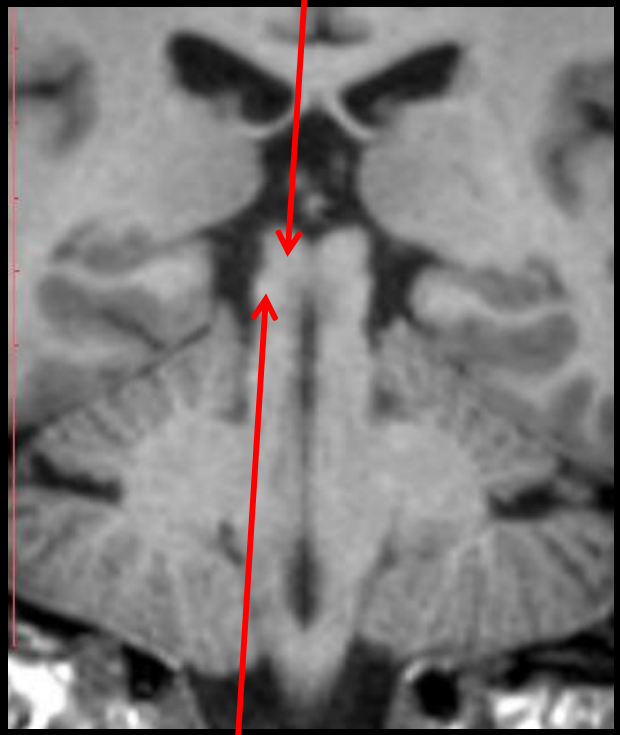
Normal

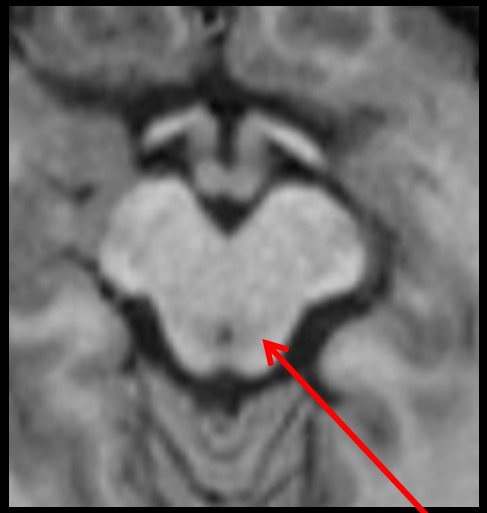


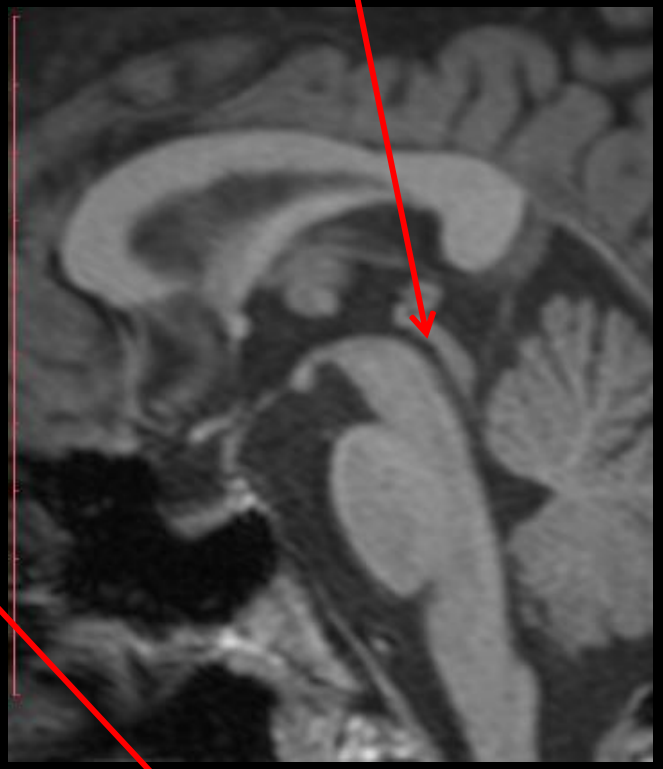
Parkinson's disease

Tectal plate:

Superior colliculus (vision pathways)







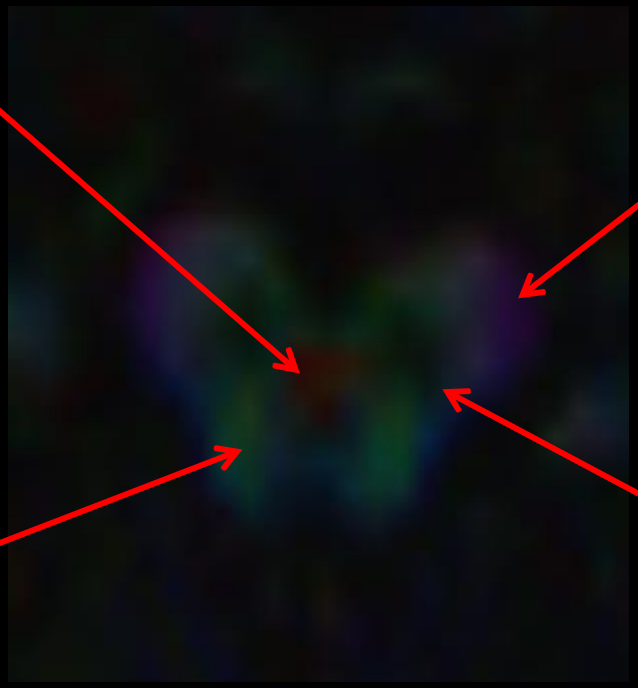
Inferior colliculus (auditory pathways)

Periaquductal gray m.

The Midbrain

Decussation of sup cerebellar ped.

Cerebral peduncle



Sup cerebellar peduncle

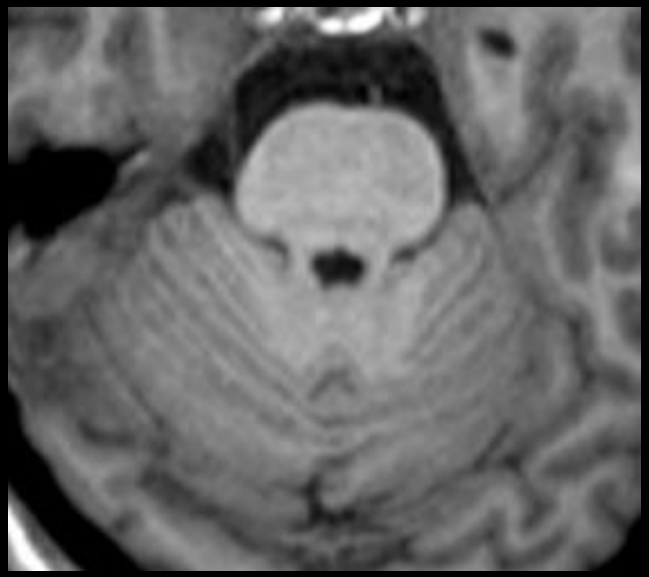
Medial lemniscus

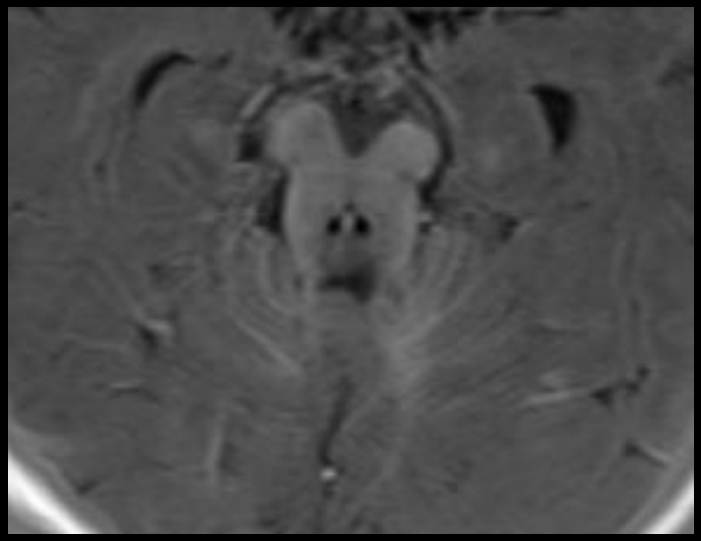
Somatosensation of skin and joints

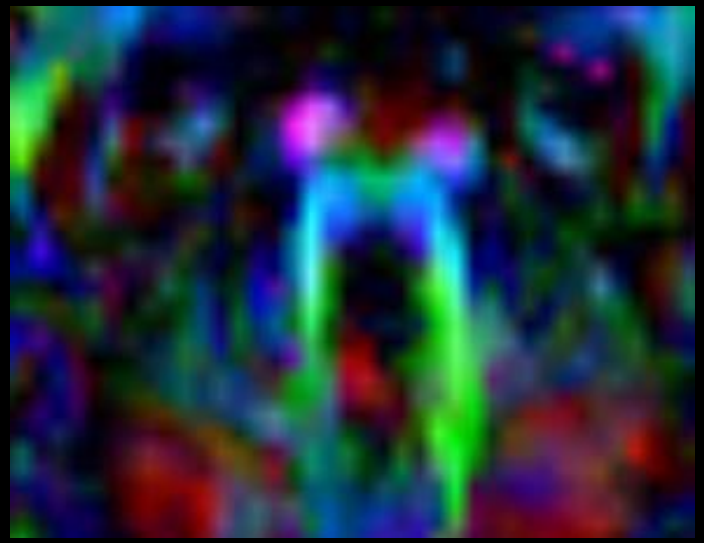
DTI

Normal

Joubert syndrome



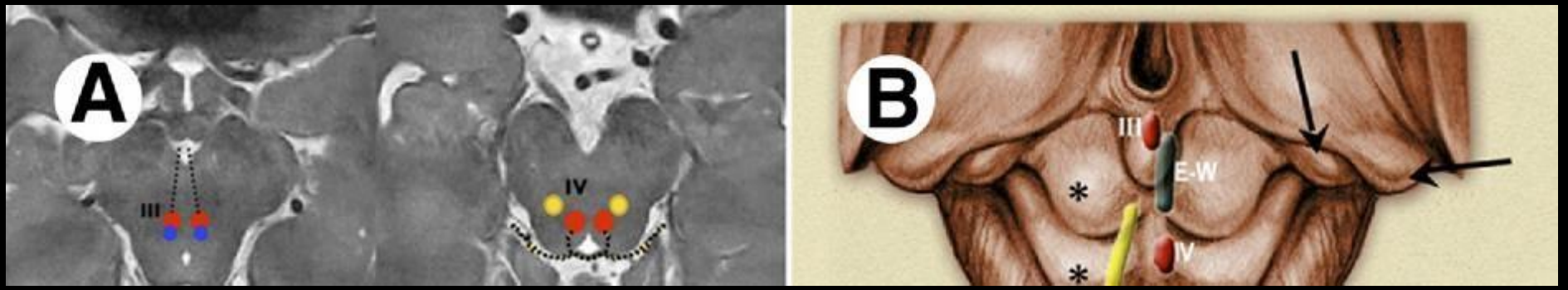




The Midbrain

The location of cranial nerve nerve nuclei

3rd and 4th



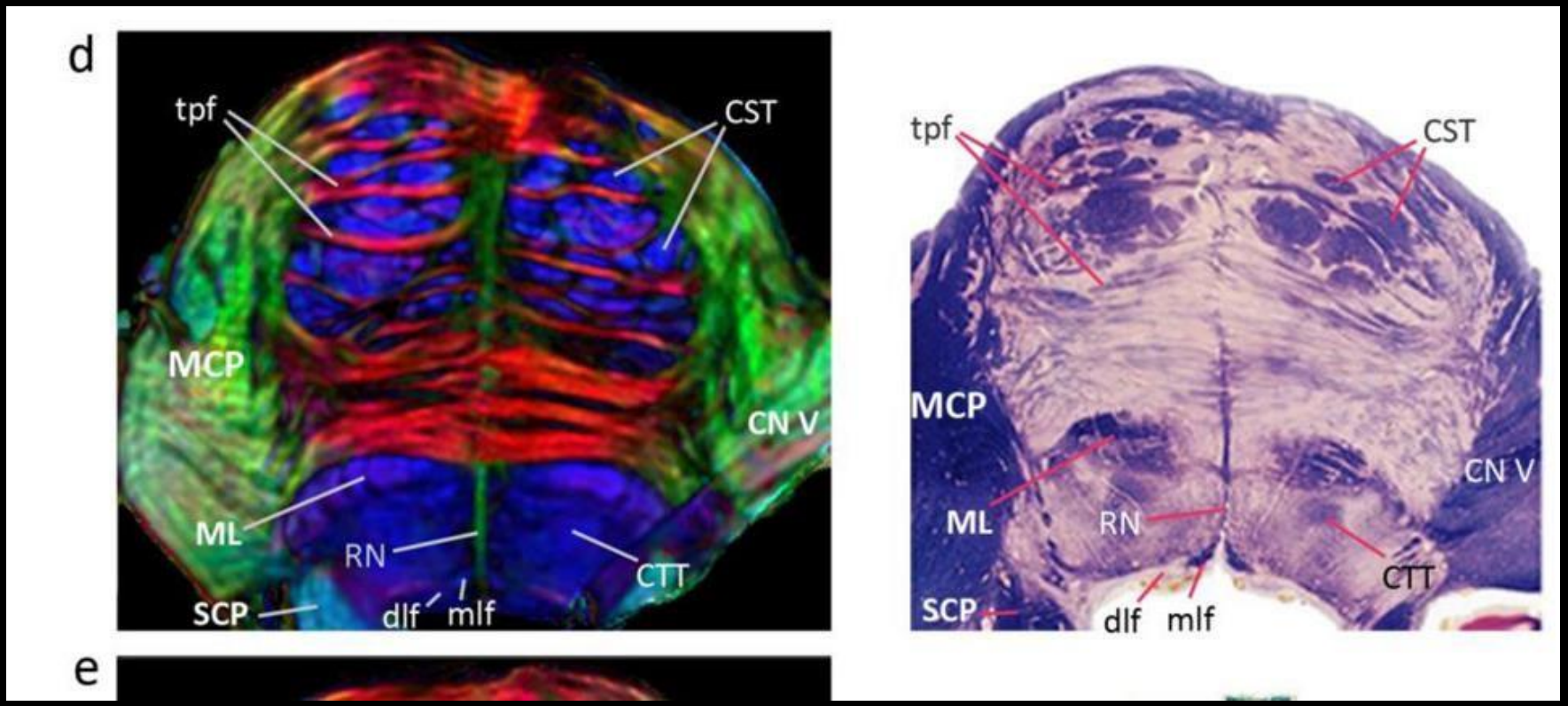
Fernandez-Gil MA, et al. Seminars in US, CT and MRI, 2010

The Pons

- ✓ Located between the midbrain & medulla oblongata
- ✓ It has convex anterior surface, and has basilar groove
- ✓ Contains transvers pontine fibers
- ✓ 5th, 6th, 7th and 8th cranial nerve nuclei



The Pons

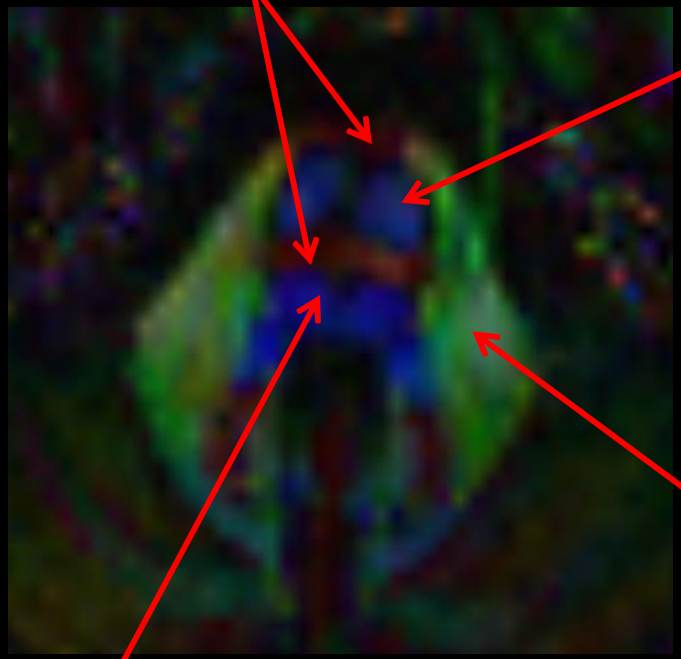


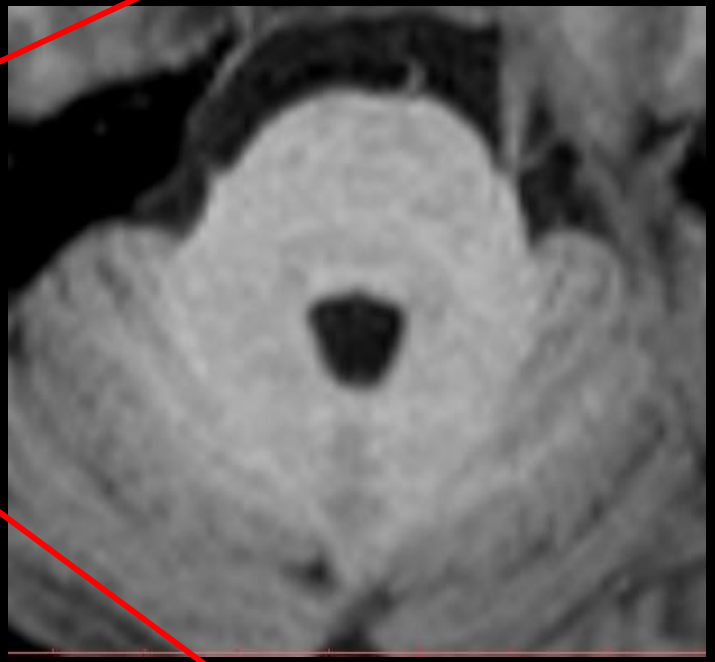
Aggarwal M, Neuroimage, 2013

The Pons

Transverse pontine fibers

Corticospinal tract



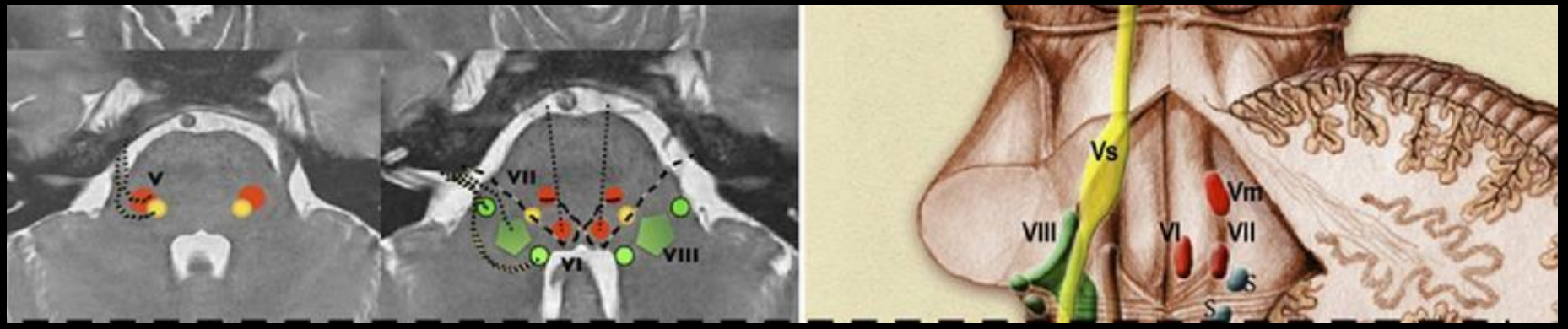


Medial lemniscus

Middle cerebellar peduncle

The Pons

5th, 6th, 7th and 8th cranial nerve nuclei location



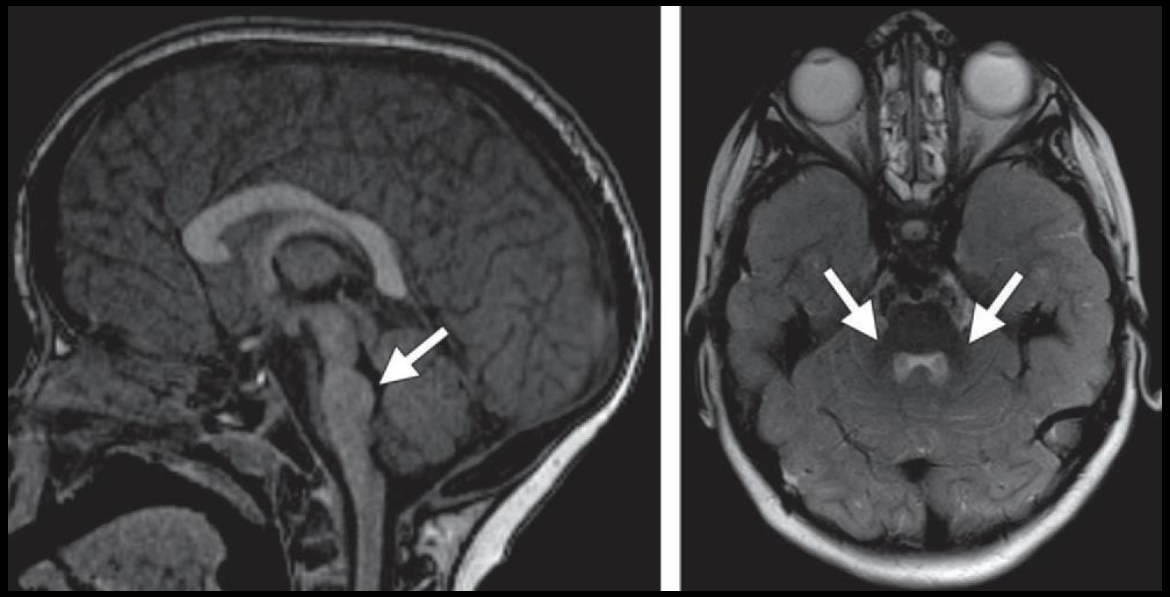
Fernandez-Gil MA, et al. Seminars in US, CT and MRI, 2010

The Pons

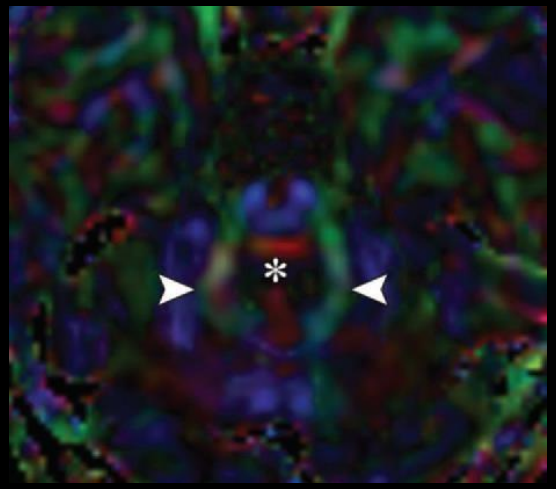
Contains neural pathways & nuclei responsible for:

- ✓ Sleep
- ✓ Respiration,
- ✓ Swallowing
- ✓ Bladder control
- ✓ Hearing
- ✓ Eye movements
- ✓ Facial expressions, sensations
- ✓ Posture
- ✓ etc

Pontine tegmental cap dysplasia:



- Flattened ventral pons
- Hypoplastic middle cerebellar peduncles
- Cap covering the dorsal pons
- Absence of transverse pontine fibers



Bosemani T et al. Radiographics 2015

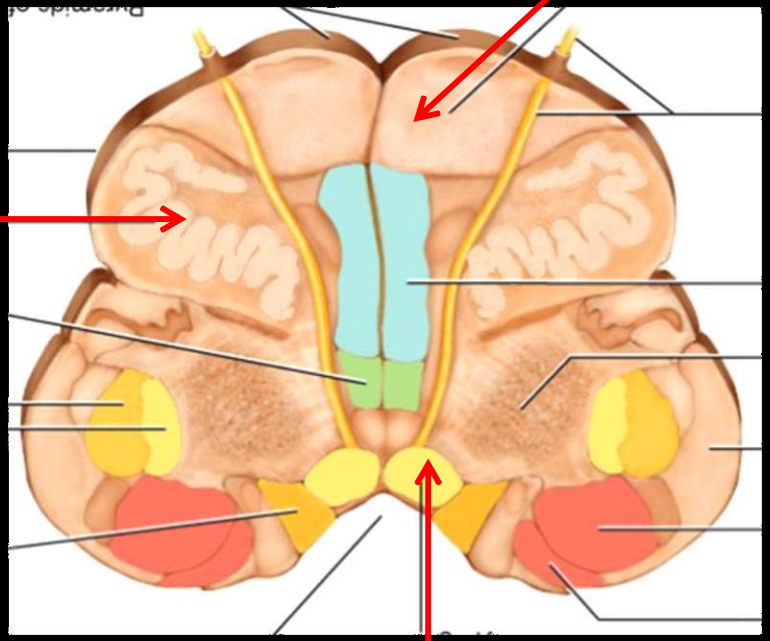
The Medulla Oblongata

- Connects the spinal cord to pons
- Spinal cord connection is approximately at the level of foramen magnum
- Contains the nuclei of 9th, 10th, 11th, 12th cranial nerves
- Responsible for autonomic functions
  - Cardiac
  - Respiratory
  - Vasomotor

https://en.wikipedia.org/wiki/Medulla_oblongata

The Medulla Oblongata

Pyramidal tracts



Inf Olivary Nucleus

(Timing of sensory inputs for coordinating movements)

Hypoglossal nerve nucleus

The Medulla Oblongata

Cuneate nucleus

Fine touch

Proprioception

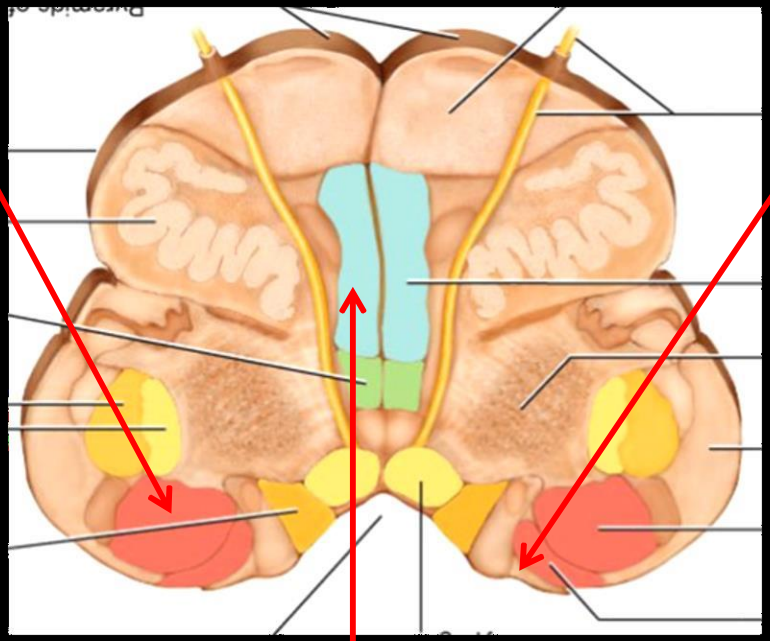
Above T6

Gracile nucleus

Fine touch

Proprioception

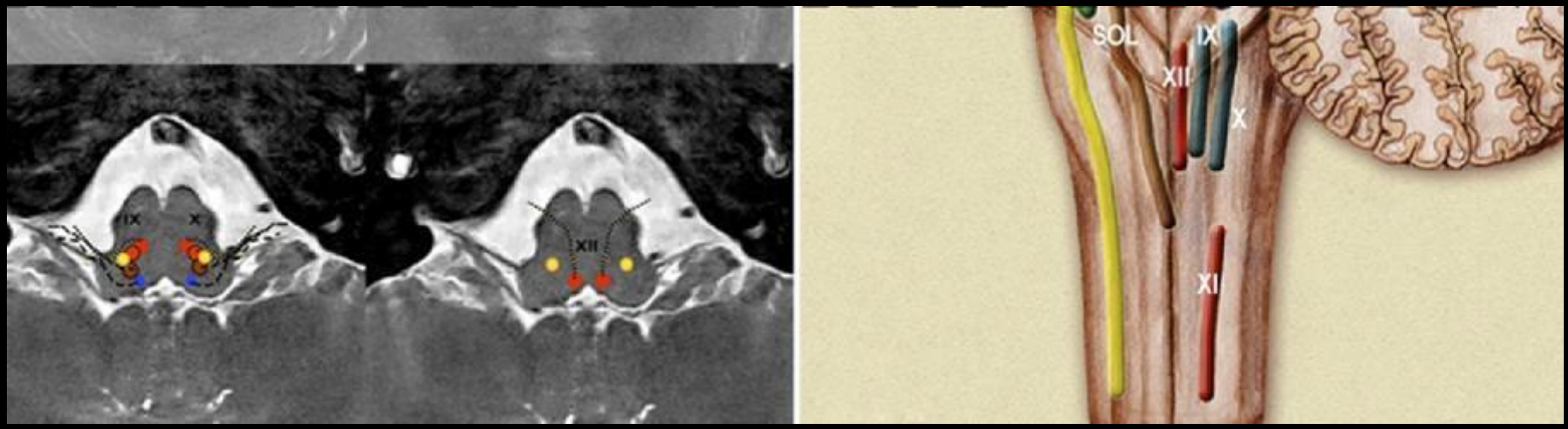
Below T6



Medial lemniscus

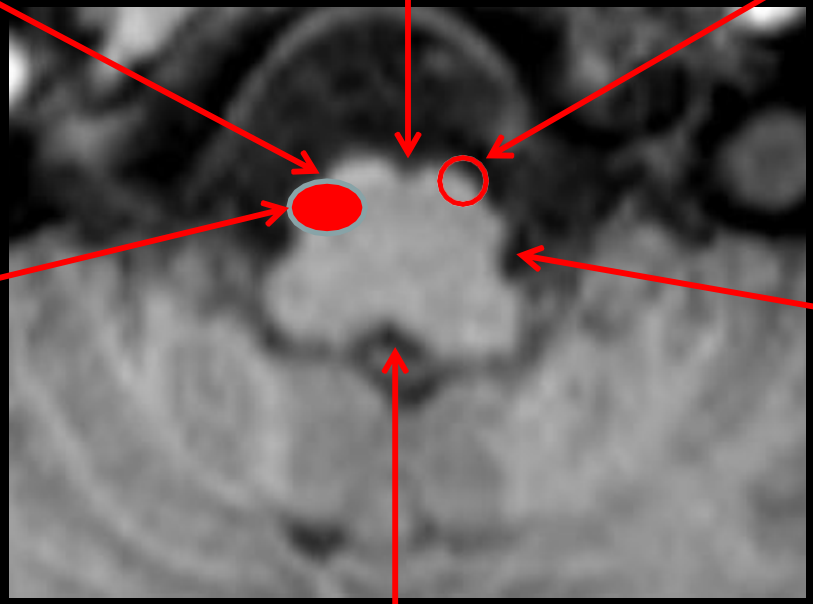
The Medulla Oblangata

9th, 10th, 11th, 12th cranial nerves nuclei locations

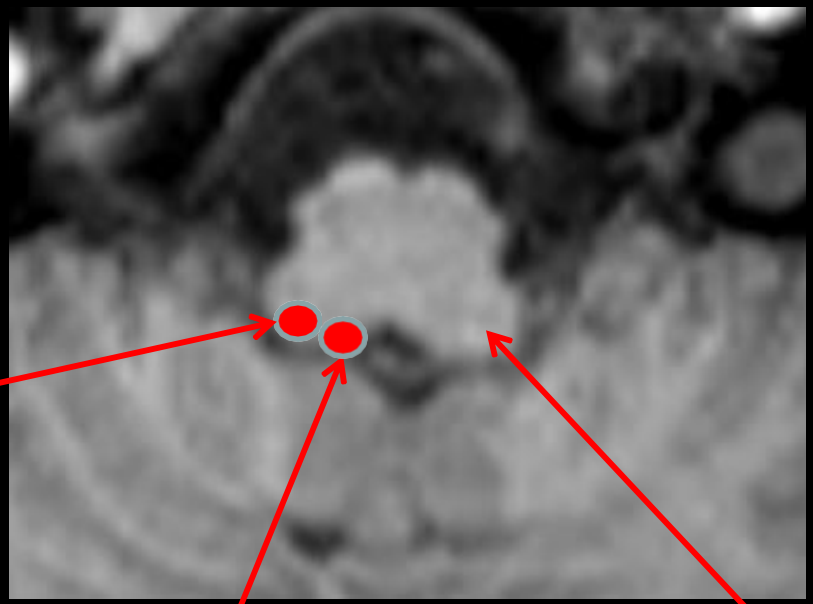


Fernandez-Gil MA, et al. Seminars in US, CT and MRI, 2010

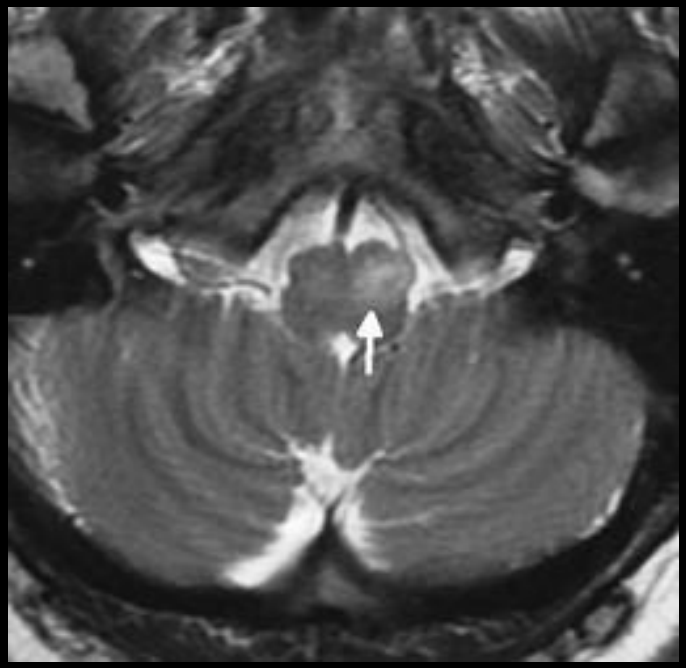
The Medulla Oblongata

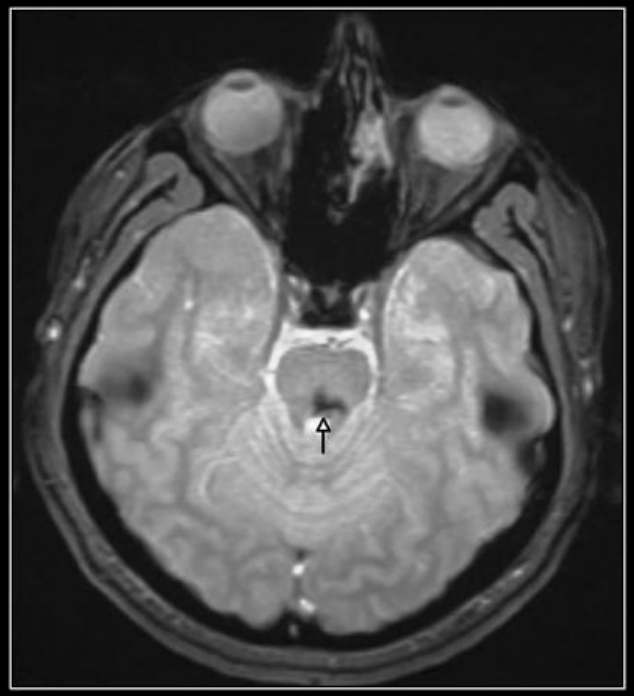


The Medulla Oblongata

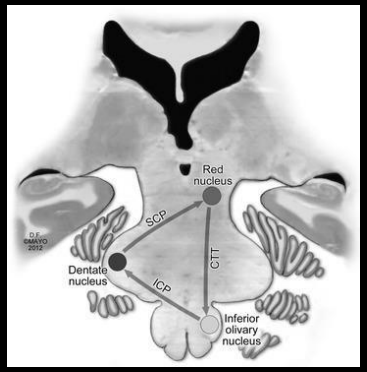


Why do we need anatomy?





The dentato-rubro-olivary pathway (Guillain-Mollaret triangle).



Neuroradiology (2012) 54:413–415
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LETTER TO THE EDITOR

Hypertrophic olivary degeneration after pontine hemorrhage

Neşe Asal · Ömer Yılmaz · Aynur Turan · Hasan Yiğit · Mahmut Duymuş · Evrim Tekin

Thanks for your attention