

Lab 3. Pons & Midbrain

Lesion Lessons

Lesion 4.1 Anne T. Pasta

i) Location

ii) Signs/symptoms

iii) Cause:



Lesion 4.2 Colin S. Terase

i) Location

ii) Signs/symptoms

iii) Cause:



Pontine Level of the Facial Genu

Locate and note the following:

Basilar pons

- massive ventral structure provides the most obvious change from previous medullary levels.
- *pontine gray* - large nuclear groups in the *basilar pons*.
 - origin of the *middle cerebellar peduncle*
- *pontocerebellar* axons - originate from *pontine gray* neurons and cross to form the *middle cerebellar peduncle*.
- *corticopontine* axons- huge projection that terminates in the *basilar pontine gray*.
- *corticospinal tract* axons
 - large bundles of axons surrounded by the *basilar pontine gray*.
 - course caudally to form the *pyramids* in the medulla.

Pontine tegmentum

- *medial lemniscus* - has now assumed a “horizontal” position and forms part of the border between the *basilar pons* and *pontine tegmentum*.
- *central tegmental tract* - located just dorsally to the *medial lemniscus*.
 - descends from the midbrain to the *inferior olive*.
- *superior olivary nucleus* - pale staining area lateral to the *central tegmental tract*.
 - gives rise to the efferent *olivocochlear* projection to the inner ear.
- *lateral lemniscus* - lateral to the *medial lemniscus*.
 - composed of secondary auditory projections from the *cochlear nuclei*.
- *trapezoid body* (area enclosed in trapezoid) - crossing pathway arising from the *cochlear nuclei* and passing beneath and through the *medial lemniscus*.
 - as they course lateral to the *medial lemniscus*, these axons turn rostrally to form the *lateral lemniscus* which ascends to the *inferior colliculus*.
 - some secondary auditory fibers synapse in the *superior olive*.
- *facial nerve* - SVE axons from the *facial motor nucleus* can be seen making their internal loop or genu over the *abducens nucleus* just below the floor of the *fourth ventricle*.
- *spinal trigeminal tract and nucleus* - located lateral to the *facial nerve* axons.
- *CN VI axons* - can be seen exiting the ventromedial aspect of the *abducens nucleus*.

Question classic

Is the middle cerebellar peduncle composed of climbing or mossy fibers?

Question classic

What sensory modalities are carried by the medial and lateral lemnisci?

Question classic

What muscle is innervated by the CN VI?

Label these structures on Figure 1.

- | | | |
|---------------------|------------------------------|-------------------------------|
| • facial colliculus | • pontine gray | • spinal nuc. and tract of V |
| • abducens nucleus | • corticospinal tract | • mesencephalic tract of V |
| • abducens nerve | • pontocerebellar fibers | • vent. spinocerebellar tract |
| • facial nerve | • middle cerebellar peduncle | • central tegmental tract |
| • ascending MLF | • spinothalamic tract | • trapezoid body |
| • tectospinal tract | • lateral lemniscus | • superior olive |
| • medial lemniscus | • facial nucleus | • fourth ventricle |

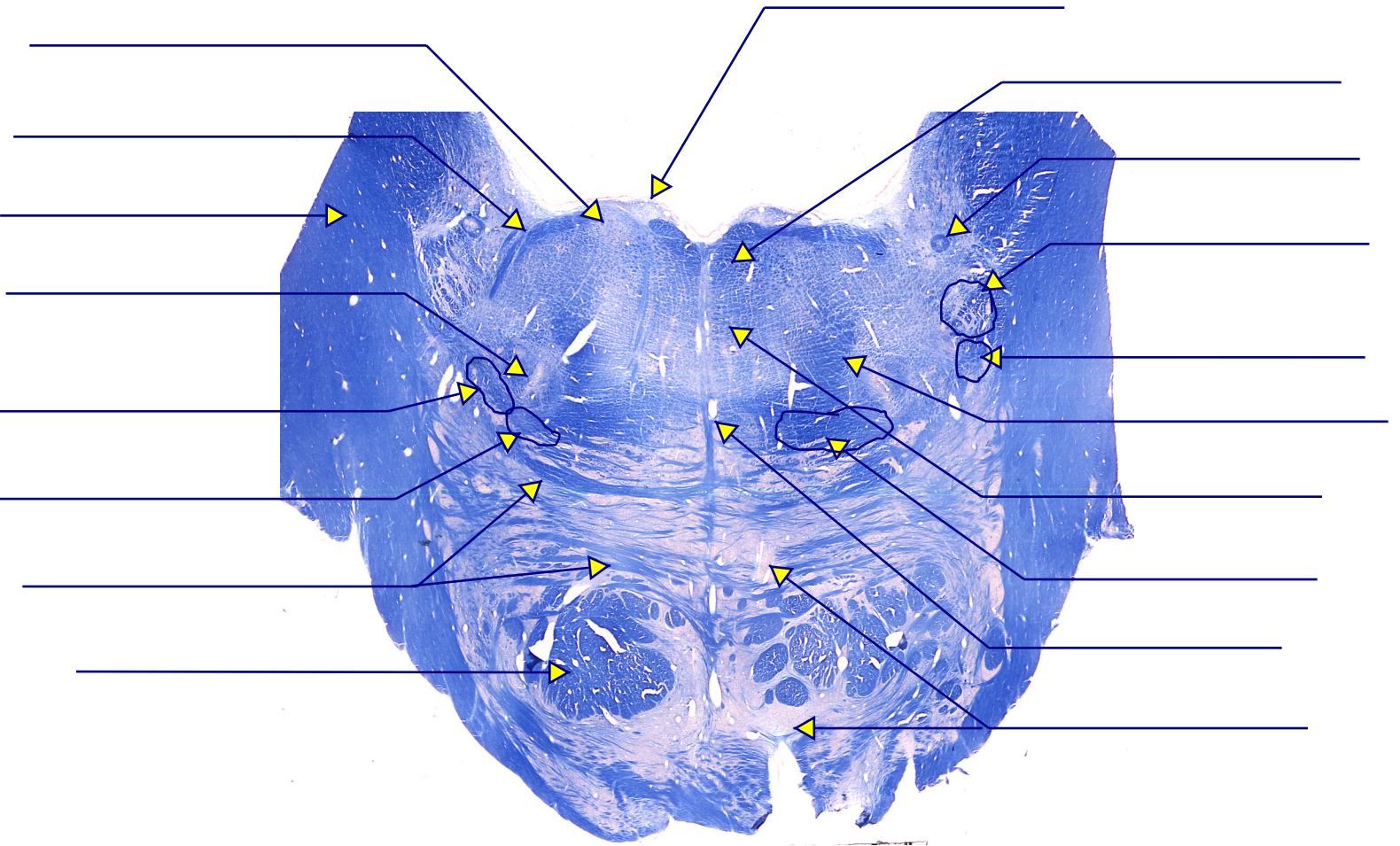


Fig 1. Pontine level of the facial nerve.

Case Break

Double Vision

A 70 year old hypertensive man, Willie Maykitt, awakens one morning with double vision and weakness of his right arm and leg. On examination there is full lateral gaze to the right, but neither eye can move to the left past the midline. Vertical gaze is normal. The right upper and lower limbs are spastic, moderately weak, and hyperreflexic compared to the left.

1. *Where is the lesion?*

2. *What centers or tracts are involved?*

3. *Which is the most likely cause and why: ischemic infarct, hemorrhage, or tumor?*

He makes a full recovery over the next 6 months, but then double vision suddenly returns.

You now notice that the left eye cannot adduct past the midline, while there is nystagmus in the fully abducting right eye. All other eye movements are full.

4. *Where is this lesion?*

5. *Where is it in relation to his previous lesion?*

6. *What arterial territory is involved?*



On this axial MRI identify the pons, fourth ventricle, cerebellum, middle cerebellar peduncles, and cerebral cortex. Also identify the basilar artery. Finally, locate the small infarct in the PPRF.

Pontine Level of the Trigeminal Motor Nucleus

Locate and note the following:

- *superior cerebellar peduncles* - prominent pathway leaving the cerebellum in the roof of the fourth ventricle.
- *middle cerebellar peduncles* - huge pathway entering the cerebellum laterally.
- *motor trigeminal nucleus* - an SVE nucleus innervating the branchial arch derived muscles of mastication.

principal sensory trigeminal nucleus - found lateral to the *motor trigeminal nucleus*.

– observe the relation of the *trigeminal nerve root* to the *principal trigeminal nucleus* and *trigeminal motor nucleus* as best seen on the higher power view.

- *ventral spinocerebellar tract* - courses over the external surface of the *superior cerebellar peduncle* enter the cerebellum (as best seen the left side of this figure).

Label these structures on Figure 2.

• <i>sup. cerebellar peduncle</i>	• <i>ascending MLF</i>	• <i>ventral spinocerebellar tr.</i>
• <i>middle cerebellar peduncle</i>	• <i>motor nucleus of V</i>	• <i>central tegmental tract</i>
• <i>corticospinal tract</i>	• <i>principal sensory nuc. of V</i>	• <i>lateral lemniscus</i>
• <i>medial lemniscus</i>	• <i>mesencephalic tract of V</i>	• <i>spinothalamic tract</i>
• <i>fourth ventricle</i>		

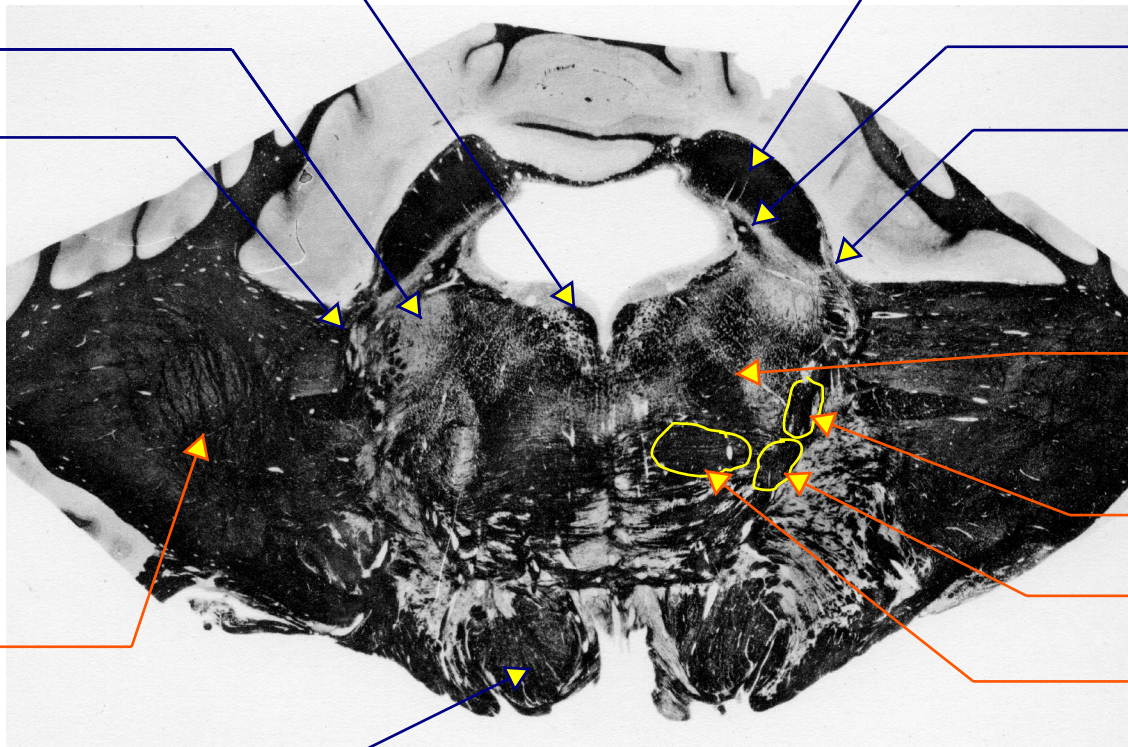


Figure 2. Pontine level of the trigeminal motor nucleus. From Jelgersma Tabular 95-862, 1931.

Case Break

Cheek Pain

A patient, Penny Pinscher, sees you after suffering 3 months of paroxysmal, lightning-like pain in the right cheek, which recurs dozens of times daily, often triggered off by touching the face. The neurological examination is normal.

1. *What is this clinical syndrome called?*
2. *If this is a young woman who has recovered from previous episodes of paraparesis and left optic neuritis (temporary blindness), where could the lesion be and what is the cause?*
3. *What would you consider more likely if her right cheek becomes permanently numb to pin or cotton sensation, or she becomes deaf in the right ear?*

Locate the following on this section:

- *CN IV* - exits dorsally (white arrow)
- *locus ceruleus* - pigmented region just lateral to the *cerebral aqueduct*
- *superior cerebellar peduncle* - near the dorso-lateral surface
- *basilar pons* - prominent ventrally

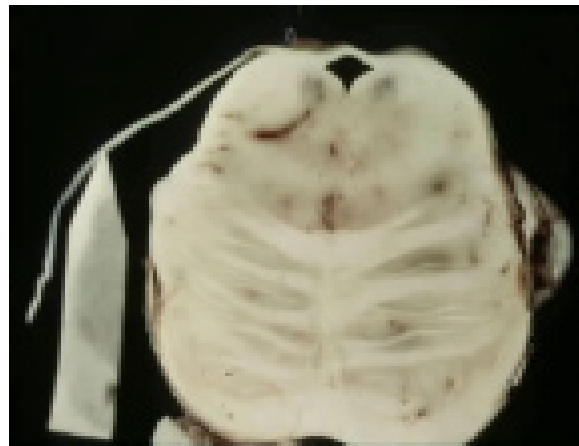


Figure 3. Gross brain stem section through the level of the pons.

Level of the Isthmus and Trochlear Nerve

Locate and note the following:

- *trochlear nerve* - decussates dorsally above the *aqueduct*
- *superior cerebellar peduncles* – prominent in the dorsolateral brain stem tegmentum.
- *periaqueductal gray (PAG)* – surrounding the cerebral aqueduct
- *lateral lemniscus* – courses superficial to the *superior cerebellar peduncle* enroute to the *inferior colliculus*.
- *mesencephalic trigeminal tract* – found lateral to the PAG and medial to the *superior cerebellar peduncle*.
- *locus ceruleus* - cluster of darkly staining, pigmented cells in the lateral region of the PAG.
 - have extremely widespread noradrenergic (NA) projections.
- *raphe nuclei* – cluster of darkly stained neurons along the midline within the PAG and ventral to the MLF.
 - have widespread serotonergic projections.

Label these structures on Figure 4.

- *trochlear nerve*
- *periaqueductal gray*
- *sup. cerebellar peduncle*
- *lateral lemniscus*
- *medial lemniscus*
- *spinothalamic tract*
- *central tegmental tract*
- *pontine gray*
- *corticospinal tract*
- *corticopontine axons*
- *pontocerebellar fibers*
- *ascending MLF*
- *midline raphe nuclei*

Structures surrounding the PAG are best seen at a higher magnification.

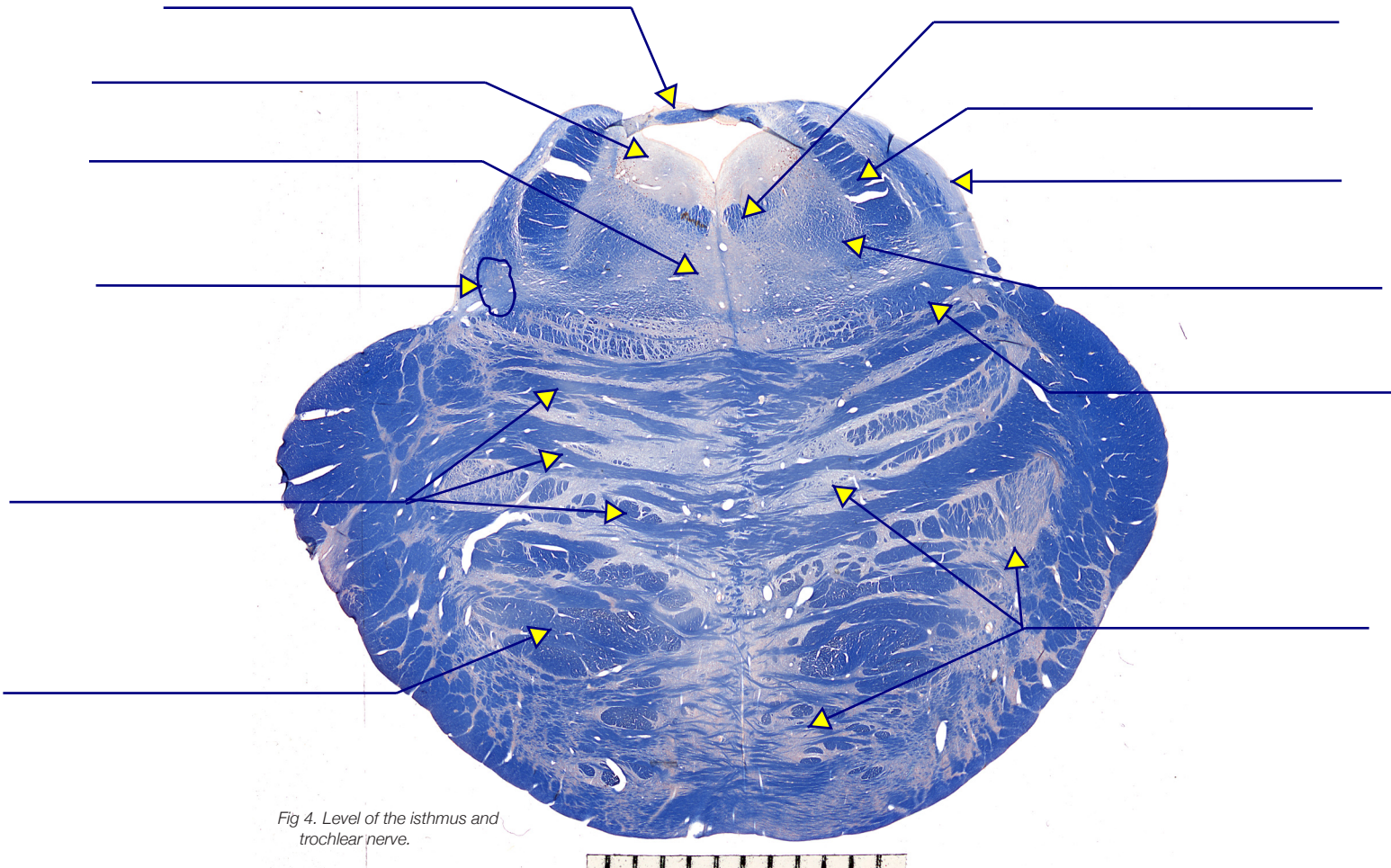


Fig 4. Level of the isthmus and trochlear nerve.

Midbrain Level of the Inferior Colliculus

Locate and note the following:

- *crus cerebri* - massive structure at the ventral aspect of the midbrain.
 - contains the *corticospinal*, *corticobulbar*, and *corticopontine tracts*
- *substantia nigra* - a black pigmented region located just above the *crus cerebri*.
- *decussation of the superior cerebellar peduncles* - large structure virtually obliterating the midline in the tegmentum.
- *lateral lemniscus* - fans out dorsally as it terminates in the *inferior colliculus* (“golf ball on tee”).
- *inferior colliculus* - a major element of the auditory system.
- *trochlear nucleus* - very small nucleus just dorsal to the *MLF*

Question classic

Transmitter associated with the substantia nigra?

Label these structures on Figure 5.

- trochlear nucleus
- periaqueductal gray
- sup. cerebellar peduncle decussation
- lateral lemniscus
- medial lemniscus
- spinothalamic tract
- central tegmental tract
- pontine gray
- crus cerebri
- substantia nigra
- ascending MLF

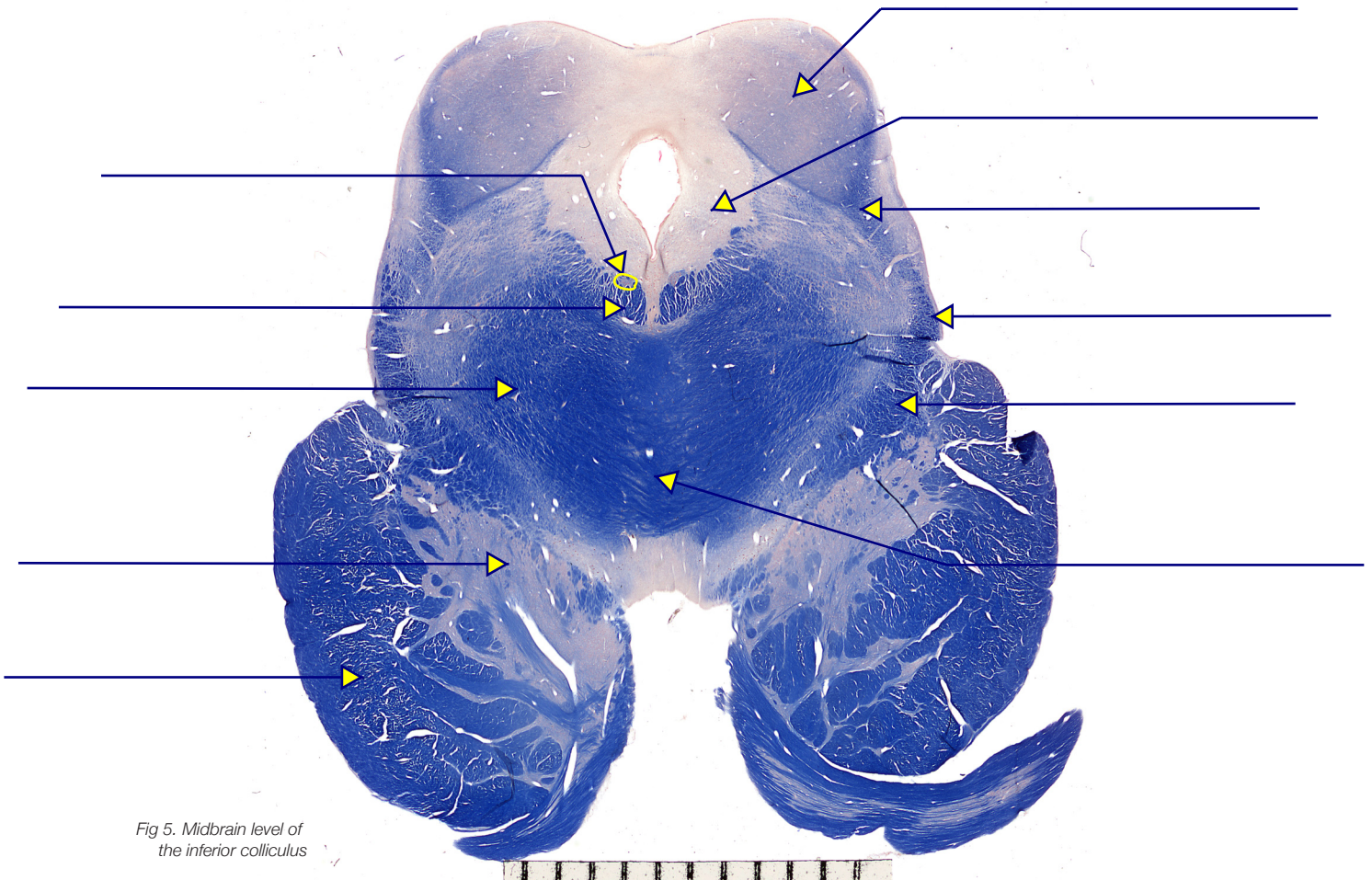


Fig 5. Midbrain level of the inferior colliculus

Midbrain Level of Superior Colliculus

Locate and note the following:

- *superior colliculus* – extremely important nucleus in controlling eye-head movements in orienting to a variety of stimuli.
- *tectospinal tract* – colliculus efferent (located on many previous sections).
- *brachium of the inferior colliculus* – located on the surface of the brainstem ventrolateral to the *superior colliculus*.
 - an auditory pathway projecting from the *inferior colliculus* (located just caudally) to the *medial geniculate body* of the thalamus (located rostrally).
- *crus cerebri* – massive structure at the ventral aspect of the midbrain.
 - contains the *corticospinal*, *corticobulbar*, and *corticopontine tracts*
- *substantia nigra* – a black pigmented region located just above the *crus cerebri*.
 - component of the basal ganglia that provides dopaminergic innervation the *caudate* and *putamen*.
 - degenerates in *Parkinson's disease*.
- *oculomotor nucleus* – located medial to the MLF.
- *interpeduncular fossa* – ventral space, midline space containing the exiting rootlets of CN III.

The crus cerebri contains the...

- *frontopontine projections* medially
- *corticospinal and corticobulbar projections* in the middle
- *parieto-temporo-occipital pontine projections* laterally

Label these structures on Figure 6.

- *oculomotor nucleus*
- *Etinger-Wesphal nucleus*
- *sup. cerebellar peduncle*
- *brachium of the inf. collic.*
- *medial lemniscus*
- *spinothalamic tract*
- *central tegmental tract*
- *cerebral aqueduct*
- *crus cerebri*
- *substantia nigra*
- *ascending MLF*

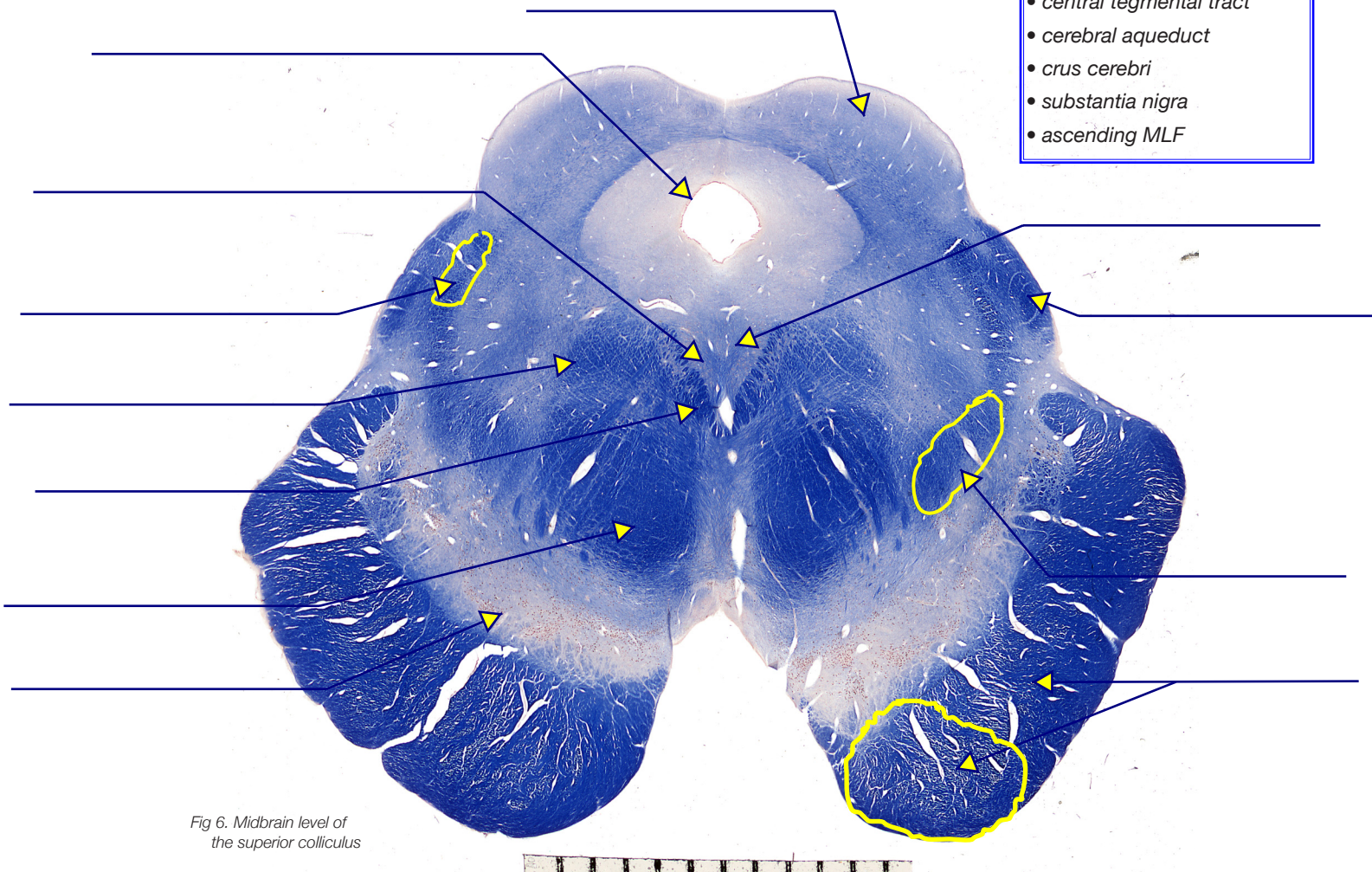


Fig 6. Midbrain level of the superior colliculus

Midbrain Level of the Red Nucleus

Locate and note the following:

- *red nucleus* – located the middle of the tegmentum above the *substantia nigra*.
 - is the source of the *rubrospinal tract* and is major termination region for the *superior cerebellar peduncle* (although many SCP fibers continue on to the *thalamus* as *cerebello-thalamic projections*).
- *interstitial nucleus of Cajal* – an accessory *oculomotor nucleus* located within the MLF.
 - is involved in control of vertical eye movements.

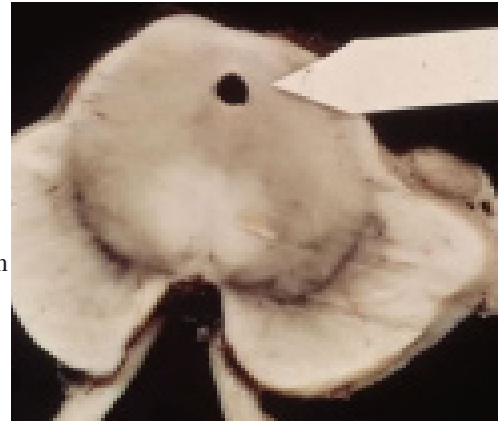


Fig 7. Gross section through the midbrain. Note the following:

- CN III - exits in the interpeduncular fossa
- cerebral aqueduct
- decussation of the superior cerebellar peduncles - in the middle of the tegmentum
- substantia nigra - on each side just above the crus cerebri.

Label these structures on Figure 8.

• superior colliculus	• periaqueductal gray
• cerebral aqueduct	• oculomotor nucleus
• medial lemniscus	• oculomotor nerve
• red nucleus	• brachium of the inf.coll.
• interstitial nuc of Cajal	• substantia nigra
• crus cerebri	• spinothalamic tract
• cerebello-thalamic tr.	• CN III axons

Important clinical correlation

A portion of the oculomotor nucleus straddles the midline; this is known as the Edinger-Westphal nucleus, and it gives rise to parasympathetic fibers that travel in the oculomotor nerve to the ciliary ganglion.

These fibers are an essential element of the circuit of the pupillary light reflex (light in one eye causes both pupils to constrict).

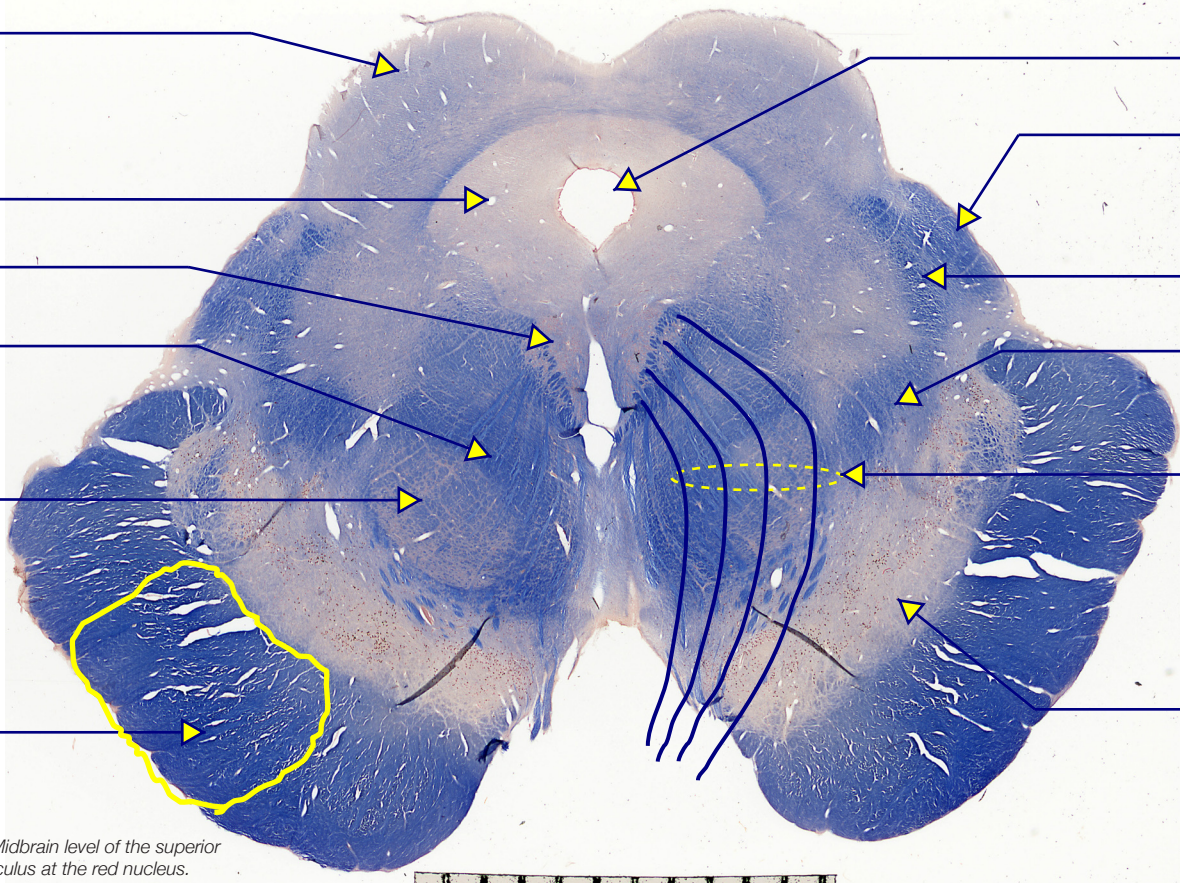


Fig 8. Midbrain level of the superior colliculus at the red nucleus.

Midbrain-Diencephalon Transition

Locate and note the following:

- *pulvinar* - large thalamic nucleus in the posterior thalamus
- *medial geniculate* nucleus – relays auditory information to the primary auditory cortex
- *brachium of the inferior colliculus* - terminates in the *medial geniculate*, the final relay station in the auditory pathway.
- *lateral geniculate nucleus* – relays visual information to the primary visual cortex.
- *brachium of the superior colliculus* - arches over the *medial geniculate body* enroute to the *lateral geniculate*.
- *optic radiations* - efferents from the *lateral geniculate* to the visual cortex in the occipital lobe.
- *pineal body* - located dorsal to the superior colliculus in the midline.
 - secretes the hormone *melatonin*.

Question classic

What is the main input to the inferior colliculus?

Label these structures on Figure 8.

• <i>superior colliculus</i>	• <i>corpus callosum</i>
• <i>pulvinar</i>	• <i>oculomotor nucleus</i>
• <i>medial lemniscus</i>	• <i>oculomotor nerve</i>
• <i>pineal gland</i>	• <i>brachium of the inf.coll.</i>
• <i>central tegmental tract</i>	• <i>brachium of the sup. coll.</i>
• <i>medial geniculate</i>	• <i>spinothalamic tract</i>
• <i>lateral geniculate</i>	• <i>optic radiations</i>
• <i>MLF</i>	• <i>decus. of the sup cbllr ped.</i>
• <i>pons</i>	• <i>PAG</i>

Other structures on this slide will be studied in Lab 6.

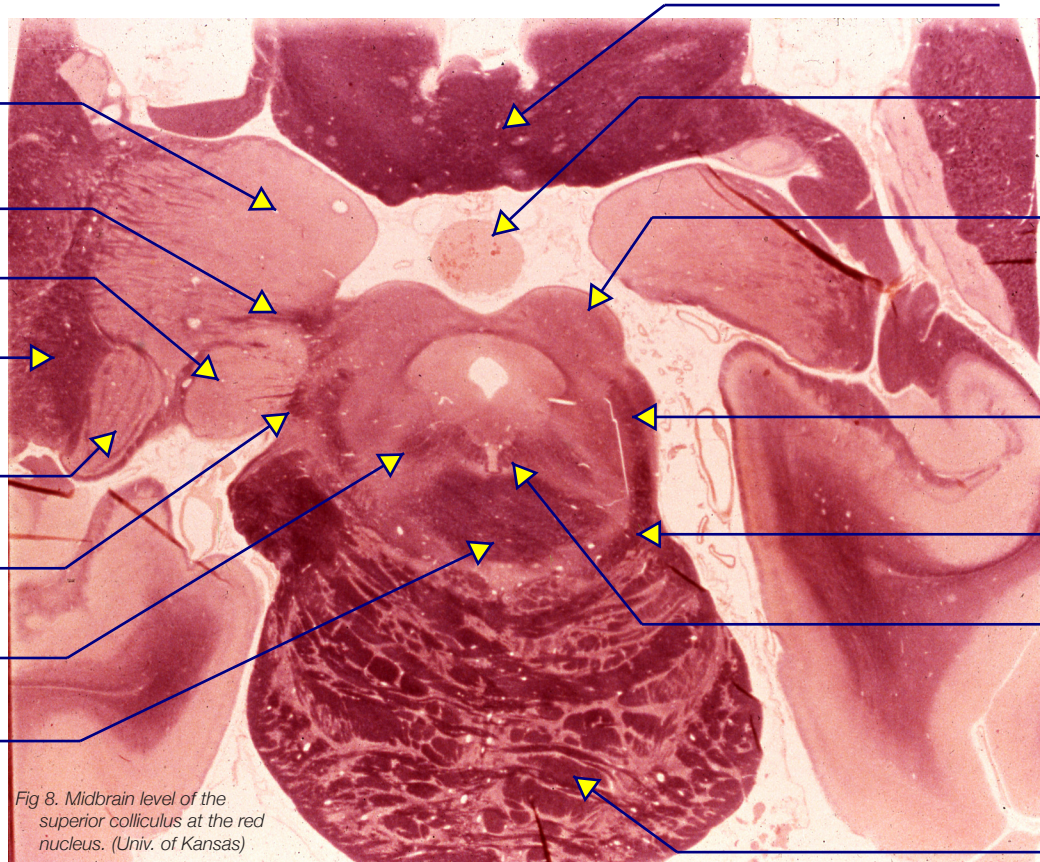


Fig 8. Midbrain level of the superior colliculus at the red nucleus. (Univ. of Kansas)

C. Review Questions

1. What is the major input to the basilar pontine gray?
2. What is the relationship of the middle cerebellar peduncle to the pontine gray?
3. Which cranial nerve courses immediately deep to the facial colliculus?
4. Which cranial nerve nucleus is found deep to the facial colliculus?
5. What is the tectum?
6. Which functional components are associated with the facial nerve? ...the trigeminal nucleus?
7. Where does the lateral lemniscus terminate?
8. What is the origin and termination of the central tegmental tract?
9. Describe the localization of cortical fibers in the crus cerebri.
10. What is peculiar about the course of the trochlear nerve?

MRI Correlation

Label these structures on Figure 9.

- | | |
|--------------------------------|-------------------------------------|
| • <i>medial rectus muscle</i> | • <i>sphenoid sinus</i> |
| • <i>lateral rectus muscle</i> | • <i>internal carotid artery</i> |
| • <i>basilar artery</i> | • <i>temporal lobe</i> |
| • <i>basilar pons</i> | • <i>middle cerebellar peduncle</i> |
| • <i>fourth ventricle</i> | • <i>cerebellar hemisphere</i> |

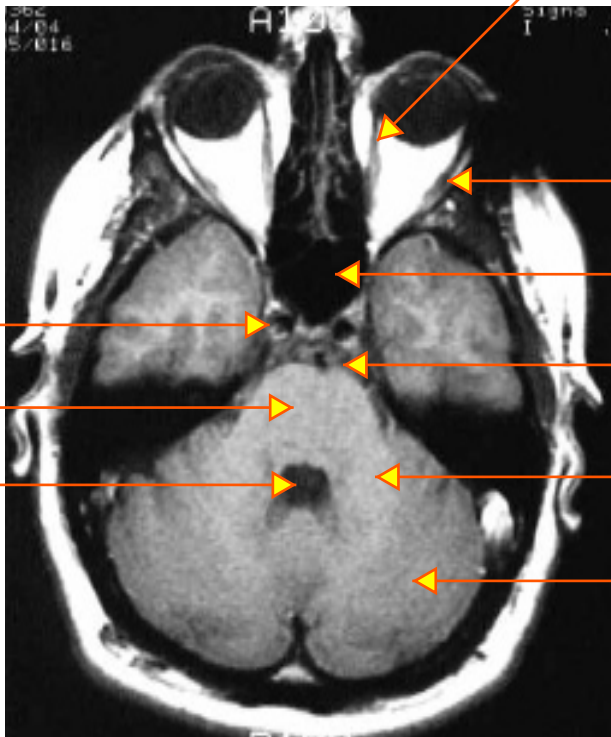


Fig 9. T1 Axial MRI. (From Rand Swenson Dartmouth Medical School)

MRI Correlation

Label these structures on Figure 10.

• optic chiasm	• optic tract
• pituitary stalk (infundibulum)	• middle cerebral artery
• mammillary body	• amygdala
• red nucleus	• superior colliculus
• cerebellar vermis	• midbrain
• orbital cortex	• occipital cortex

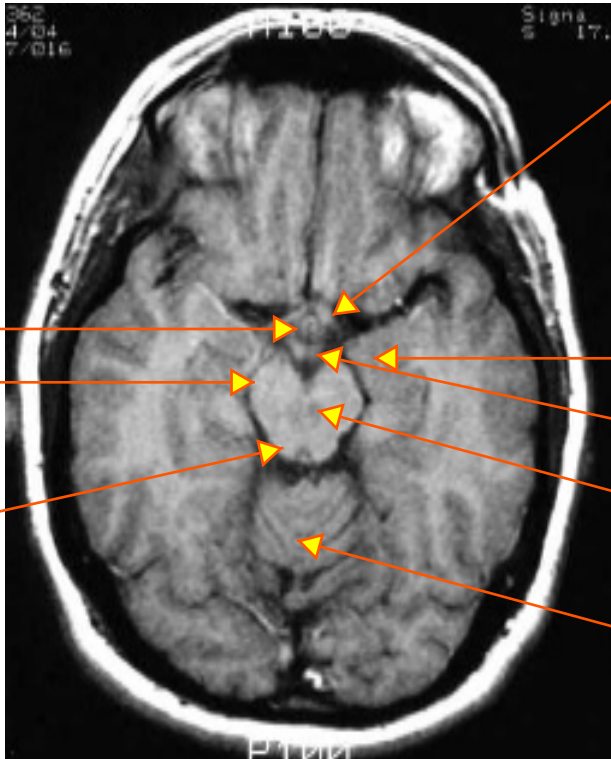


Fig 10. T1 Axial MRI. (From Rand Swenson
Dartmouth Medical School)

2. Can you diagram the neuroanatomy controlling horizontal, conjugate eye deviation?

3. How can you distinguish a lesion to the facial nerve from a lesion of corticobulbar projections to the facial nucleus?

4. Where is the internal genu of Cranial Nerve VII?

5. What functional components are associated with cranial nerves II, III, IV, VI and VII?