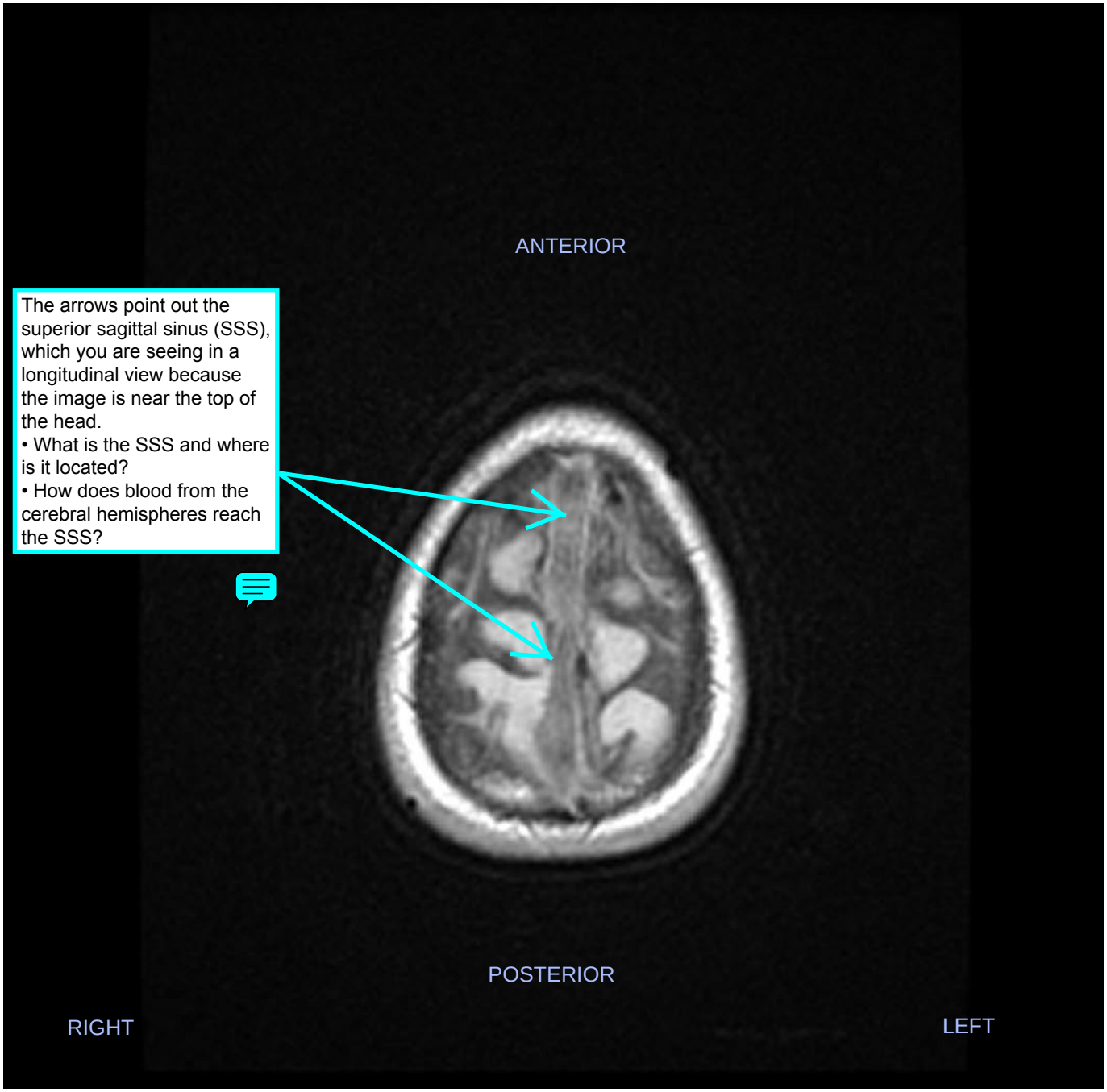
UMass Medical School
Mind Brain Behavior 1

Axial MRI 1



The arrows point out the superior sagittal sinus (SSS), which you are seeing in a longitudinal view because the image is near the top of the head.

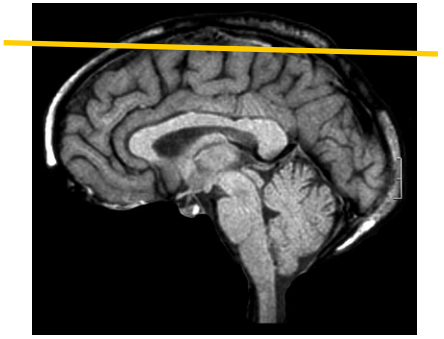
- What is the SSS and where is it located?
- How does blood from the cerebral hemispheres reach the SSS?

MRI (magnetic resonance imaging)

The goal of MRI imaging is to display differences in tissue contrast in order to achieve high resolution, high contrast views of the brain and spinal cord. Unlike conventional X-rays, structures can be made to look different in MRI depending on the technique used. Just as an example, CSF appears dark in T1 images but bright (hyperintense) in T2 images. There are many different techniques that can be used to accentuate particular components of nervous tissue, and clinicians select a combination of techniques depending on the particular patient and the goal of the study.

This axial atlas is made from T1 images. In T1 images the CSF appear dark because of its water content. You can confirm this for yourself by identifying the subarachnoid space in the next image in this Atlas.

MORE INFORMATION ABOUT MRI



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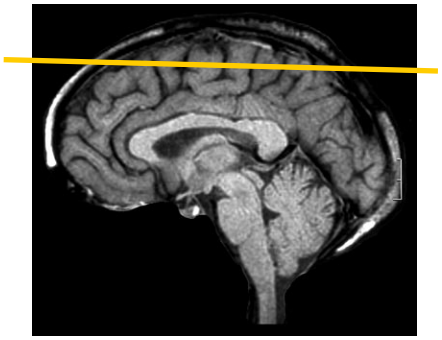
Axial MRI 2



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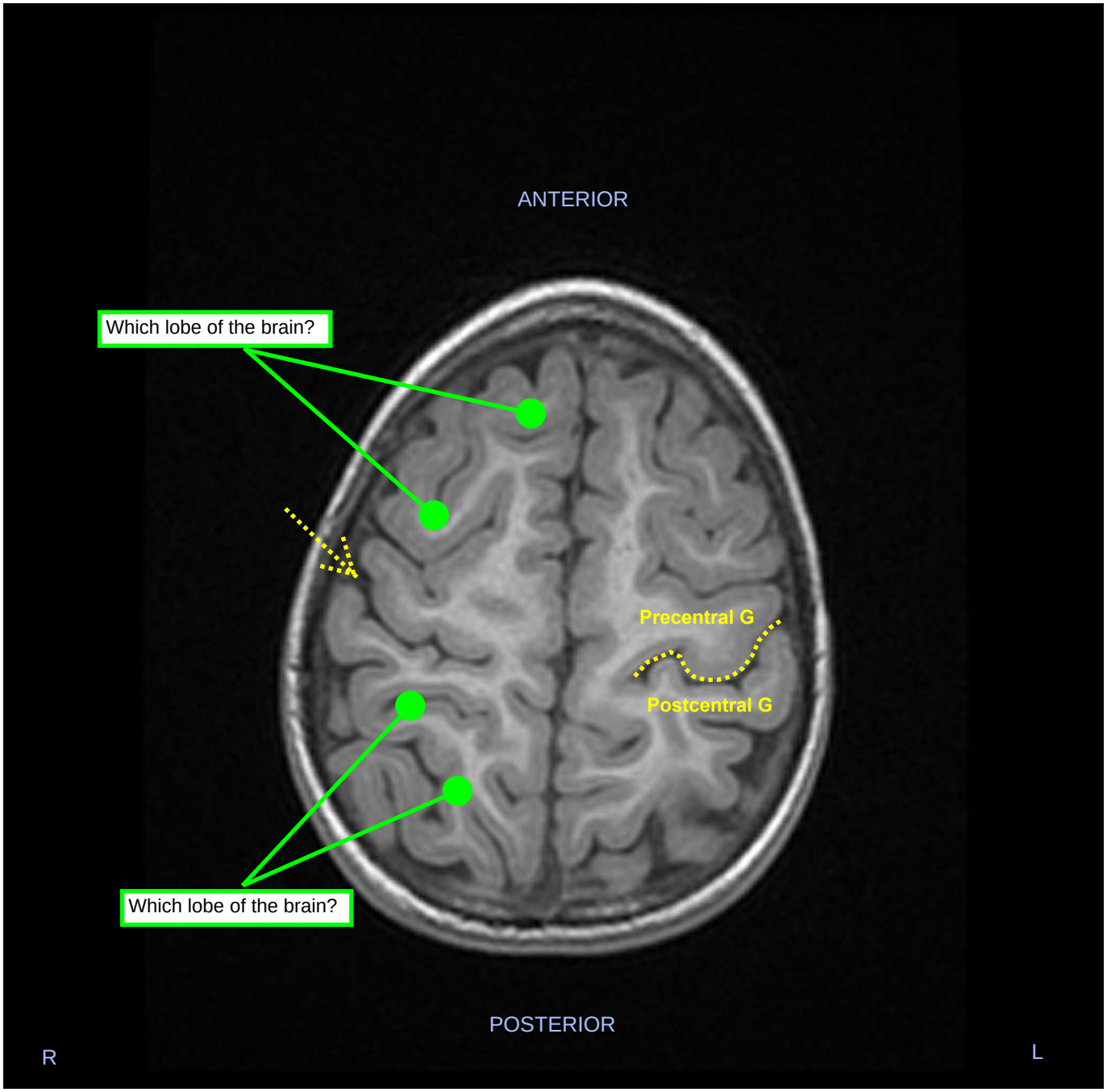
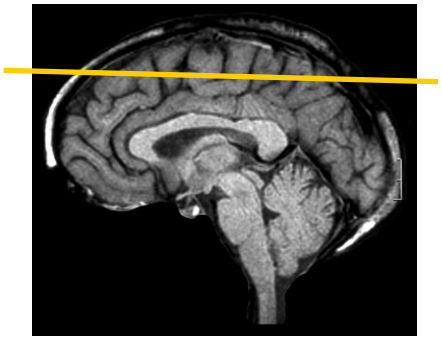
Axial MRI 3



The c**entral fissure** is traced by yellow dotted lines. We do not ask first-year medical students to make this identification. Using this landmark, find the precentral gyrus and postcentral gyrus on the left side of the brain where they are labeled, and right side where they are not.

- What is the functional role of the **precentral gyrus?**
- What is the functional role of the **postcentral gyrus?**



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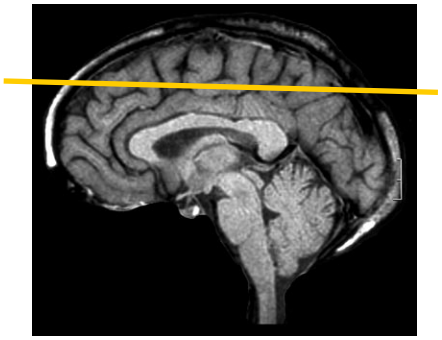
Axial MRI 4

In this T1-weighted MRI Atlas:

White matter is white or pale gray. (relatively higher fat/lipid content)

Gray matter is a darker gray. (relatively higher water content)

QUESTION: Decide whether each of the **red markers** indicates gray matter or white matter.



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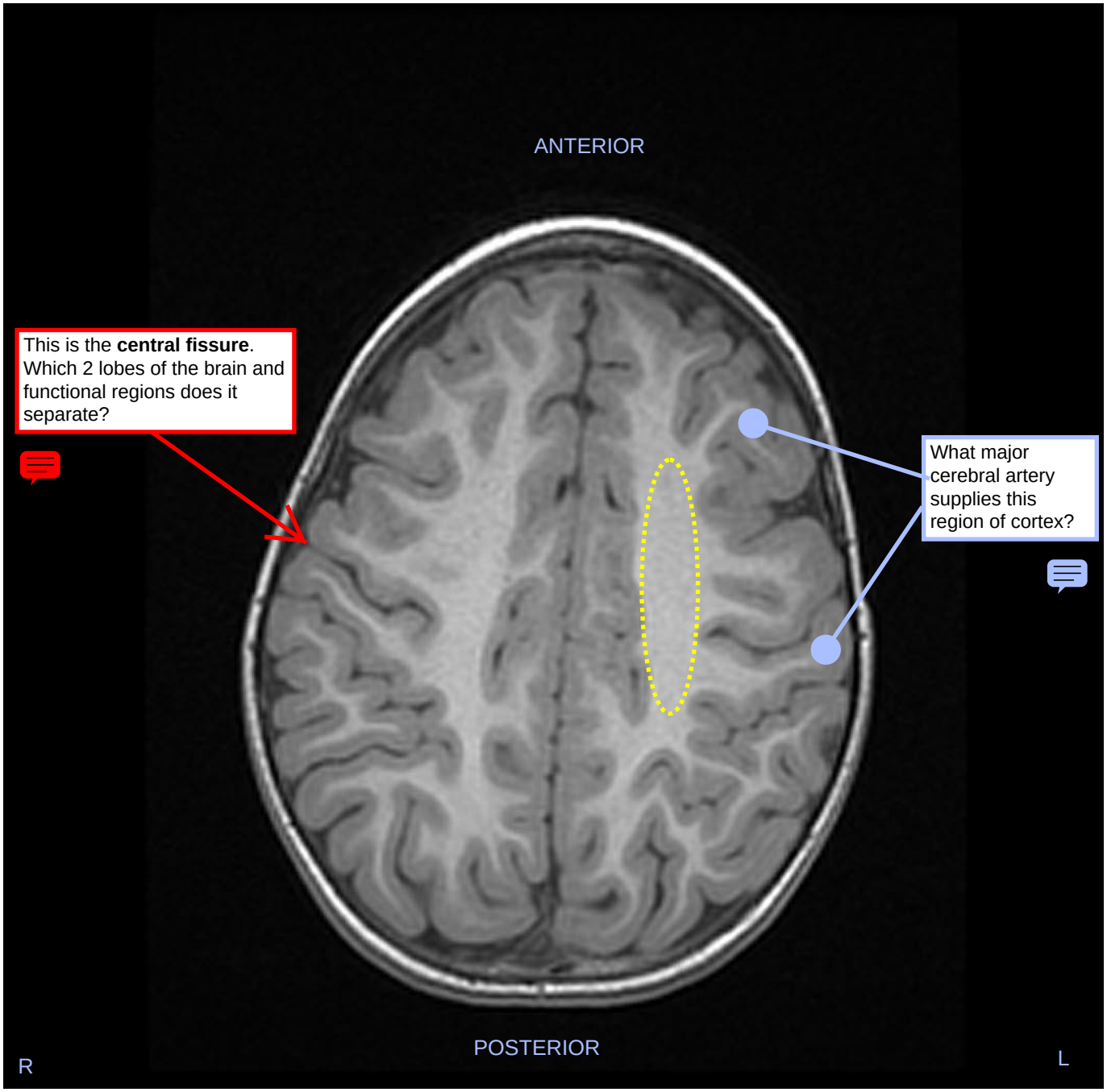
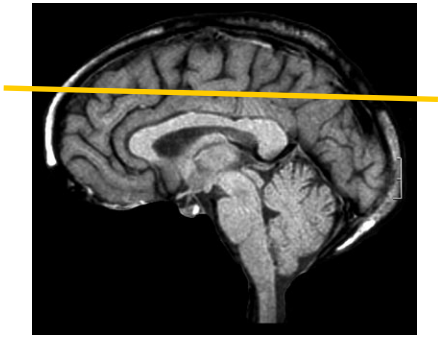
Axial MRI 5





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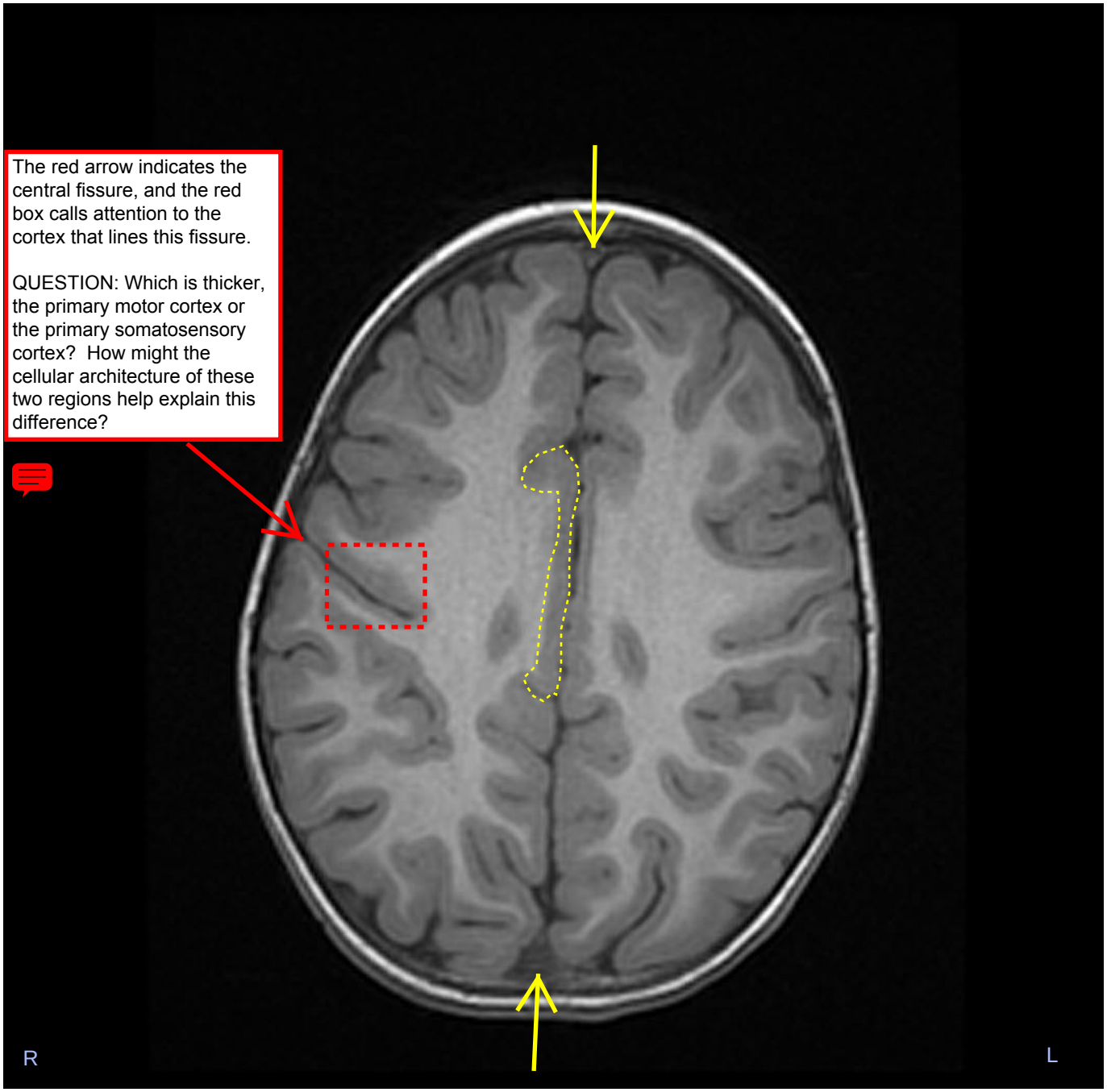
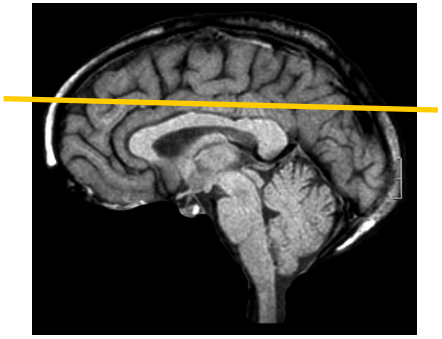
Axial MRI 6

The red arrow indicates the central fissure, and the red box calls attention to the cortex that lines this fissure.

QUESTION: Which is thicker, the primary motor cortex or the primary somatosensory cortex? How might the cellular architecture of these two regions help explain this difference?



Is the corpus callosum present in this section? If not, find the first page in this atlas where you can see it clearly.



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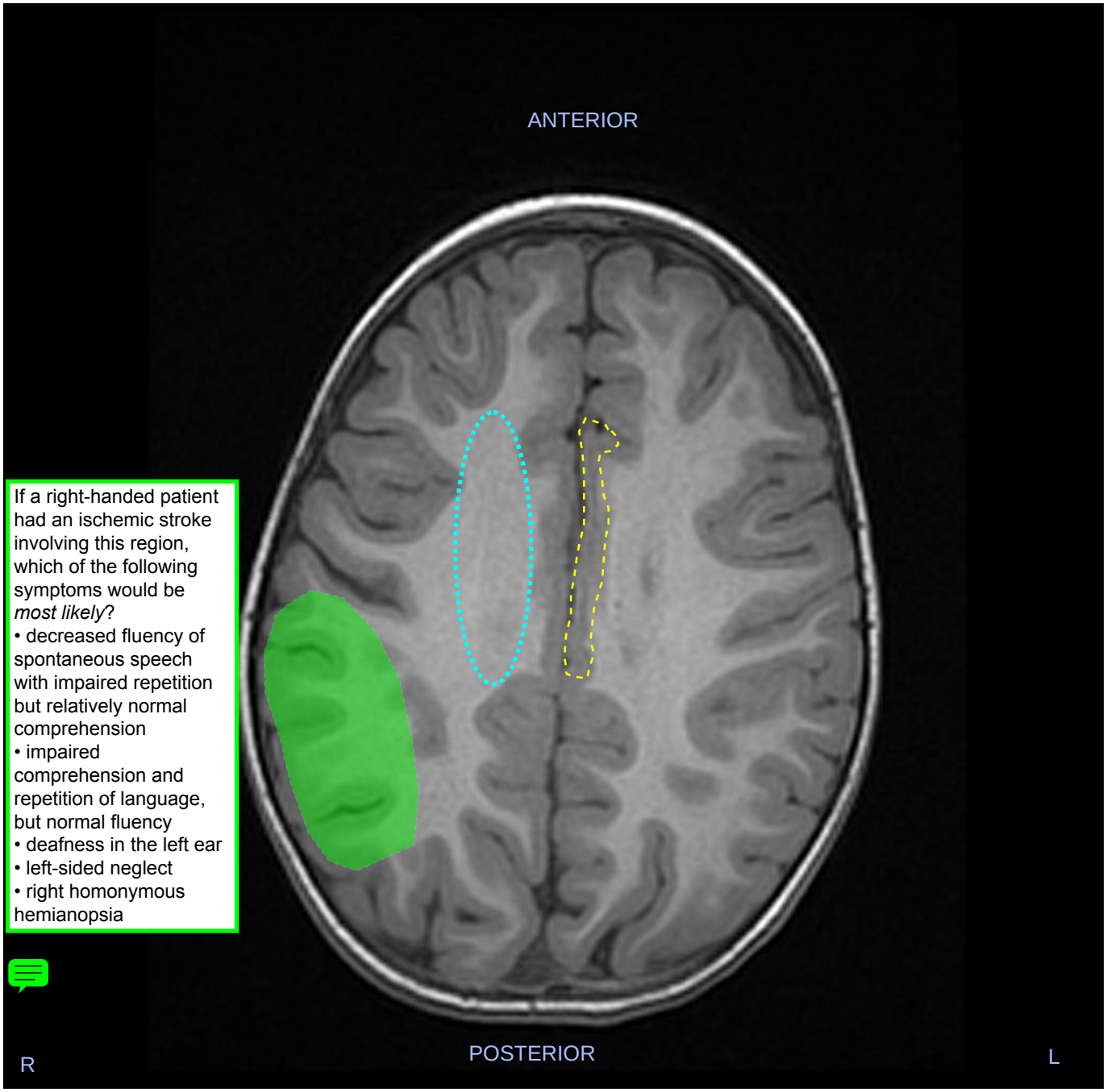
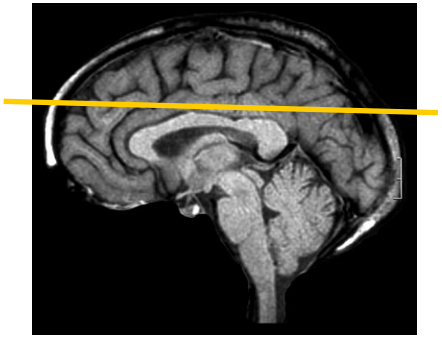
Axial MRI 7



If a right-handed patient had an ischemic stroke involving this region, which of the following symptoms would be *most likely*?

- decreased fluency of spontaneous speech with impaired repetition but relatively normal comprehension
- impaired comprehension and repetition of language, but normal fluency
- deafness in the left ear
- left-sided neglect
- right homonymous hemianopsia

It becomes increasingly difficult to identify the central fissure in axial images showing more inferior brain regions (atlas images 7 and beyond). If this were an actual patient case in which the central fissure had to be identified with certainty, the radiologist would likely use images formatted in the sagittal plane .



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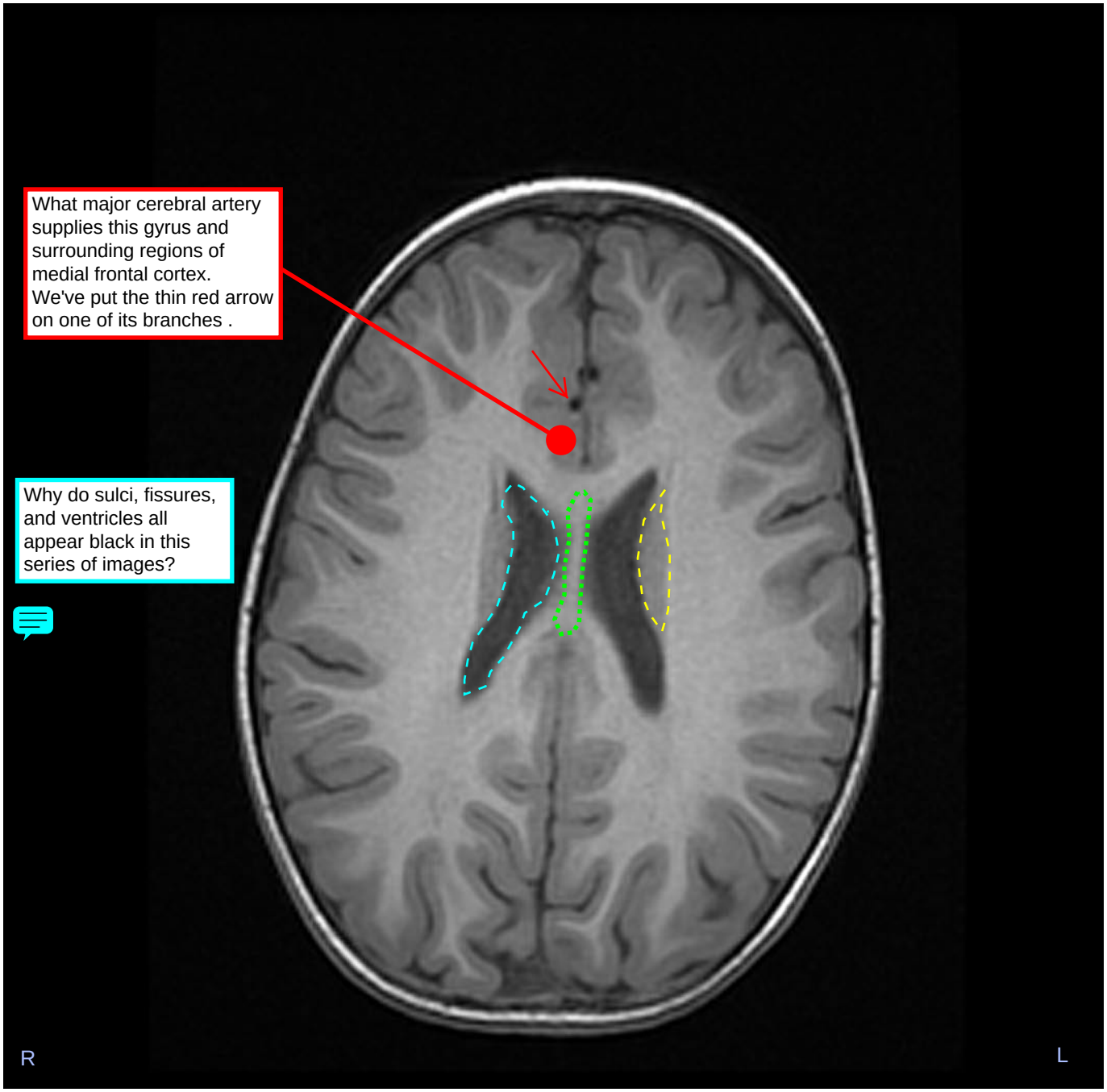
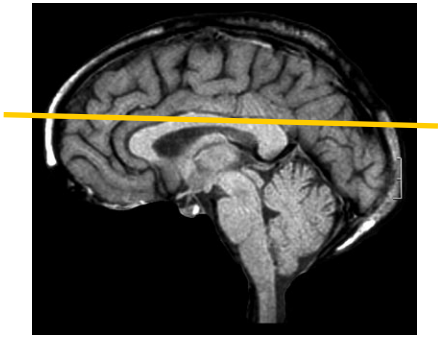
Axial MRI 8



The thalamus is not present in this section. Approximately where do you anticipate it will be located in axial images that show more inferior parts of the brain? Confirm your answer by examining pages 9 and 10.

In these T1 MRI images, rapidly flowing blood does not give a signal. So arteries, veins, and dural venous sinuses are black as long as their lumen contains rapidly flowing blood. However, if blood flow is slower and more irregular (as is sometimes the case with venous flow) the signal can be a mixture of black and white densities. Finally, if there is a fresh thrombus that is completely occluding a major artery, the site of blockage can sometimes be identified by its characteristic white appearance.

The small red arrow points to a circular black profile indicating a medium-size arterial branch.



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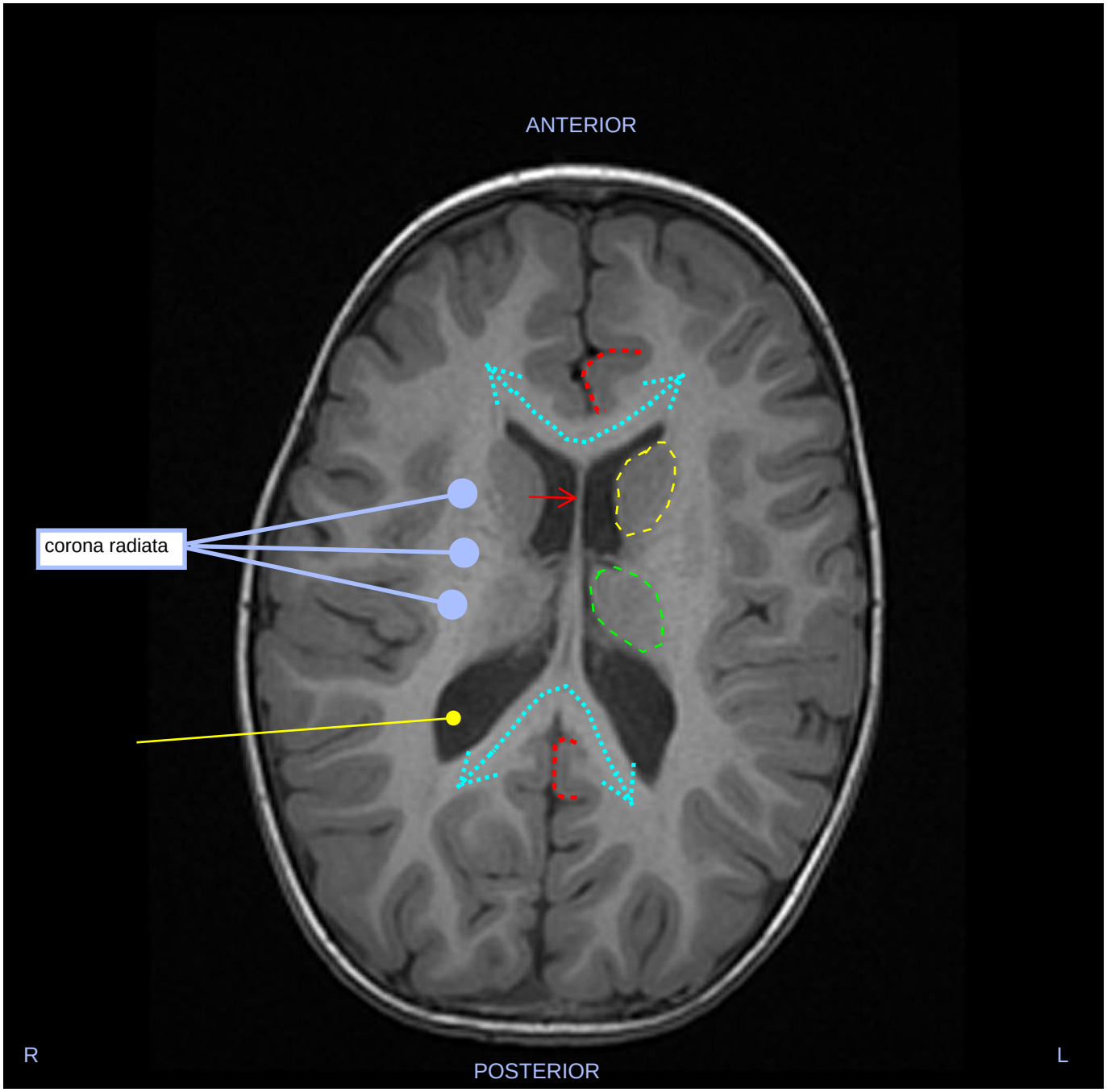
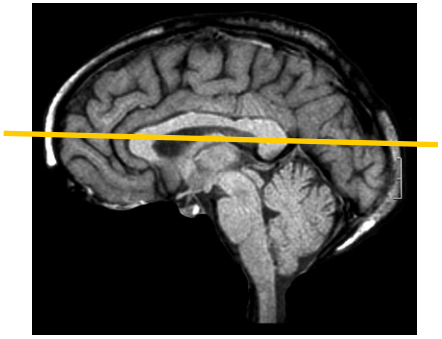
Axial MRI 9



At this level, the white matter lateral to the caudate and thalamus is called the **corona radiata** (labeled on the right side of brain)**.** It contains thousands of axons that are traveling to or from the internal capsule.

The name corona radiata (radiating crown) describes the trajectory of these axons as they fan out to reach the lateral and medial cortical regions from which they arise or in which they synapse. However in this image you see them collectively as a uniform-appearing white matter region.

Note that the same axons are given different descriptive names along their course. In more inferior levels (images 10, 11, 12), axons of the **corona radiata** will form a major part of the **internal capsule** (details in image 12). At more superior levels (images 8,7,6), axons of the corona radiata will form part of the **centrum semiovale**.



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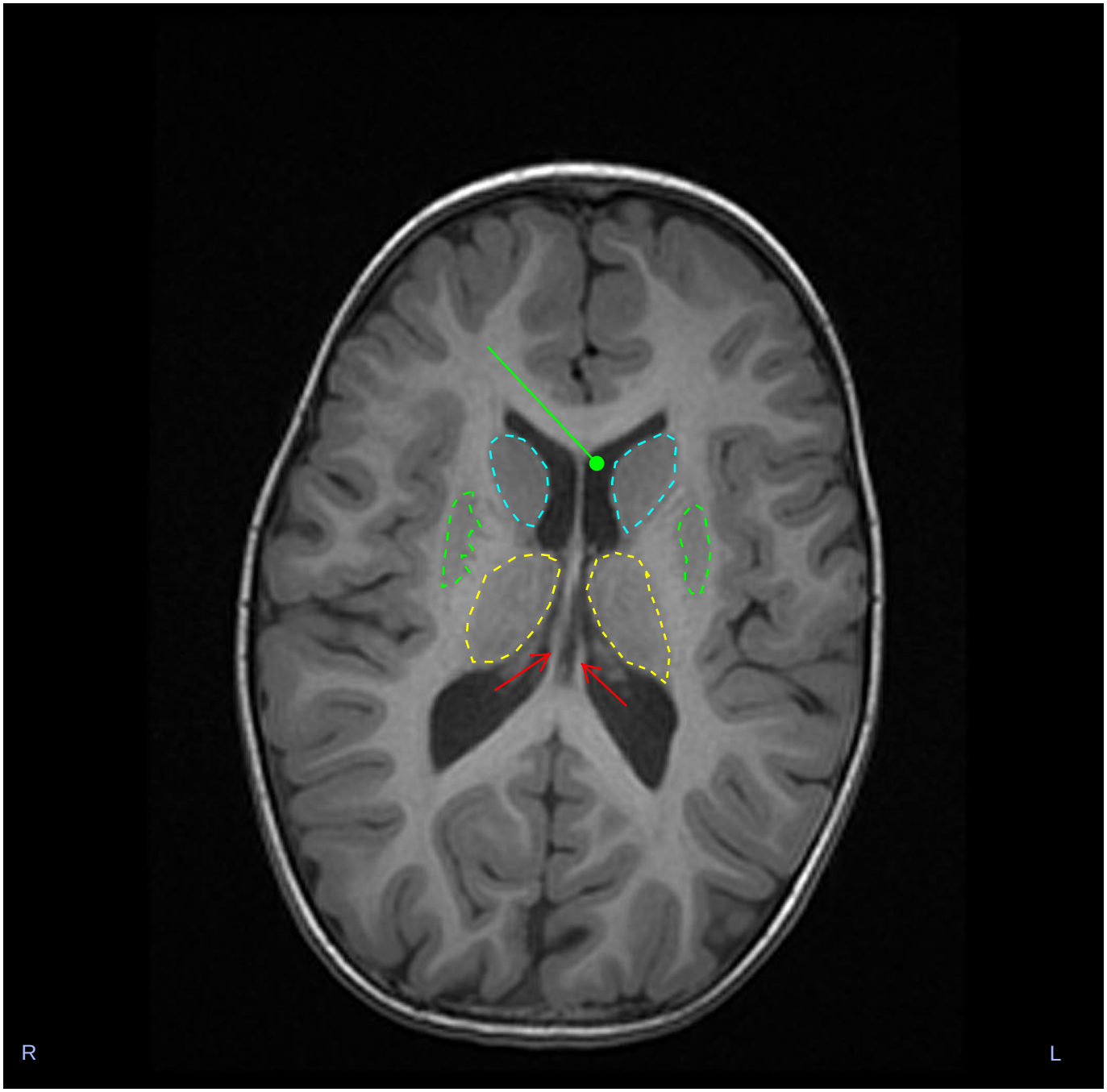
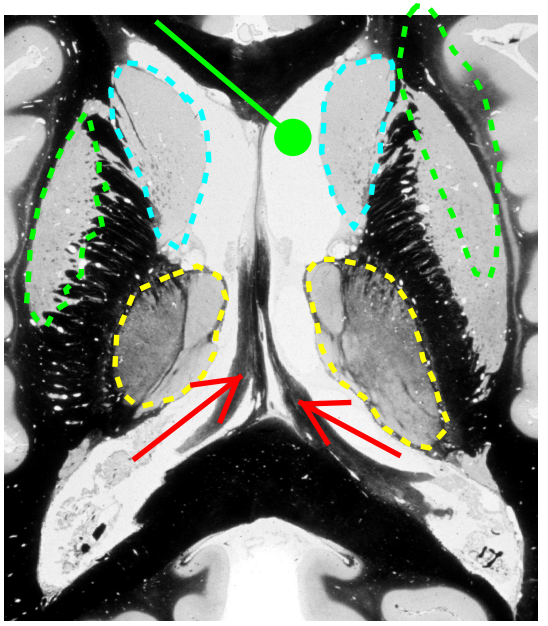
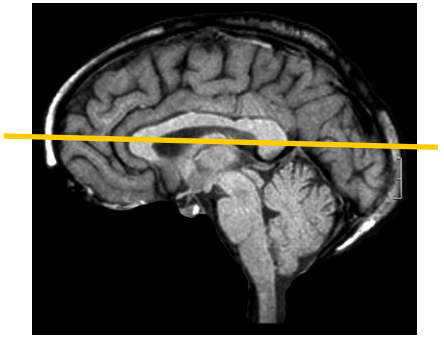
Axial MRI 10



The entire **thalamus** is circled in this image. Please be sure that you have located it. Currently, identification of specific thalamic nuclei in MRI images isn't usual practice. However, you will probably find that you can pick out some individual thalamic nuclei because of their distinctive shapes or locations.



Myelin-stained section demonstrating the same major structures shown by MRI.



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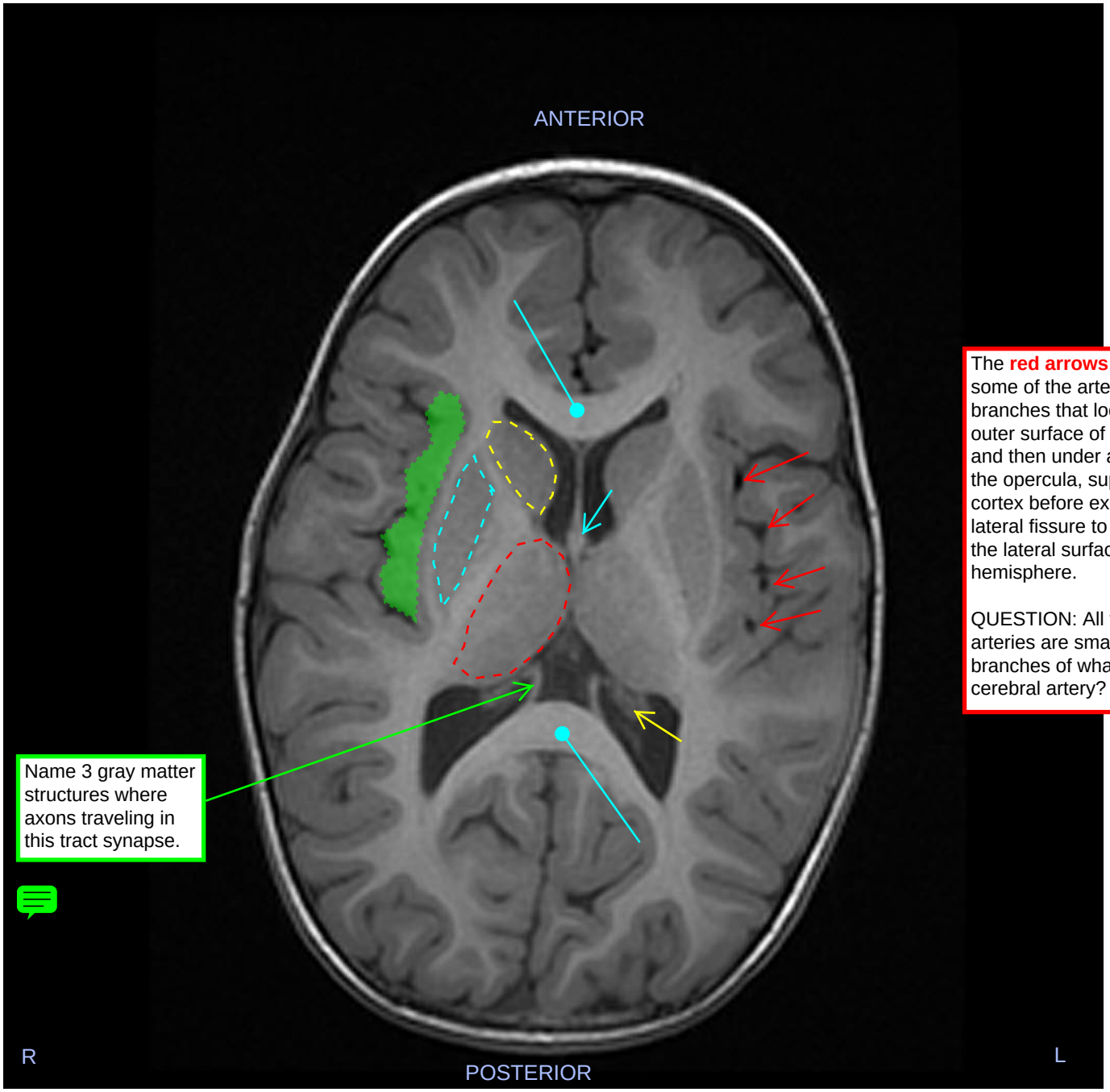
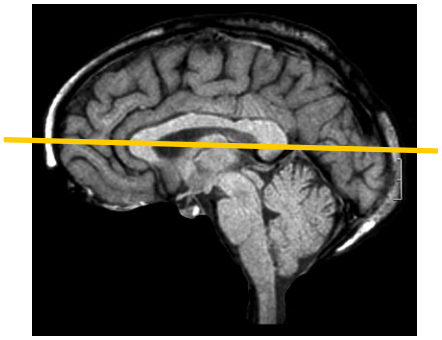
Axial MRI 11



The **red arrows** point out some of the arterial branches that loop over the outer surface of the insula and then under and around the opercula, supplying that cortex before exiting the lateral fissure to travel on the lateral surface of the hemisphere.

QUESTION: All these arteries are smaller branches of what major cerebral artery?

Name 3 gray matter structures where axons traveling in this tract synapse.



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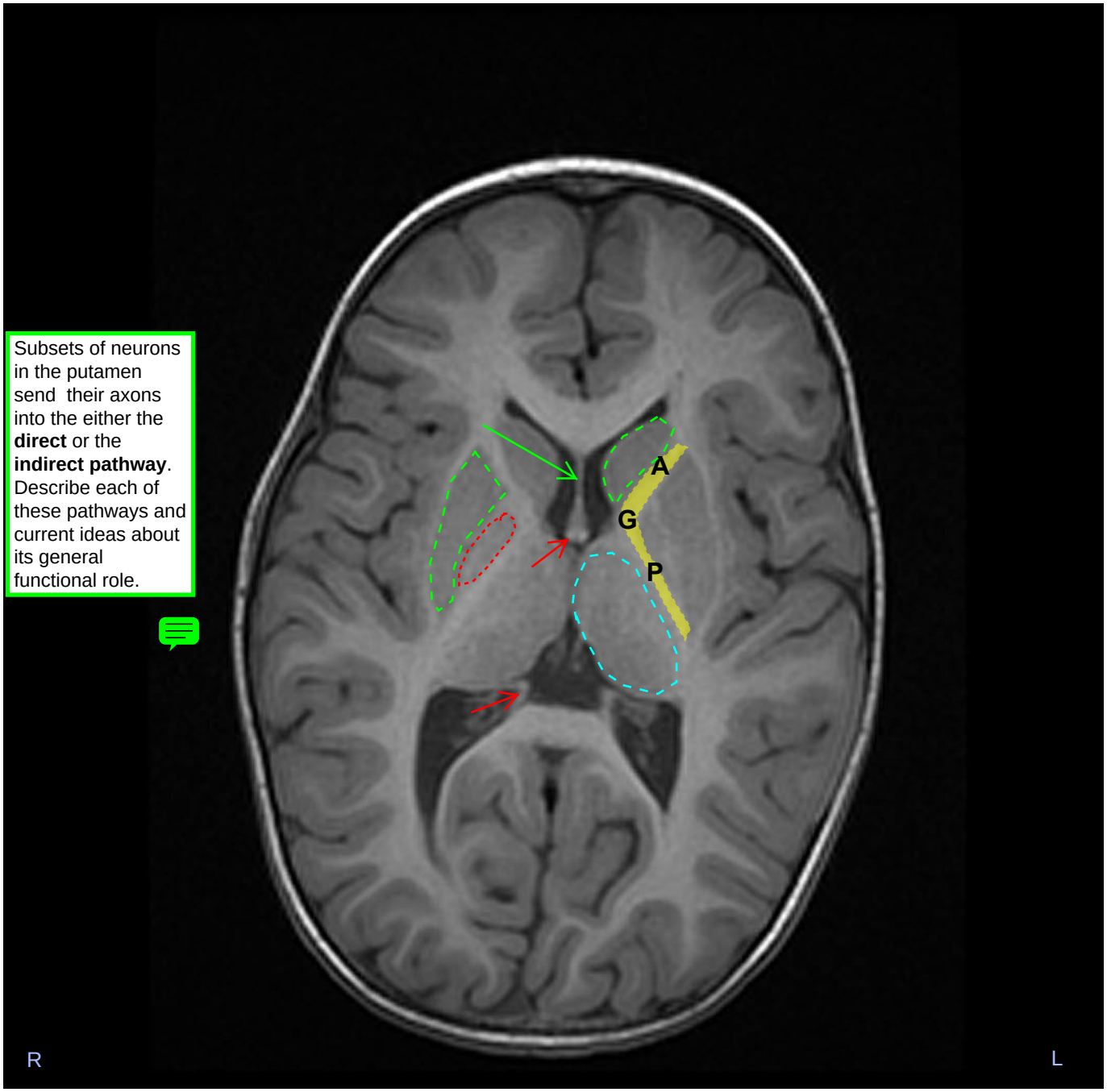
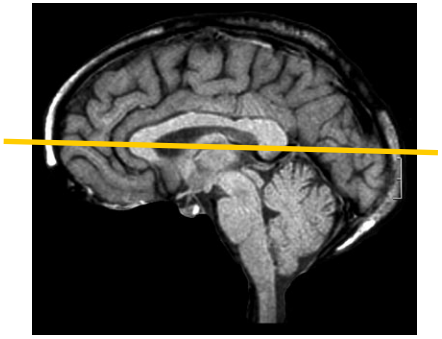
Axial MRI 12



Subsets of neurons in the putamen send their axons into the either the **direct** or the **indirect pathway**. Describe each of these pathways and current ideas about its general functional role.

The **internal capsule** is indicated in yellow. This white matter is made up of thousands of axons that carry information between the thalamus and cerebral cortex (thalamocortical axons and corticothalamic axons), and axons originating in the cortex that travel to subcortical structures in the brainstem (e.g., cranial nerve nuclei, griseum pontis, red nucleus, reticular formation) and the spinal cord.

In this image three regions of the internal capsule have been labeled: the anterior limb (A), the genu (G) and the posterior limb (P). QUESTION: For each region, identify the structures that are located immediately medial and immediately lateral.



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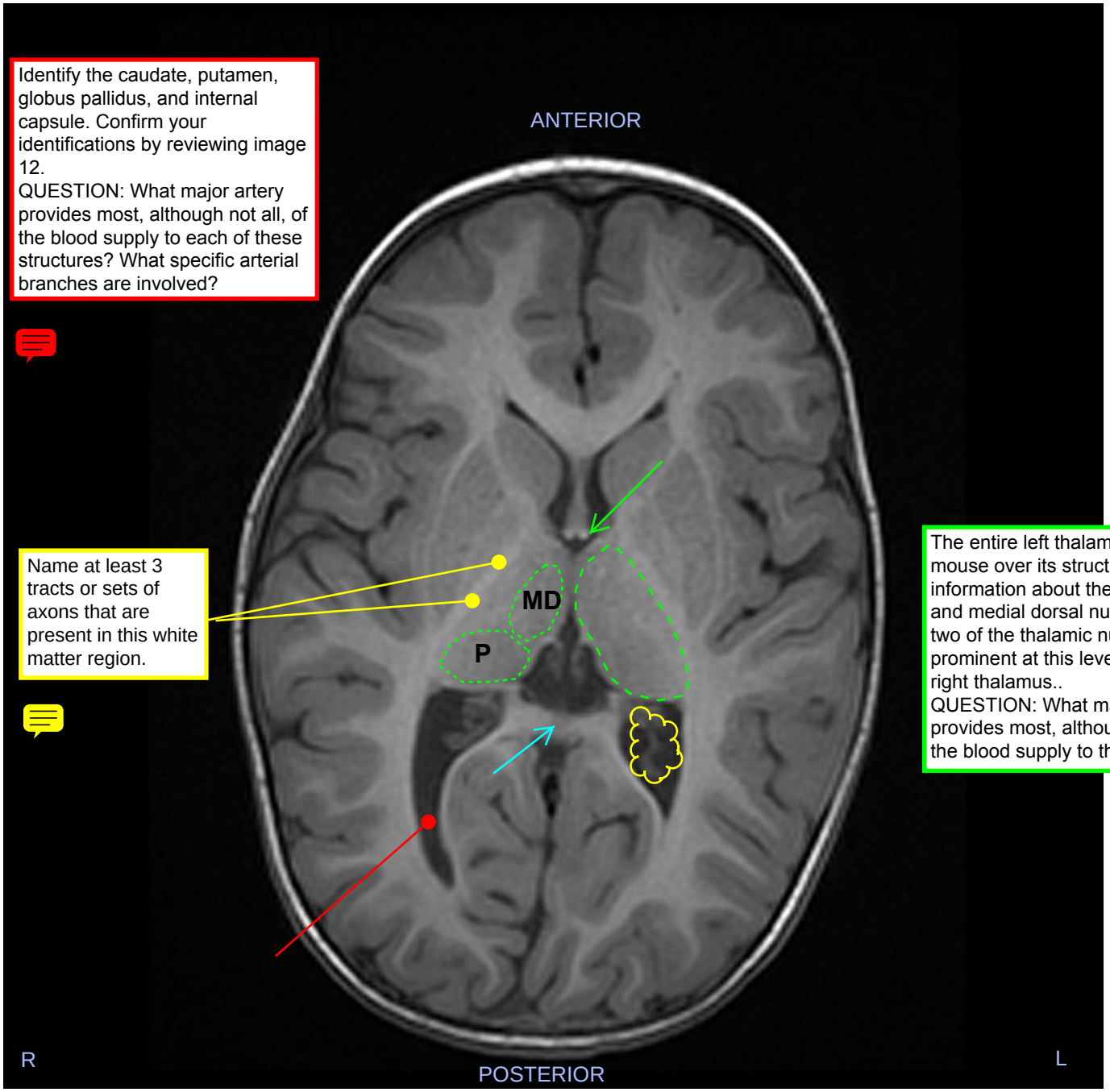
Axial MRI 13

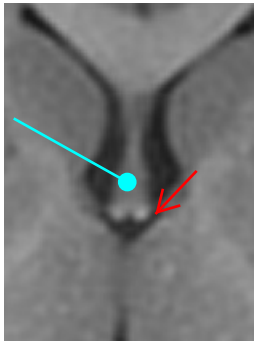
Identify the caudate, putamen, globus pallidus, and internal capsule. Confirm your identifications by reviewing image 12.
QUESTION: What major artery provides most, although not all, of the blood supply to each of these structures? What specific arterial branches are involved?



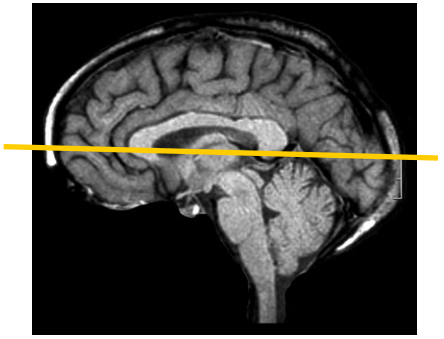
Name at least 3 tracts or sets of axons that are present in this white matter region.

The entire left thalamus is circled, mouse over its structure outline for information about the pulvinar (P) and medial dorsal nucleus (MD), two of the thalamic nuclei that are prominent at this level (outlined in right thalamus..
QUESTION: What major artery provides most, although not all, of the blood supply to the thalamus?

This image shows the **interventricular foramen** (foramen of Monro), the slender connection between each lateral ventricle and the third ventricle (red arrow).



The blue dot indicates the septal area. The two bright white dots within it are the left and right fornix.



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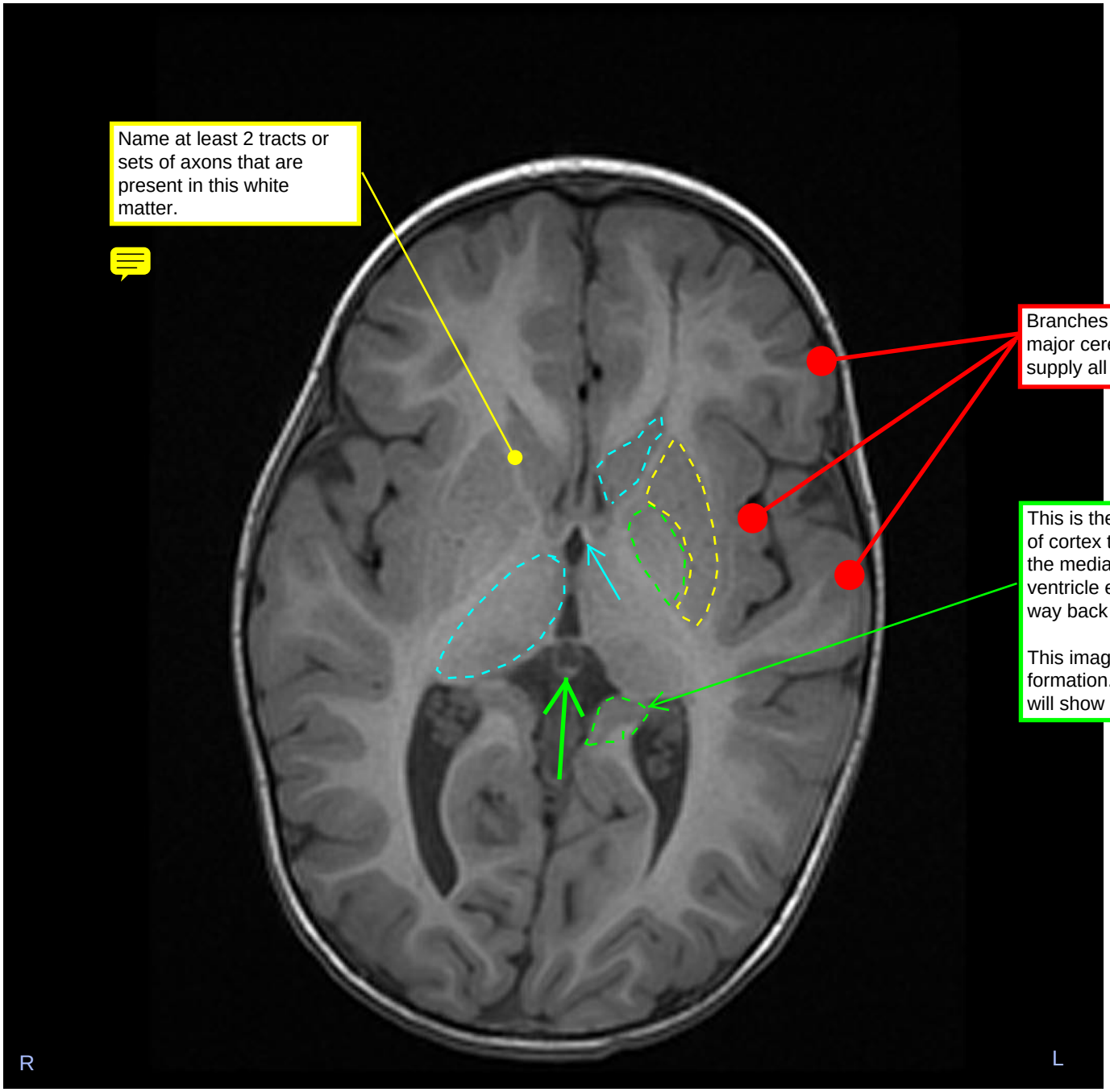
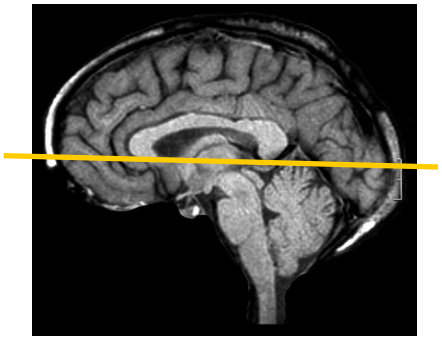
Axial MRI 14





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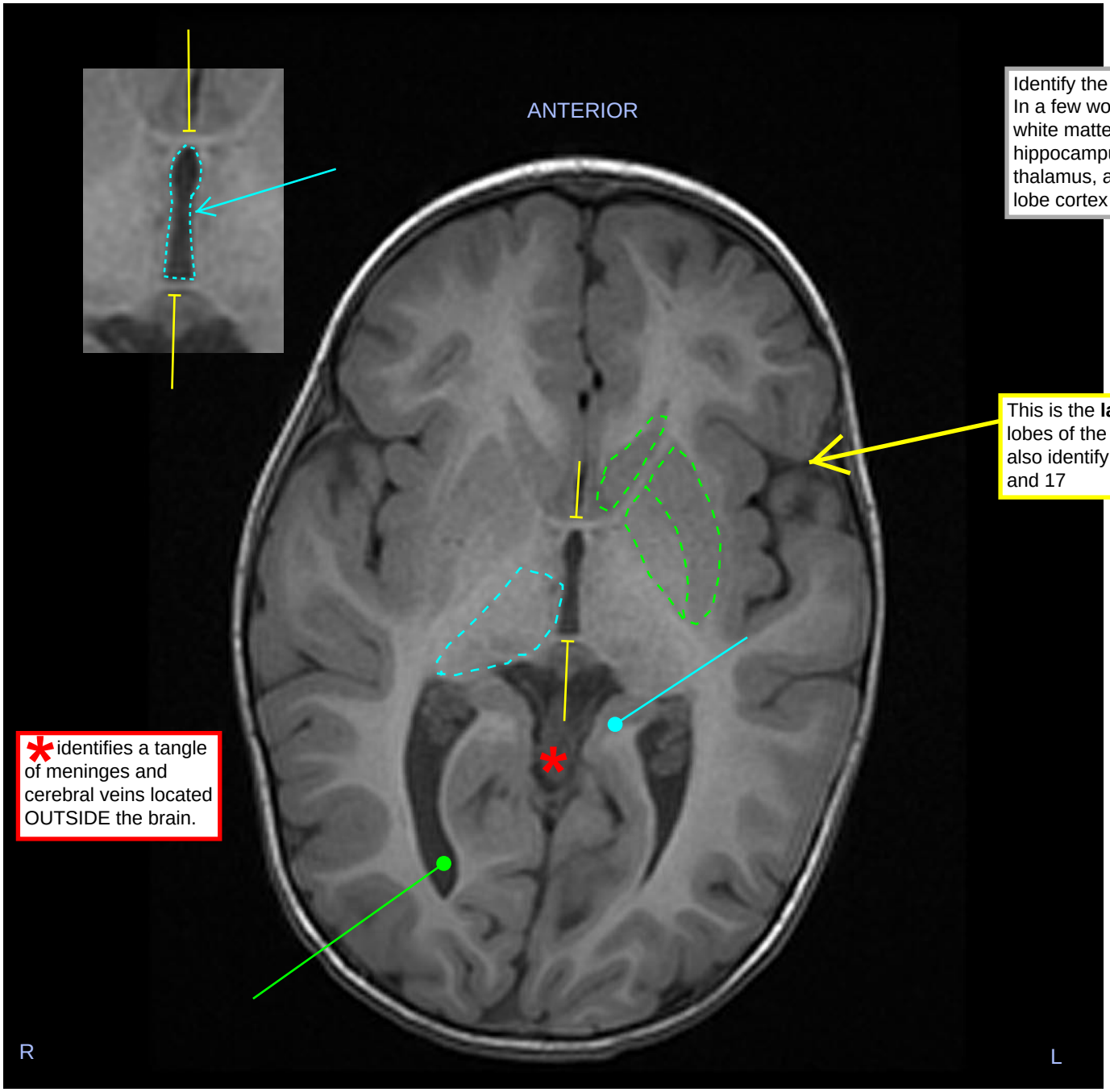
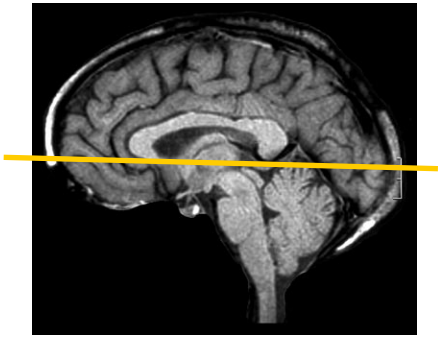
Axial MRI 15



Identify the **hippocampus** at this level and check your accuracy. In a few words, what is the major role of the hippocampus? What white matter pathway carries most of the outputs from the hippocampus to frontal lobe cortex, septal area, hypothalamus, thalamus, and rostral brainstem? What region of medial temporal lobe cortex provides the majority of its inputs?

This is the **lateral (Sylvian) fissure**. Which lobes of the brain does it separate? You can also identify the lateral fissure in images 16 and 17

* identifies a tangle of meninges and cerebral veins located OUTSIDE the brain.



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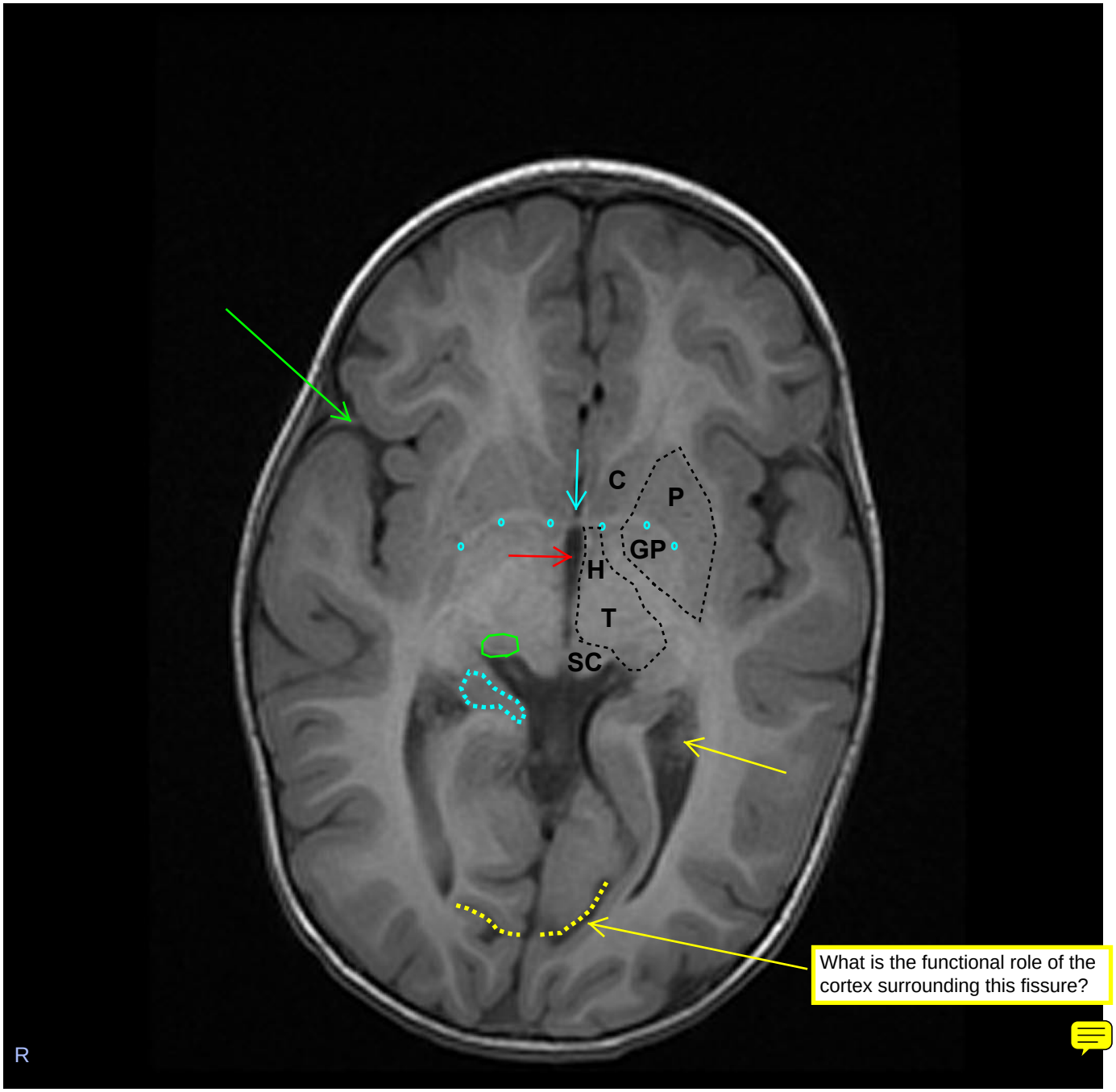
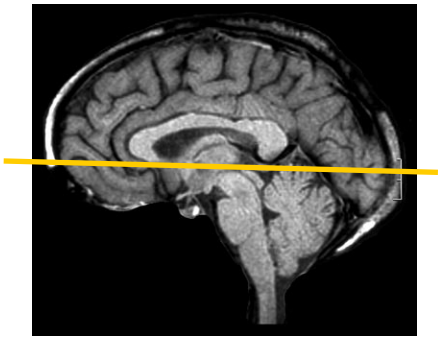
Axial MRI 16



This level is quite difficult to interpret, so key structures have been labeled. Beginning anterior, the section includes the caudate (C), putamen (P), and GP (globus pallidus). Identify the anterior commissure and confirm your answer.

Surrounding the third ventricle (green arrow), are parts of the hypothalamus (H) and thalamus (T). In the posterior right thalamus, the medial geniculate nucleus is circled. The section also includes the superior colliculus (SC) of the midbrain.



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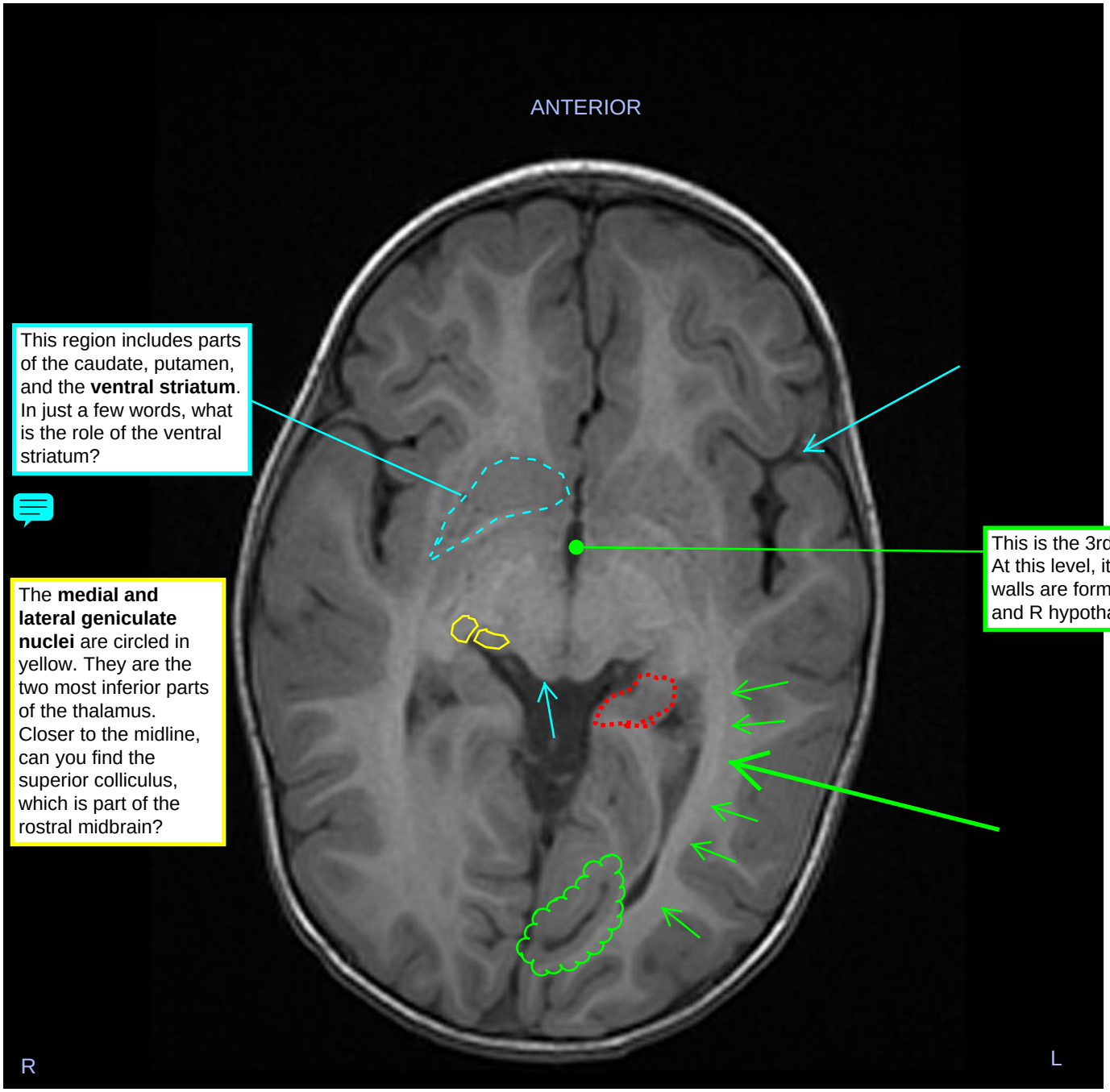
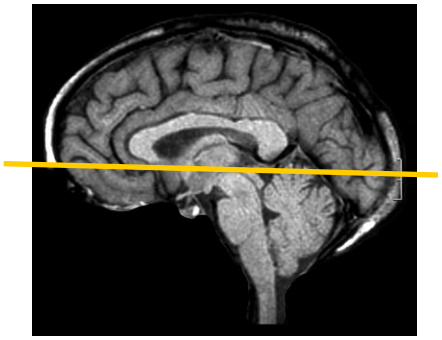
Axial MRI 17



This region includes parts of the caudate, putamen, and the **ventral striatum**. In just a few words, what is the role of the ventral striatum?

The **medial and lateral geniculate nuclei** are circled in yellow. They are the two most inferior parts of the thalamus. Closer to the midline, can you find the superior colliculus, which is part of the rostral midbrain?

This is the 3rd ventricle. At this level, its lateral walls are formed by the L and R hypothalamus



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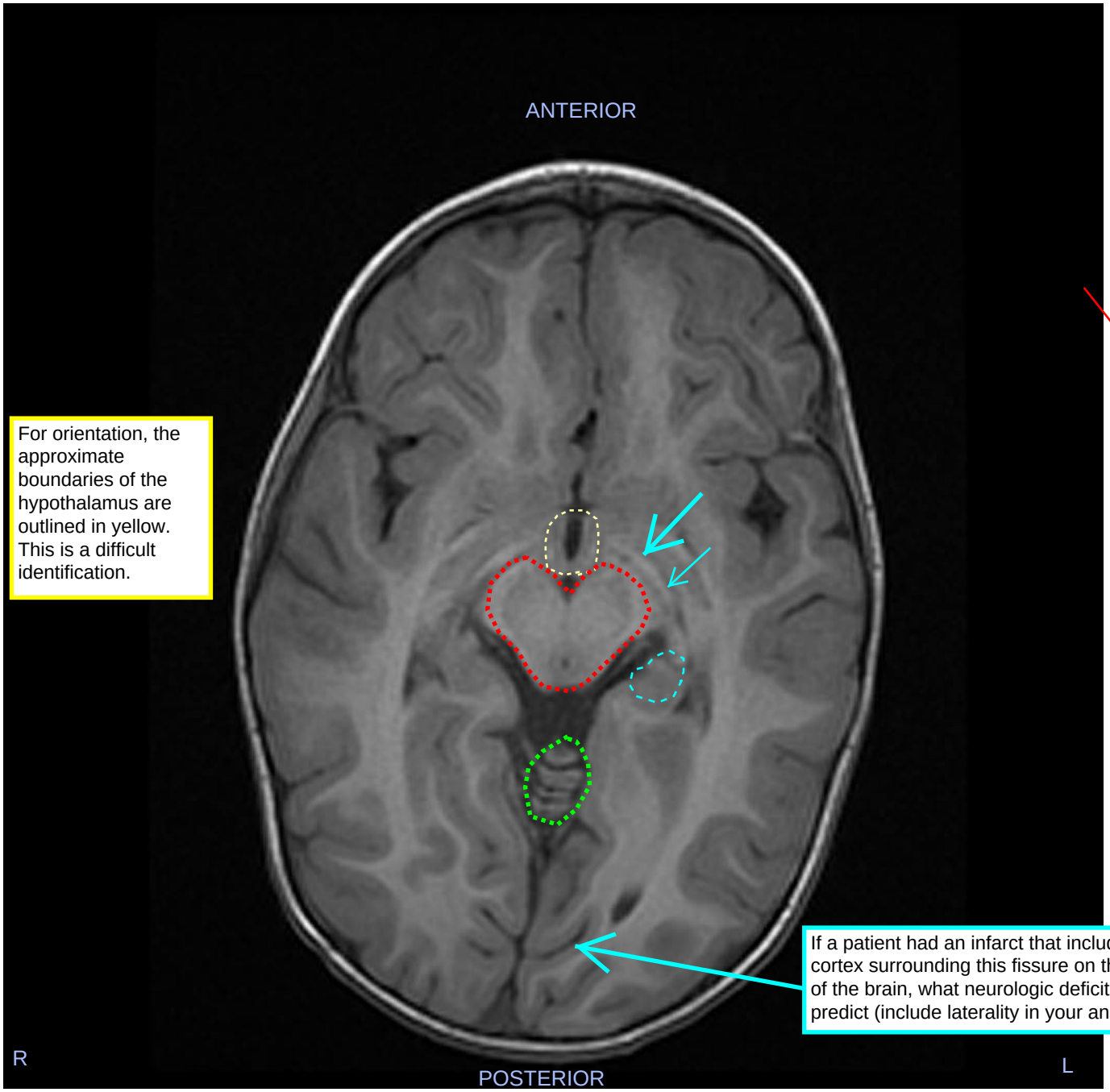
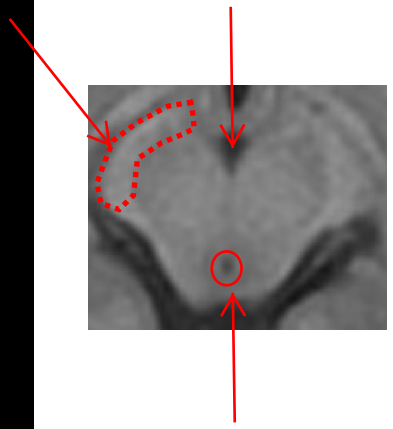
Axial MRI 18

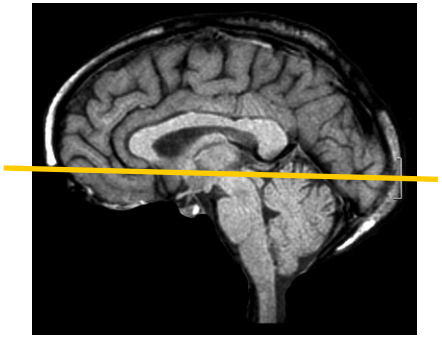


For orientation, the approximate boundaries of the hypothalamus are outlined in yellow. This is a difficult identification.

If a patient had an infarct that included all the cortex surrounding this fissure on the left side of the brain, what neurologic deficit would you predict (include laterality in your answer)



Midbrain profile: V-shape interpeduncular fossa anterior, and tiny circular cerebral aqueduct posterior.



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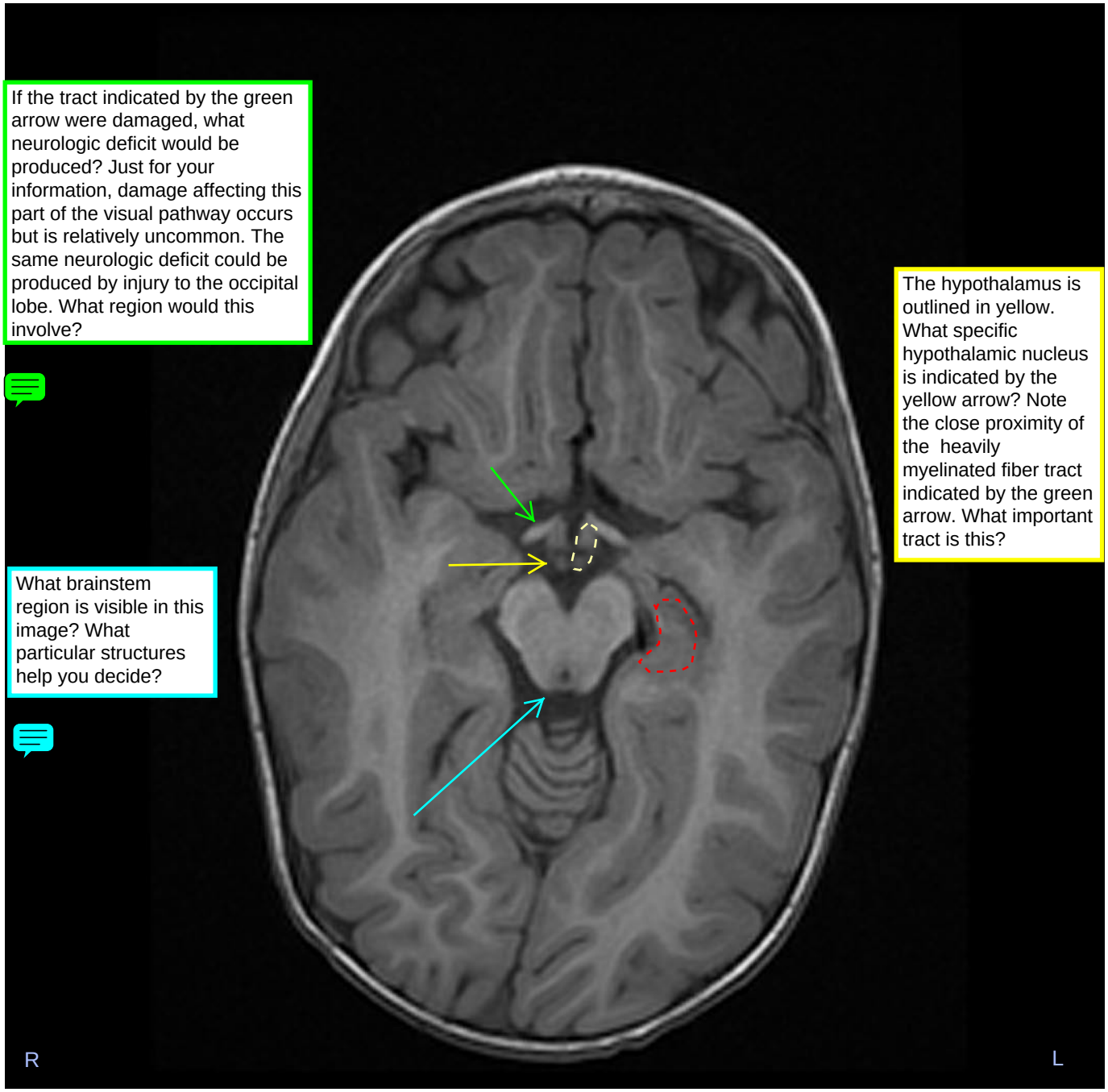
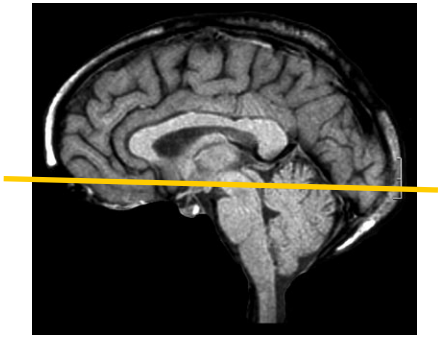
Axial MRI 19

If the tract indicated by the green arrow were damaged, what neurologic deficit would be produced? Just for your information, damage affecting this part of the visual pathway occurs but is relatively uncommon. The same neurologic deficit could be produced by injury to the occipital lobe. What region would this involve?

The hypothalamus is outlined in yellow. What specific hypothalamic nucleus is indicated by the yellow arrow? Note the close proximity of the heavily myelinated fiber tract indicated by the green arrow. What important tract is this?

What brainstem region is visible in this image? What particular structures help you decide?





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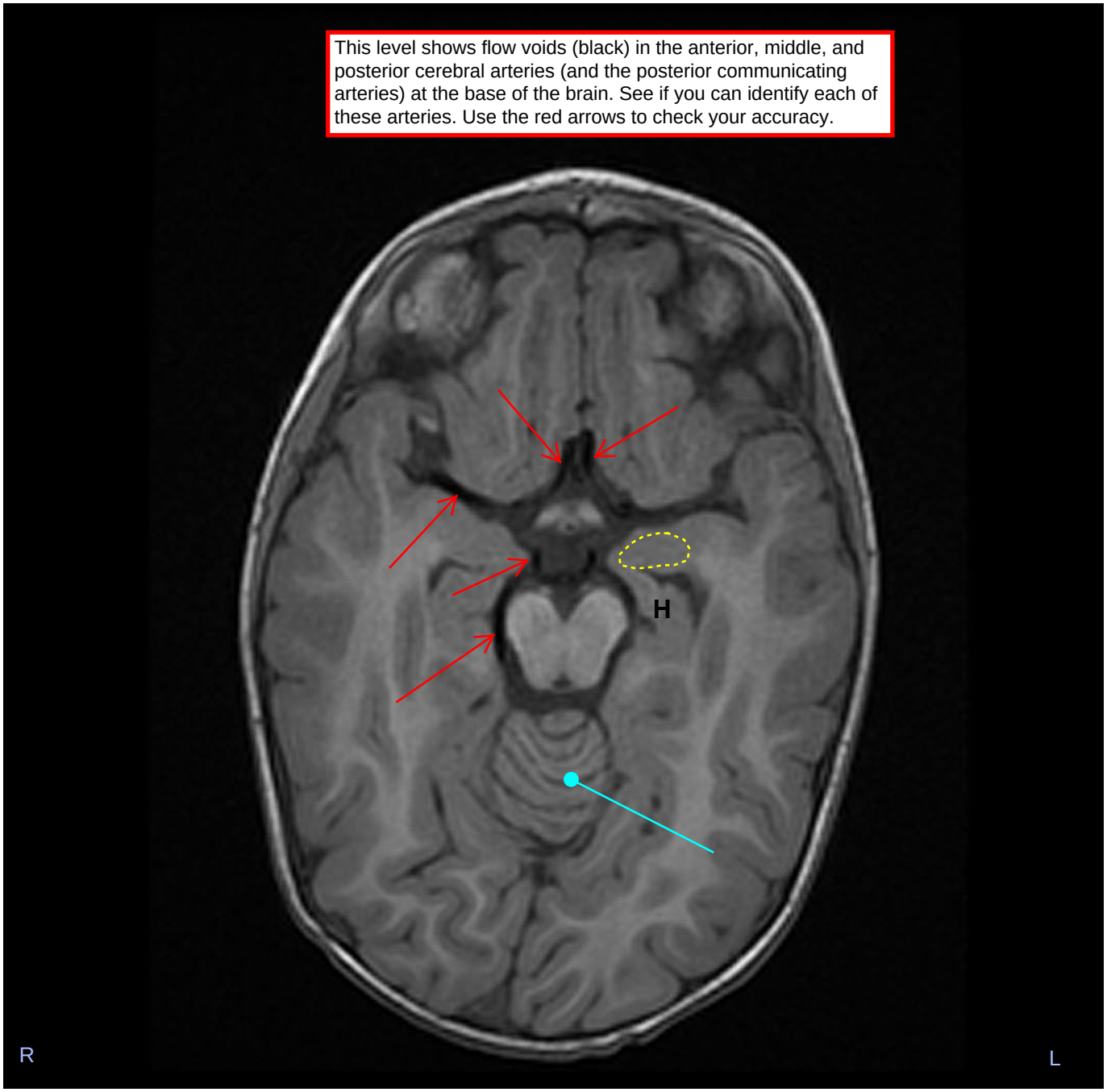
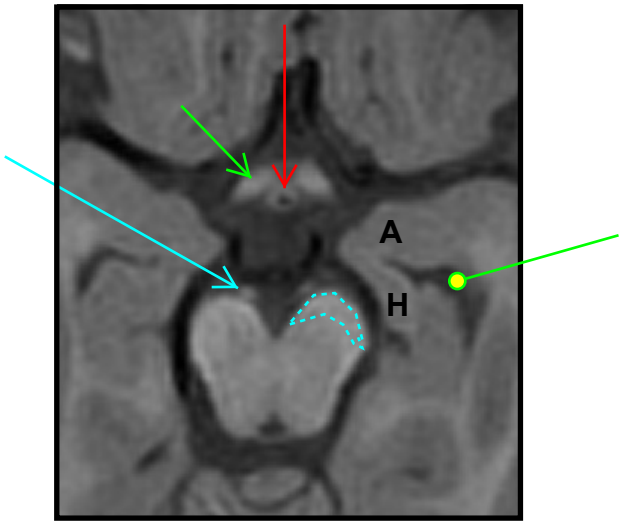
Axial MRI 20

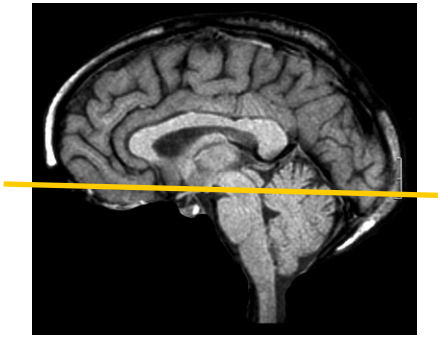
This level shows flow voids (black) in the anterior, middle, and posterior cerebral arteries (and the posterior communicating arteries) at the base of the brain. See if you can identify each of these arteries. Use the red arrows to check your accuracy.



The **oculomotor nerve** (CN3) is visible near the ventral surface of the midbrain. Identifying it is beyond the scope of most basic neuroscience courses, but if you're interested in trying, confirm your answer using the enlarged image below.
QUESTION: If the right CN3 has ceased all normal function, what signs and symptoms might you anticipate? (One reason this might occur is severe compression by an aneurysm arising from the junction of the basilar artery and the right PCA.)



The red arrow points to the pituitary stalk. The shorter green arrow indicates part of the optic chiasm (image 21 shows this relationship too).



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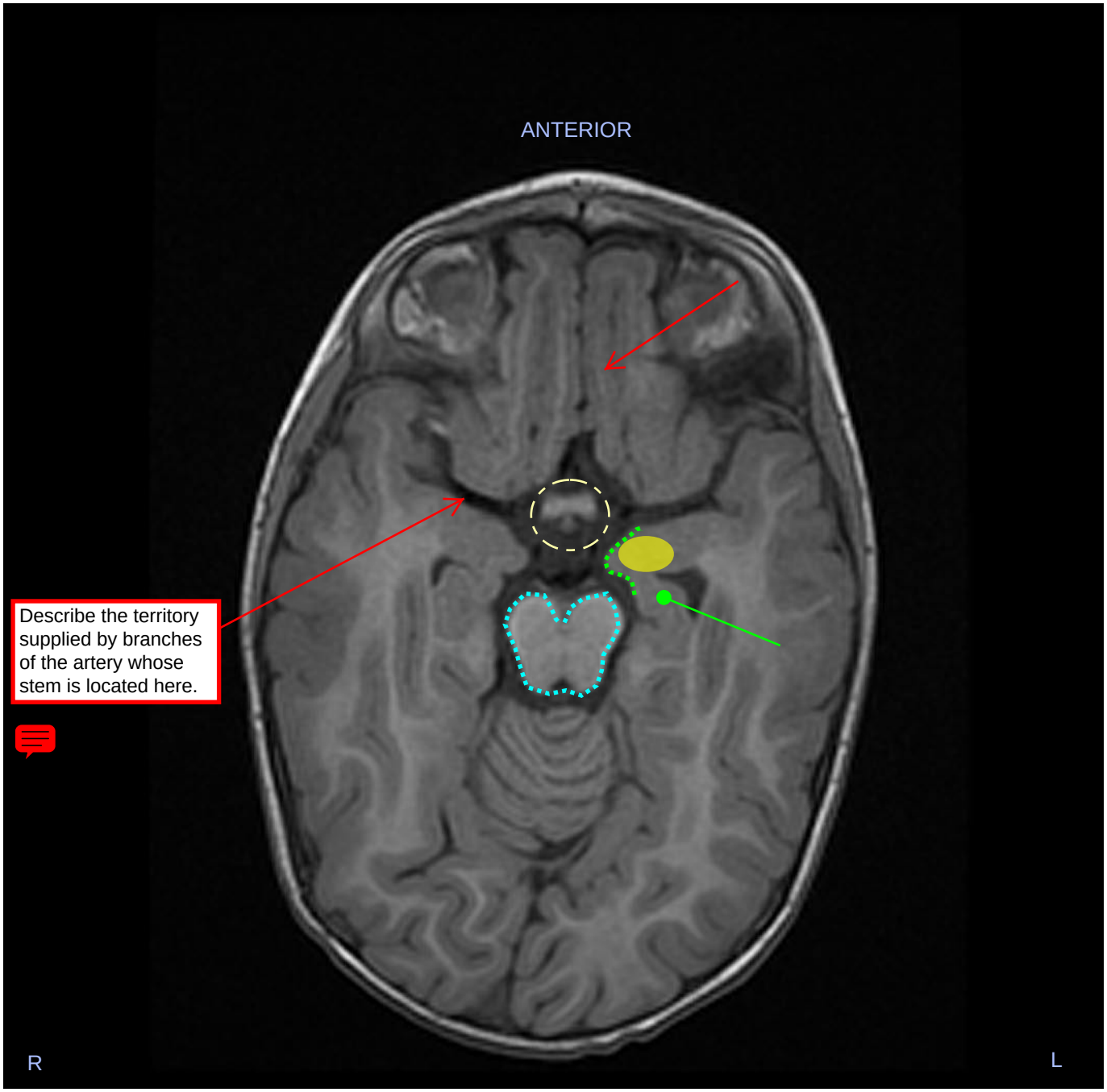
Mind Brain Behavior 1

Axial MRI 21



Describe the territory supplied by branches of the artery whose stem is located here.

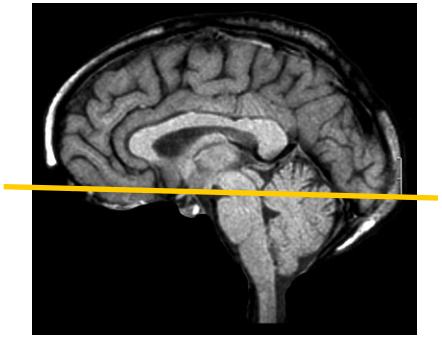
Use this image to review what can happen if intracranial pressure is increased because of a space-filling mass such as tumor, hemorrhage or cerebral edema and the **uncus (**or less frequently another part of the medial temporal lobe) is pushed inferior, through the tentorial notch, causing midbrain compression.

The uncus is outlined in **green** on the image.

Clinical signs of uncal herniation typically include hemiplegia, a dilated and unresponsive pupil and impaired eye movements, and decreased levels of consciousness. For each, what anatomic structure is directly involved?

Sometimes the posterior cerebral artery is compressed by uncal herniation, infarcting posterior cerebral artery territory. (Remember that the PCA has to pass upward through the tentorial notch.)

Name at least 3 major structures that are supplied by PCA.



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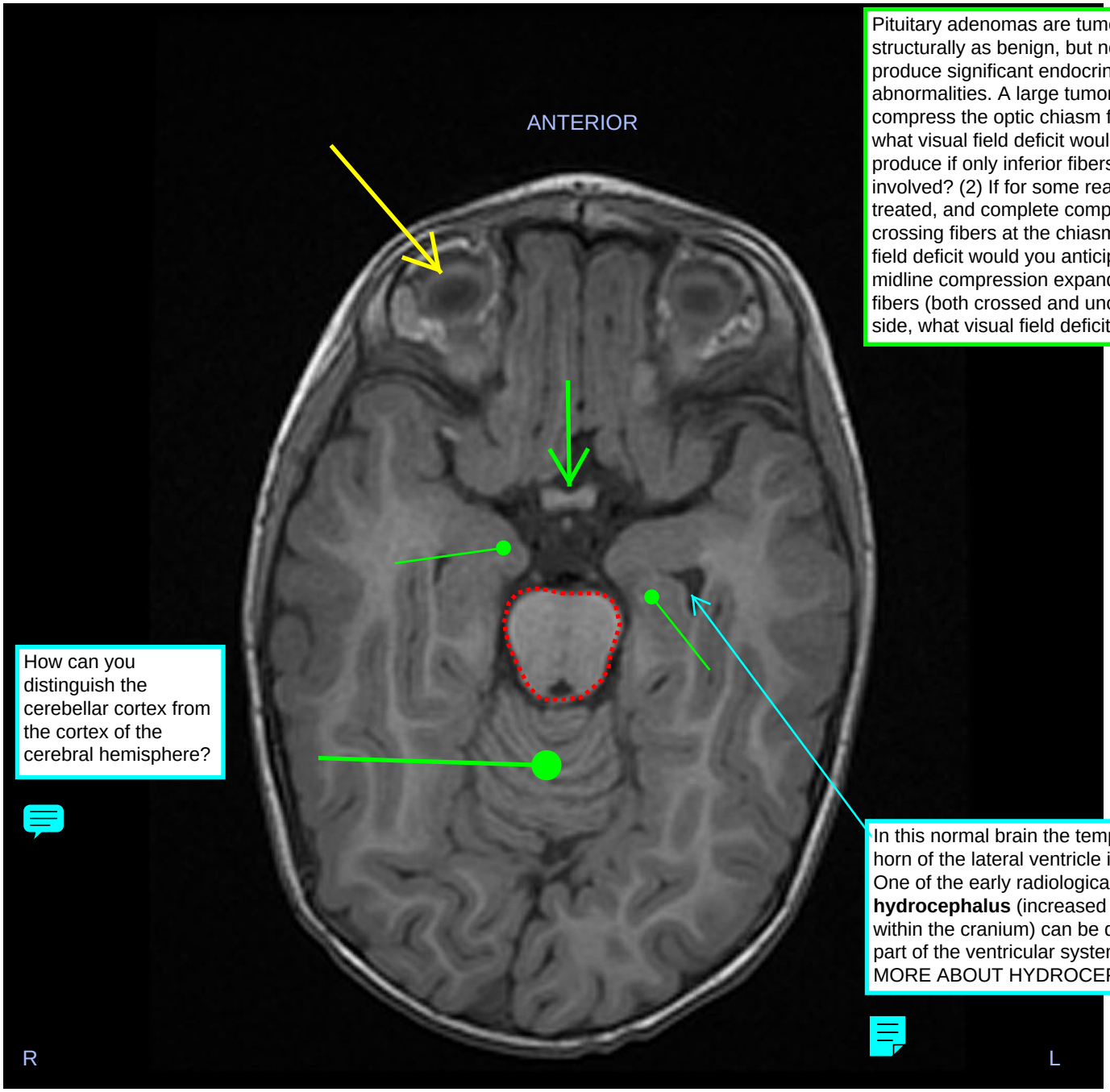
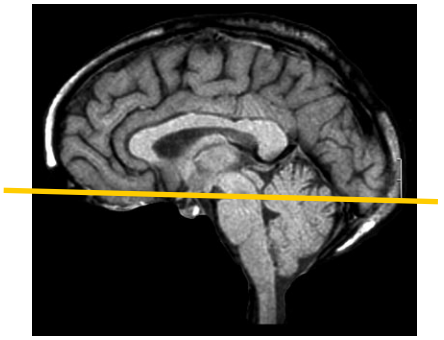
Axial MRI 22



Pituitary adenomas are tumors that are classified structurally as benign, but nonetheless can produce significant endocrine and neurologic abnormalities. A large tumor, for example, can compress the optic chiasm from below. (1) Initially what visual field deficit would this compression produce if only inferior fibers in the chiasm were involved? (2) If for some reason the tumor was not treated, and complete compression of all the crossing fibers at the chiasm occurred, what visual field deficit would you anticipate then? (3) If the midline compression expanded to ALSO include all fibers (both crossed and uncrossed) on the right side, what visual field deficit then?

How can you distinguish the cerebellar cortex from the cortex of the cerebral hemisphere?

In this normal brain the temporal (inferior) horn of the lateral ventricle is a narrow slit. One of the early radiological indicators of **hydrocephalus** (increased CSF volume within the cranium) can be dilation of this part of the ventricular system.
MORE ABOUT HYDROCEPHALUS



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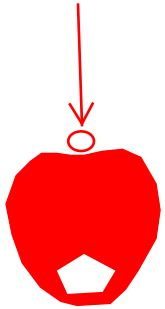
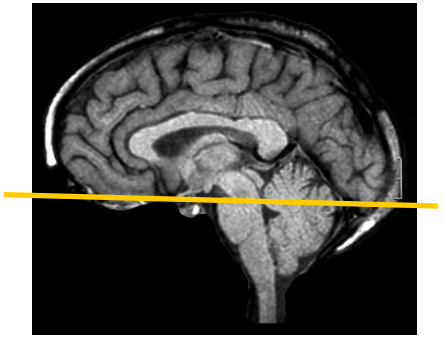
Axial MRI 23



Pons profile: Rounded (gently indented) anterior surface, and widened 4th ventricle posterior. Circle



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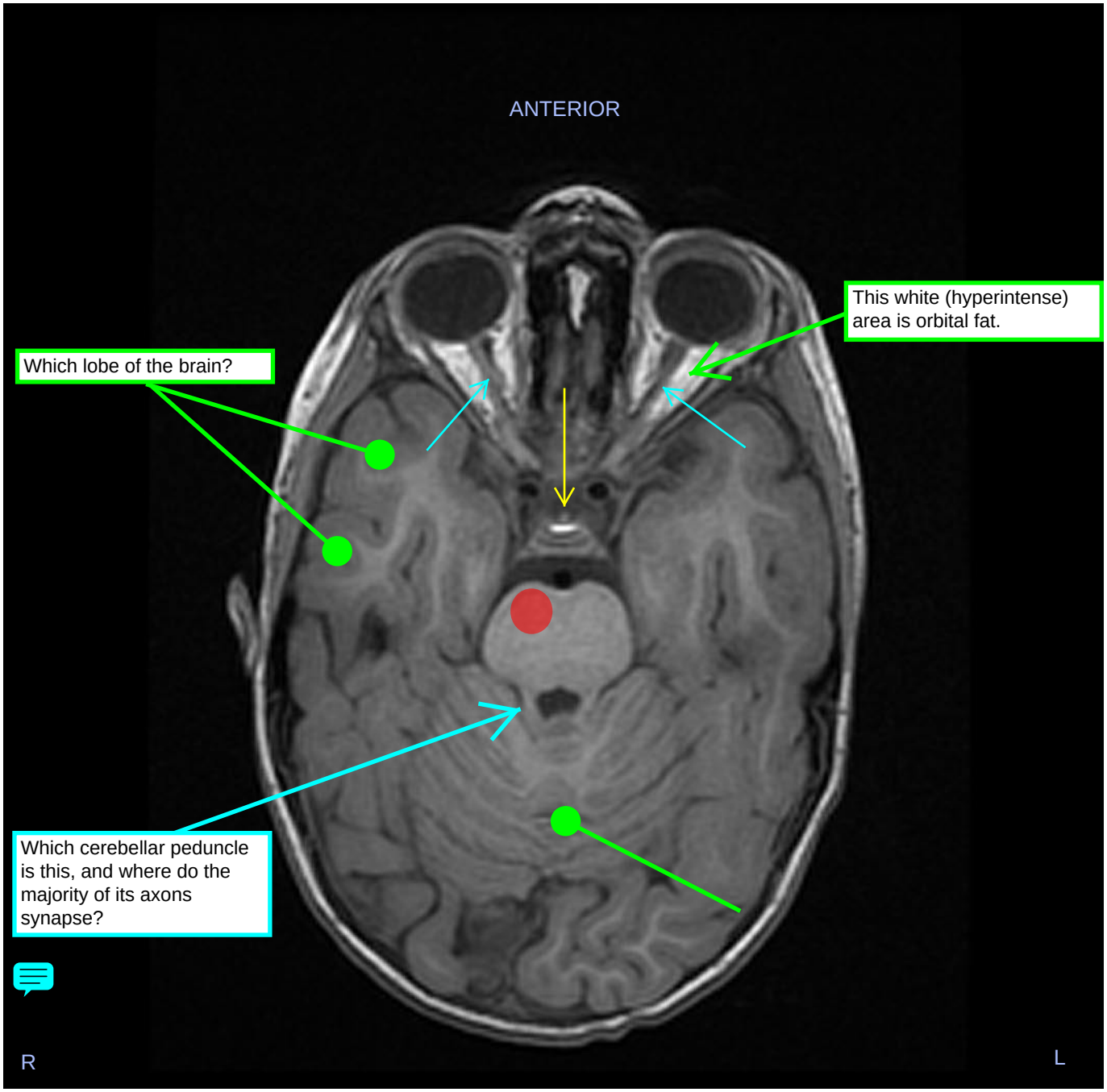
Axial MRI 24



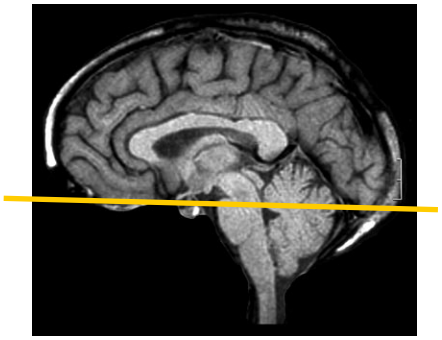
Three months following an ischemic stroke, a patient's neurologic exam demonstrated the following signs and symptoms:

Facial weakness on the left side that primarily involved the lower part of his face (his smile was lopsided and he had difficulty puffing out his left cheek; however he could raise his eyebrows and wrinkle his forehead evenly).
Difficulty enunciating words clearly, but no problem with language itself. (This *dysarthria* had improved somewhat since the time of his stroke.)
Weakness of the left arm and leg, with increased muscle tone, exaggerated biceps, triceps, brachioradialis, patellar, and Achilles tendon reflexes, and a dorsiflexor plantar response on the left.

The remainder of the patient's neurologic exam was normal.

Explain how the brainstem lesion shown here in **red** explain the patient's deficits.

Can you think of a region in the *cerebral hemisphere* where a lesion would be likely to produce the same pattern of normal and abnormal exam findings? Can you find an image in this atlas that shows this region?



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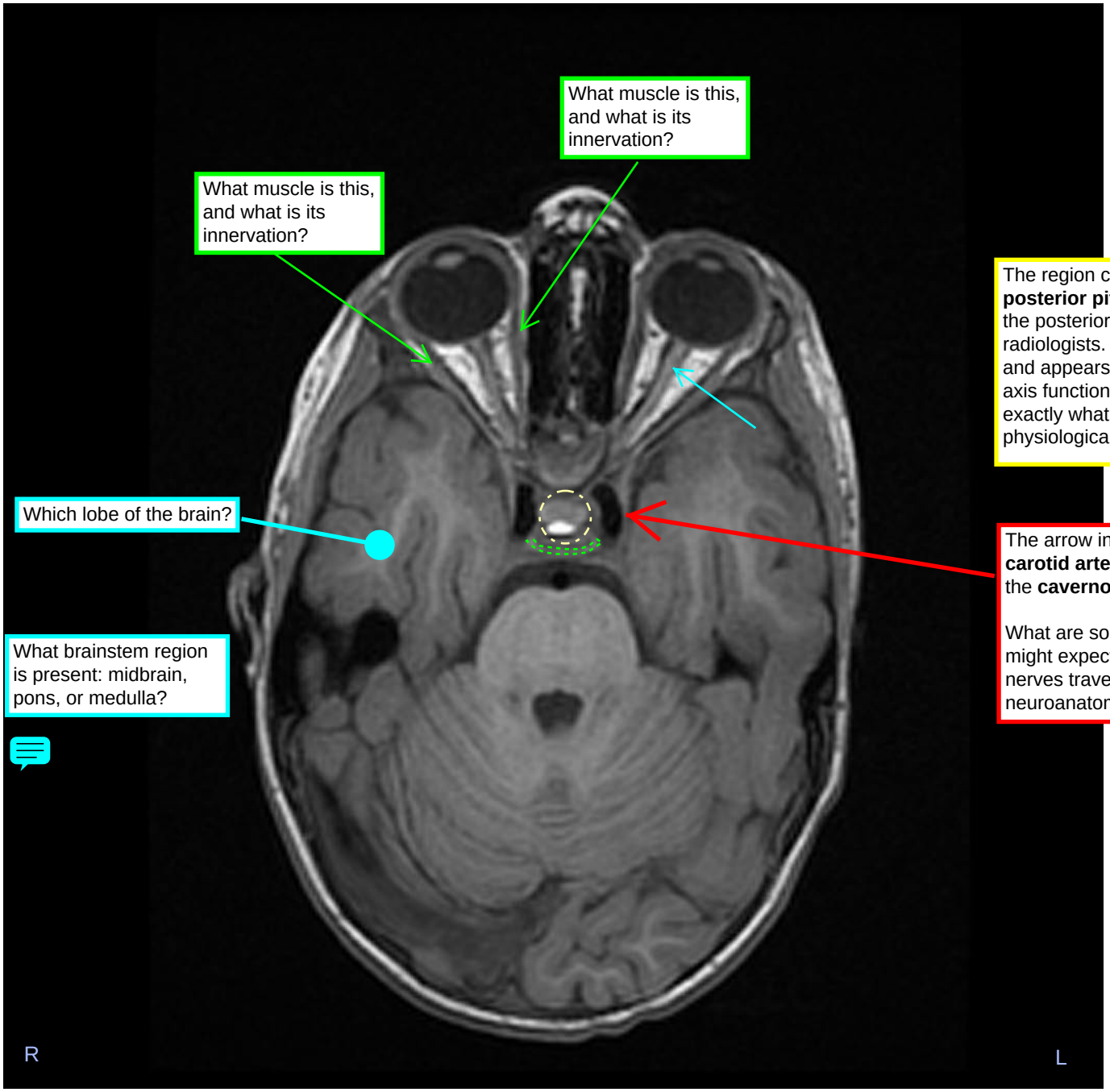
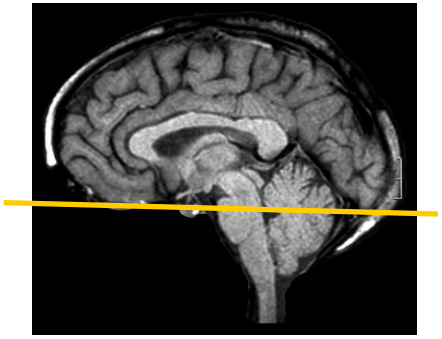
Axial MRI 25



The region circled in yellow contains both the **anterior and posterior pituitary**. The extremely hyperintense (white) region in the posterior pituitary is termed the posterior bright signal by radiologists. It has been reported in 90-100% of normal adults, and appears related to normal hypothalamic-neurohypophyseal axis function. However much more remains to be learned about exactly what produces the signal, its possible normal physiological variations, and its potential diagnostic value.

The arrow indicates the location of the **internal carotid artery**, which at this level is traveling within the **cavernous sinus**.

What are some of the signs and symptoms that you might expect after a large lesion involving all the nerves traveling through this venous sinus? What neuroanatomic structures would each involve?



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Axial MRI 26

In children and young adults, the **lens** is elastic and its thickness can be varied so that both near and far objects can be brought into focus on the retina. When a visual object is brought closer, the ciliary muscle contracts, this releases tension on the lens so that it rounds up and becomes thicker. Which cranial nerve is responsible? What is the efferent pathway?

ethmoid sinus

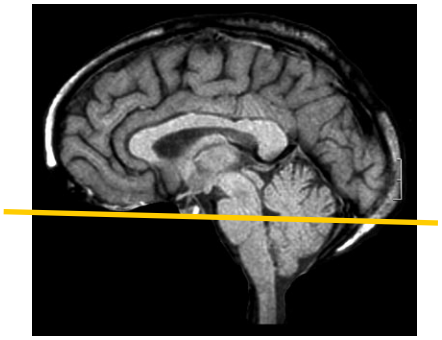
ANTERIOR

Which cerebellar peduncle?

What cranial nerve is this? Hint: Consider what brainstem region you're looking at, and which cerebellar peduncle is closely associated with the point of attachment of the nerve to the brainstem.

R

L



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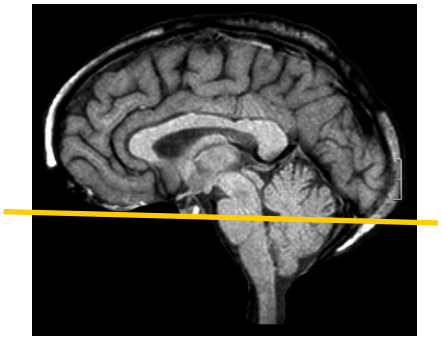
Axial MRI 27



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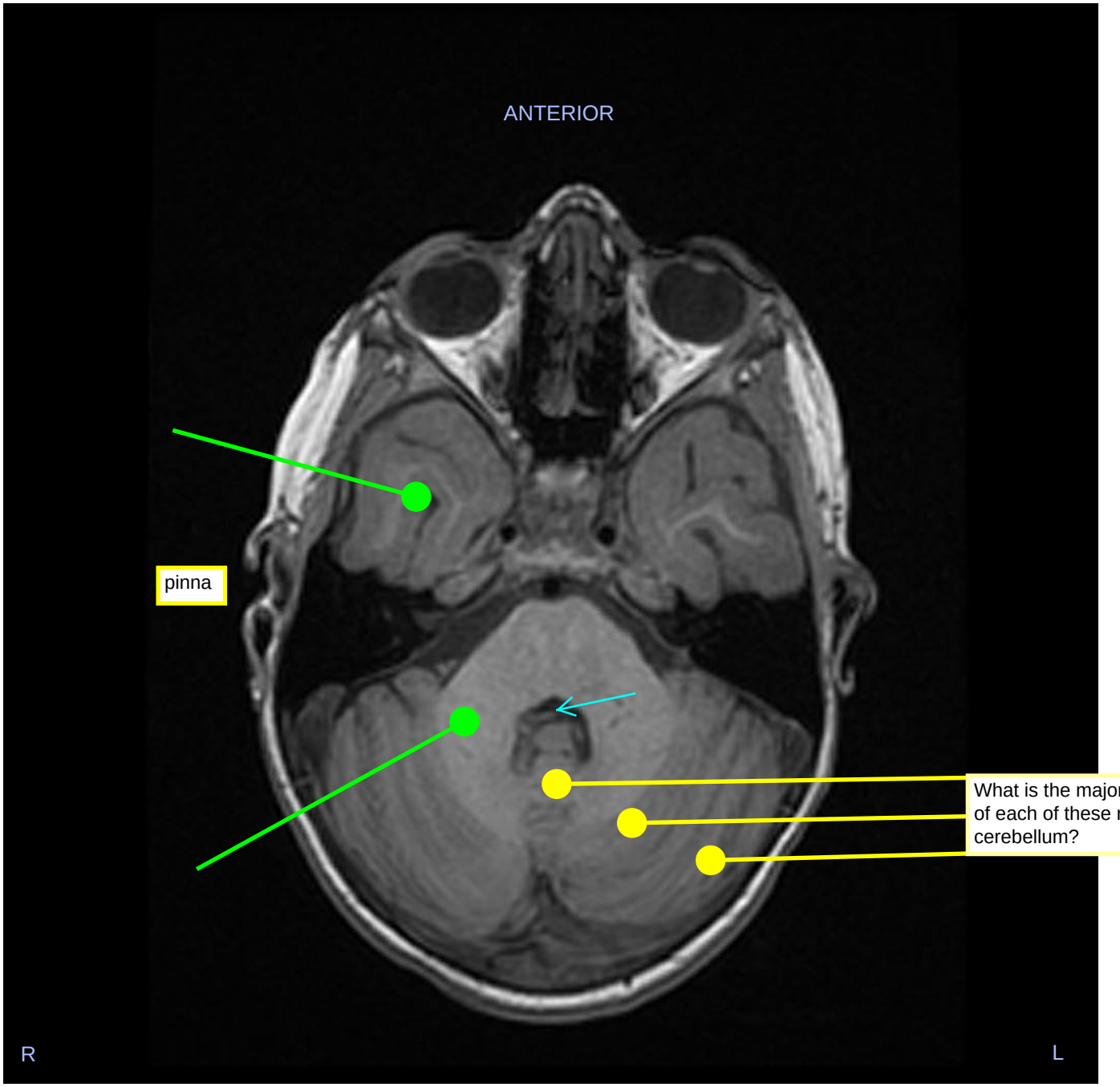
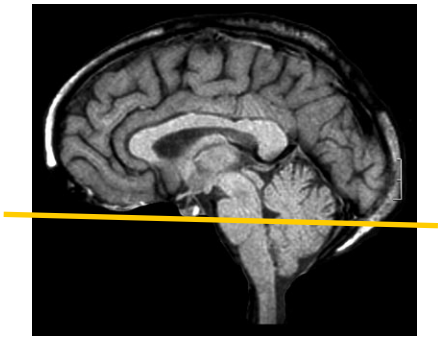
Axial MRI 28



What is the major functional role of each of these regions of the cerebellum?



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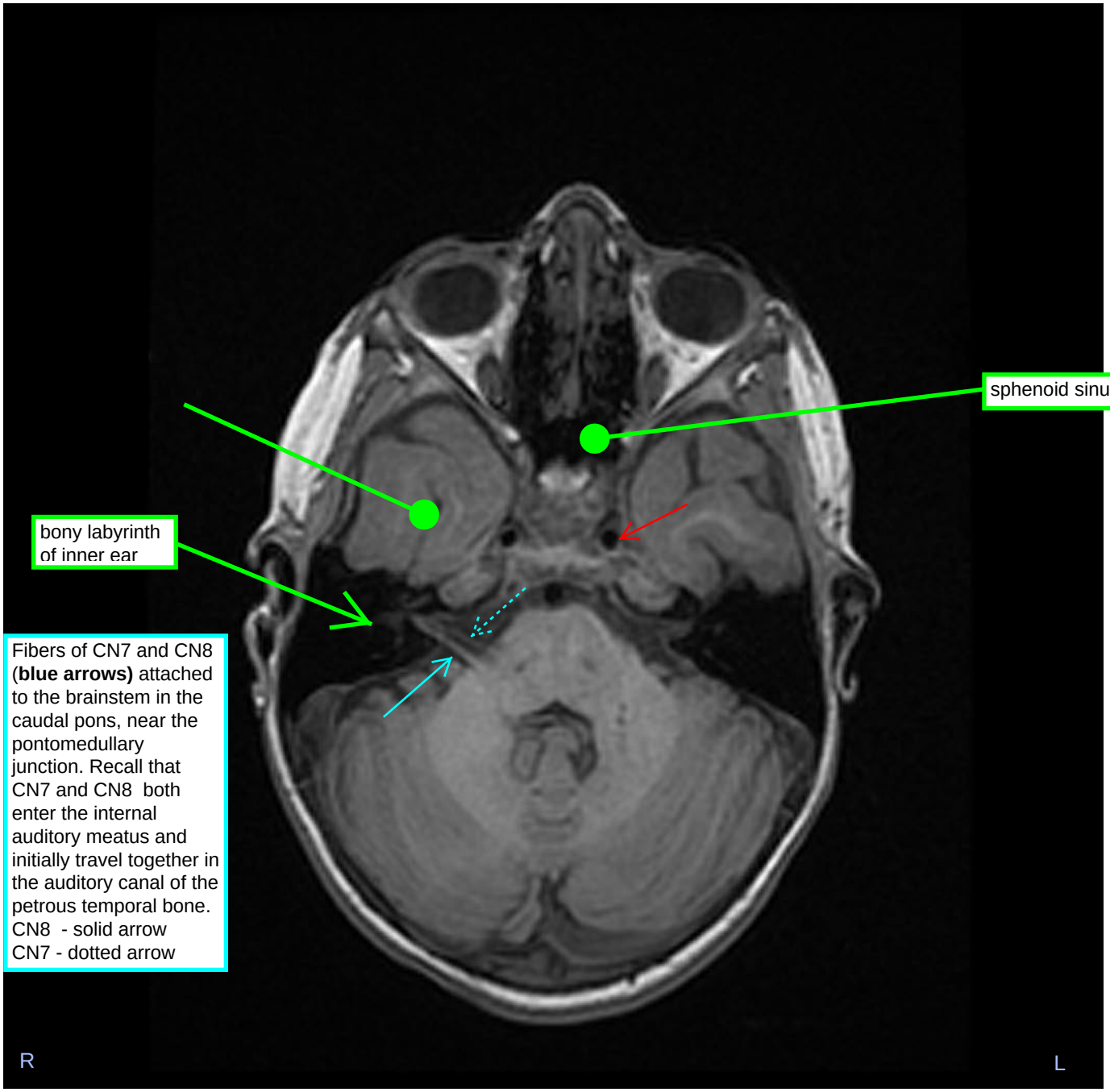
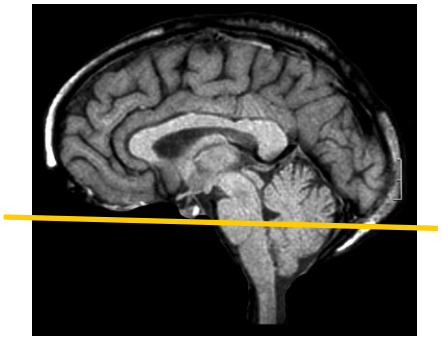
Axial MRI 29



Fibers of CN7 and CN8 (**blue arrows)** attached to the brainstem in the caudal pons, near the pontomedullary junction. Recall that CN7 and CN8 both enter the internal auditory meatus and initially travel together in the auditory canal of the petrous temporal bone.
CN8 - solid arrow
CN7 - dotted arrow



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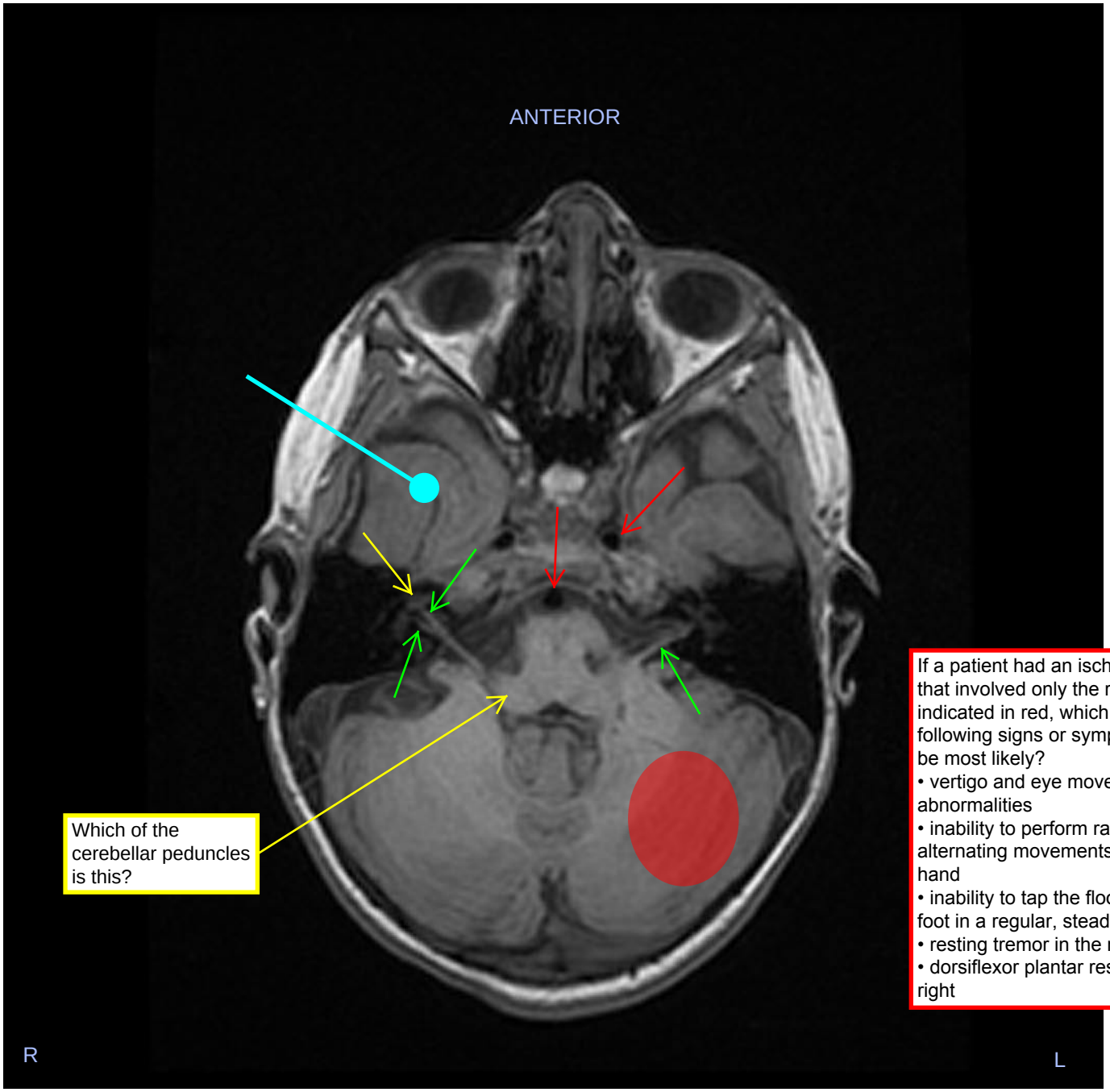
Axial MRI 30

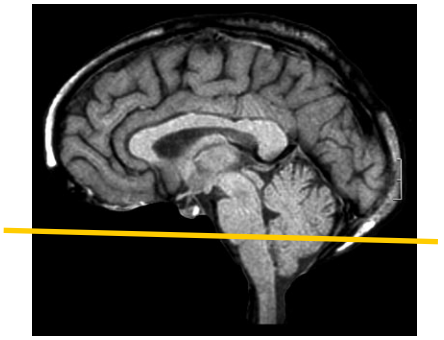


This image is at the level of the **pontomedullary junction.** Identify the 8th nerve and cochlea. Use the arrows for confirmation.

Which of the cerebellar peduncles is this?

If a patient had an ischemic stroke that involved only the region indicated in red, which of the following signs or symptoms would be most likely?

- vertigo and eye movement abnormalities
- inability to perform rapid, alternating movements with the right hand
- inability to tap the floor with the left foot in a regular, steady rhythm
- resting tremor in the right hand
- dorsiflexor plantar response on right



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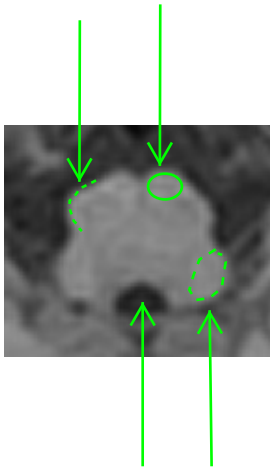
Axial MRI 31

This image is at the level of the **rostral medulla**

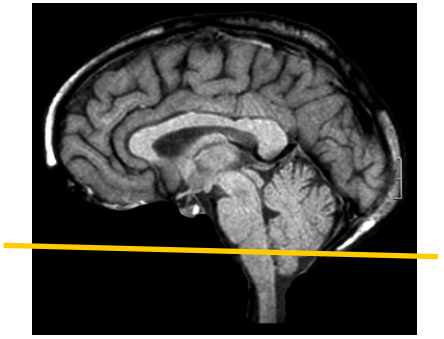
Identify the following structures (use the green markings on the magnified image below to confirm your answers):
4th ventricle
medullary pyramid
location of the inferior olive
location of the inferior cerebellar peduncle



ANTERIOR

Rostral Medulla profile: Inferior olives form bulges on the anterior lateral surface, while the inferior cerebellar peduncles form posterior lateral bulges (ears). In the rostral medulla (like the pons), the 4th ventricle is wide.

This is a cranial nerve. Based on the level of the brainstem and the location where the nerve is attached to the brainstem, which two cranial nerves could this be?



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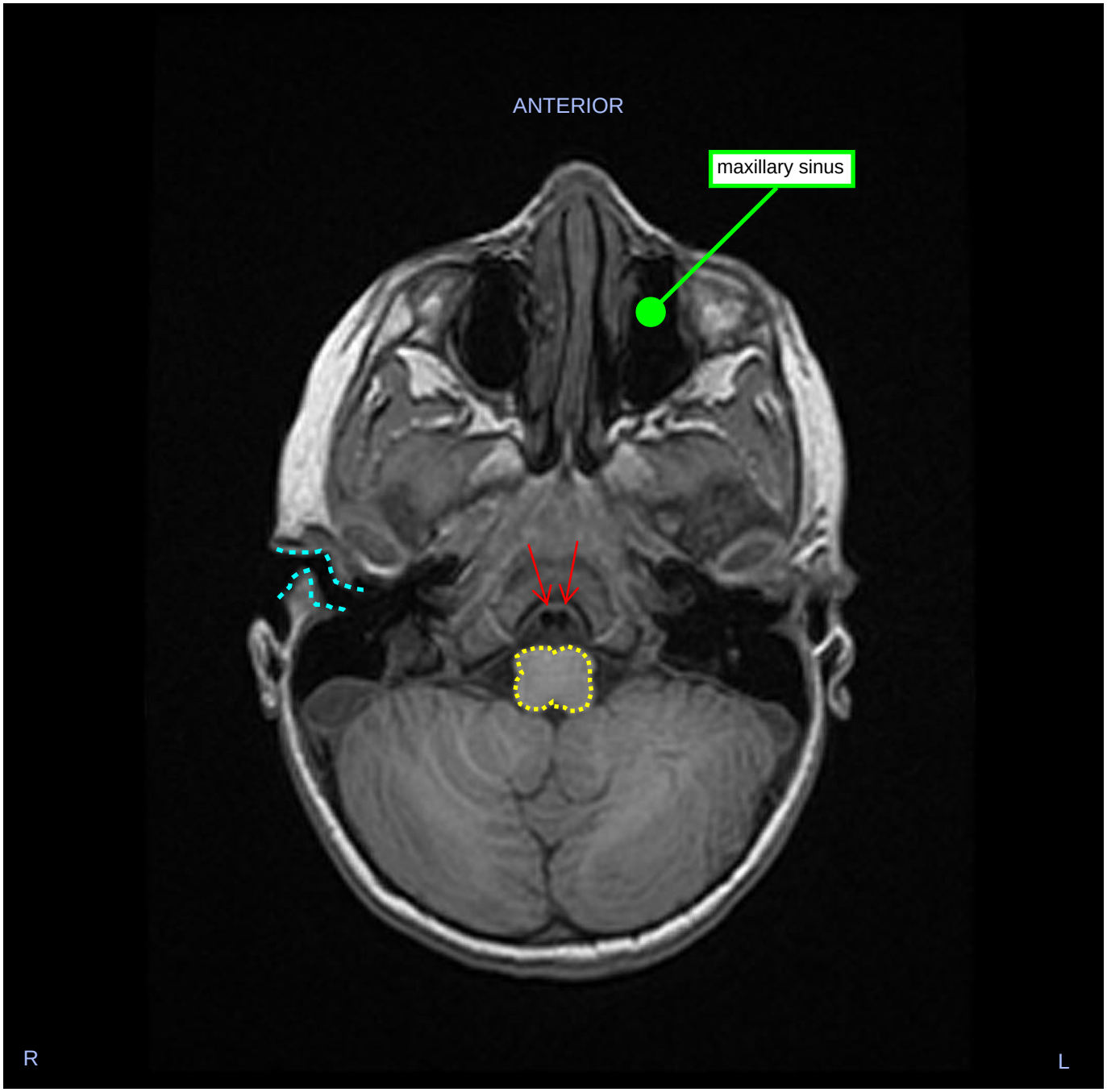
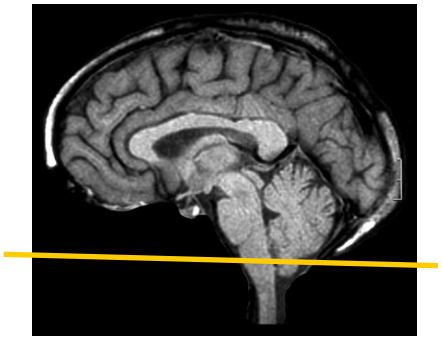
Axial MRI 32





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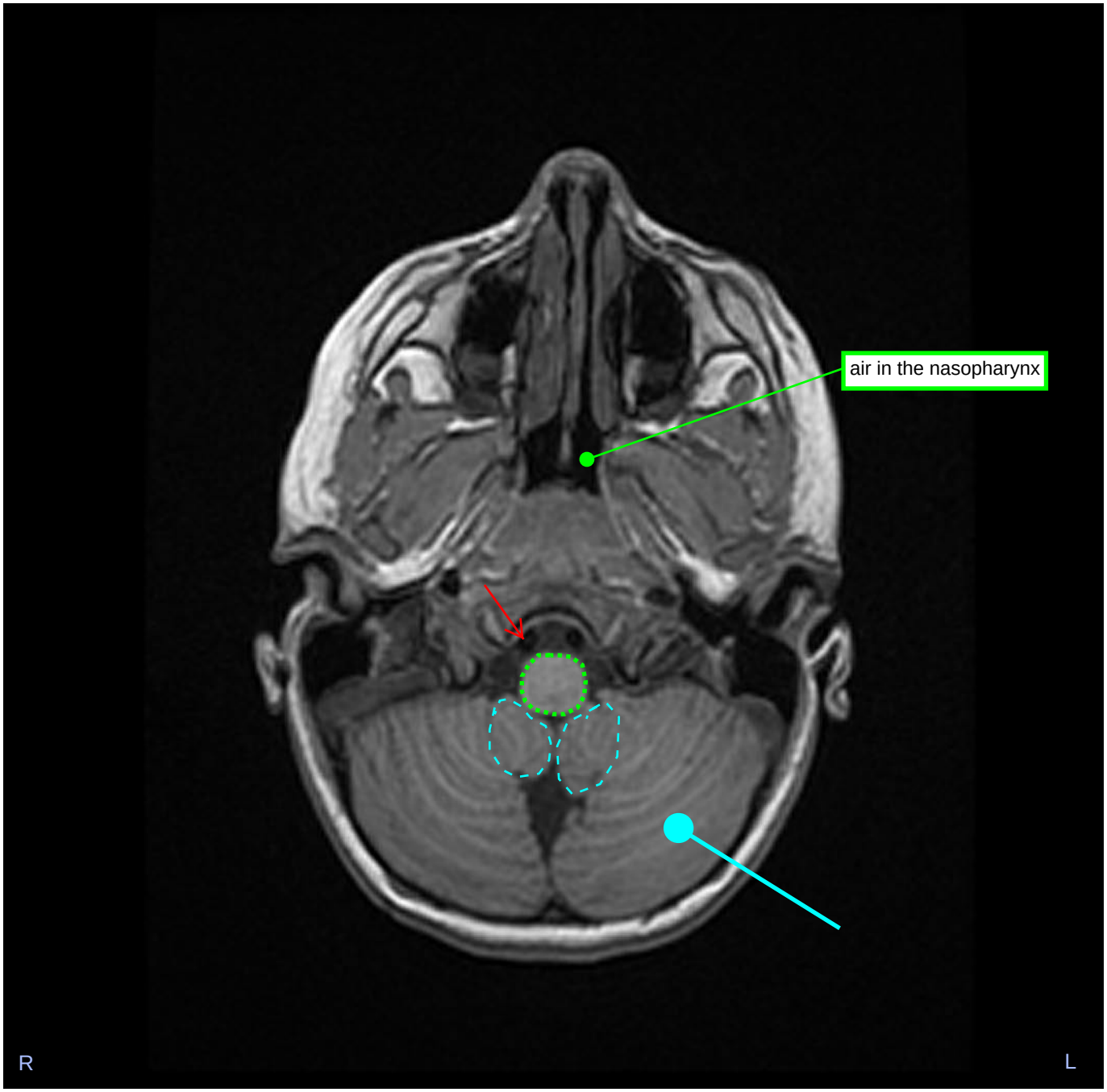
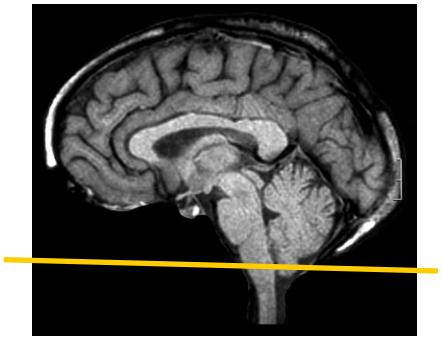
Axial MRI 33



This image is at the anterior edge of the foramen magnum. What region of the brainstem is present? Confirm your answer.

At this level the inferior parts of the cerebellum are visible. The famous **cerebellar tonsils** are circled in blue. In situations where a mass lesion or enormously elevated intracranial pressure pushes the brainstem downward, the tonsils may herniate caudally through the foramen magnum. There they compress the caudal medulla, usually resulting in the patient's death because cardiac and respiratory centers in the reticular formation malfunction.



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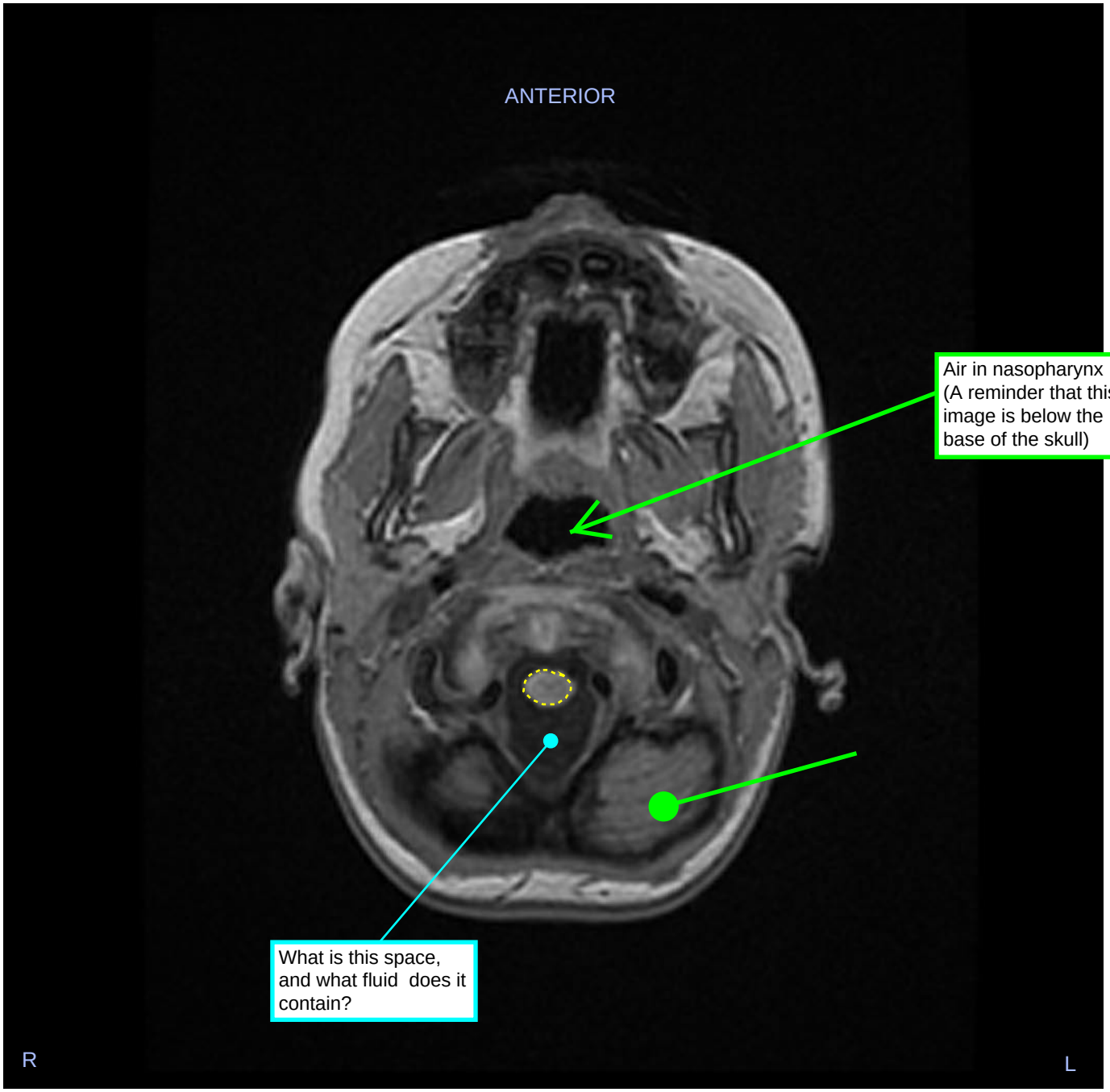
Axial MRI 34



This is the level of the **upper cervical spinal cord** (outlined in yellow). As this is caudal to the pyramidal decussation, most corticospinal axons are located lateral (rather than anterior), accounting for the overall shape of the cord).

The **vertebral arteries** travel upwards through the transverse foramina of the upper 6 cervical vertebrae. When they reach C1 they turn medially, curving around the lateral masses of the vertebra to enter the subarachnoid space.The arteries then travel upwards through the foramen magnum into the cranial cavity, in the location shown in image 33.