Lab 4. Cerebral Hemispheres & Cerebellum

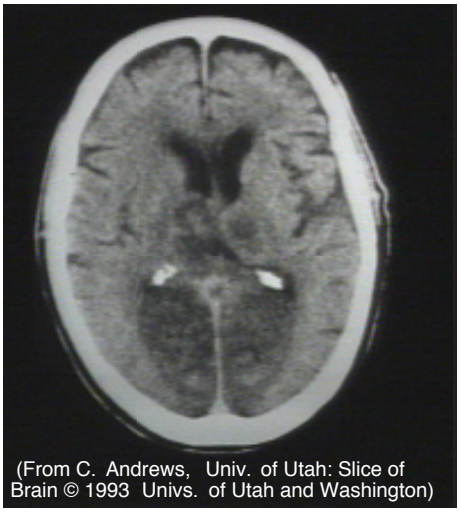
Lesion Lessons

Lesion 5.1. Manny Festo

i) Location

ii) Signs/symptoms

iii) Cause:



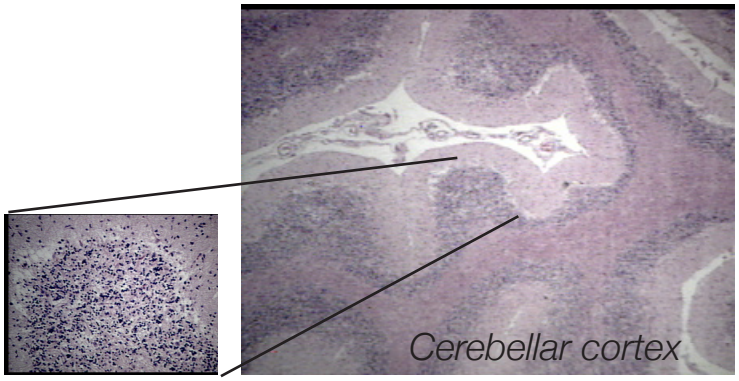
(From C. Andrews, Univ. of Utah: Slice of Brain © 1993 Univs. of Utah and Washington)

Web note

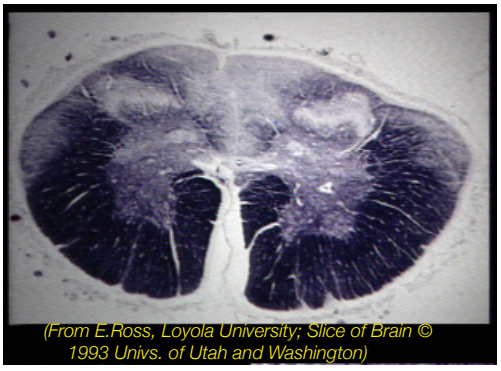
Lesion 5.2. Phil Abuster

i) Location

ii) Signs/symptoms



iii) Cause:



(From E.Ross, Loyola University; Slice of Brain © 1993 Univs. of Utah and Washington)

Web note

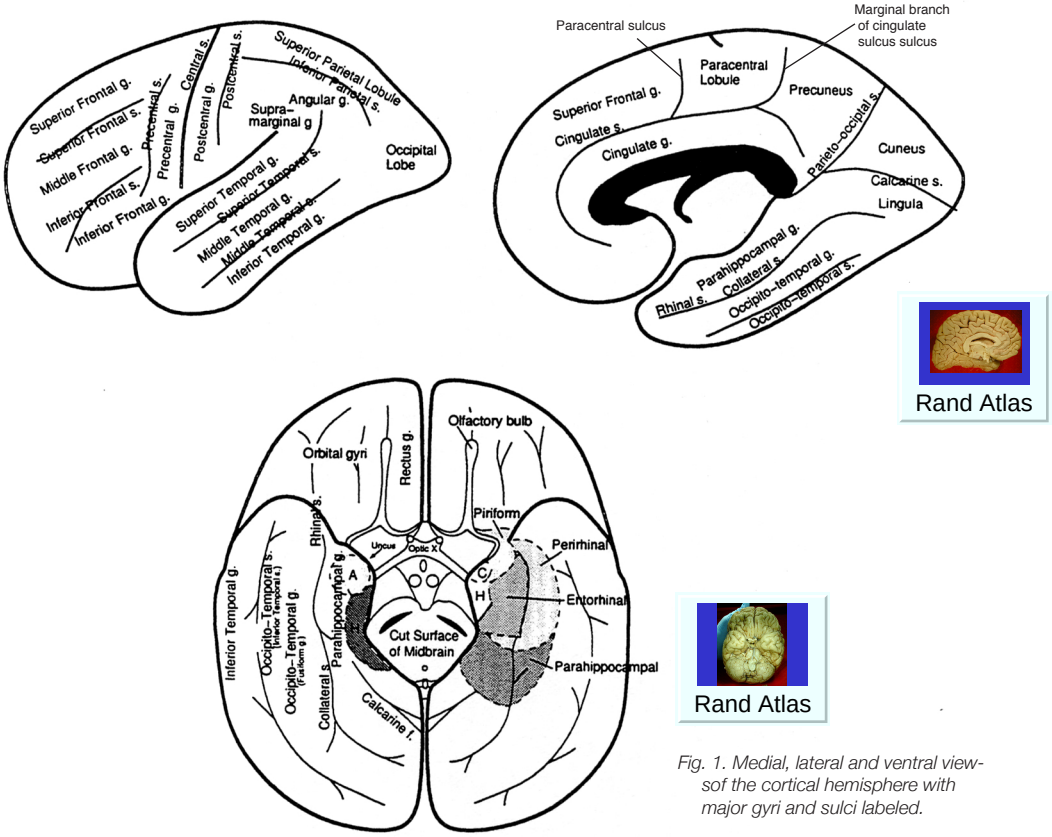


Fig. 1. Medial, lateral and ventral view-sof the cortical hemisphere with major gyri and sulci labeled.

Cerebral Hemisphere

- use the whole brain to study the dorsal, lateral, and ventral surfaces.
- use the half brain to study the medial surface (Figure 1).
- no two brains are quite alike in their surface pattern, and even two halves of the same brain differ. The sulci and gyri, however, are generally constant in shape and position.

Sulcus vs. fissure

The term sulcus generally indicates a shallower groove than a fissure, but many times the words are used interchangeably.

Locate and note the following three major sulci (or fissures):

- *central sulcus (of Rolando)*
  - – runs across the external surface from rostro-lateral to caudal-medial about midway between the *frontal* and *occipital* poles.
  - – upper end usually extends over the convexity of the medial surface of the hemisphere; its lower end extends all the way to but rarely touches the *lateral fissure*.
- *lateral fissure (of Sylvius)*
  - – begins above the *temporal pole* and extends dorsally and caudally.
  - – on the lateral surface of the hemisphere, an imaginary line drawn parallel to the *parieto-occipital sulcus* is arbitrarily used as a third boundary line to separate *parietal* and *occipital* lobes.
- *parieto-occipital sulcus*
  - – largely on the medial surface of the hemisphere).

Major lobes and fissures (sulci)

These three sulci or fissures conventionally divide the hemisphere into frontal, parietal, temporal, and occipital lobes.

Locate and note the boundaries of the following lobes on Figure 2 and identify on gross brain specimens:

- *frontal lobe* – includes the entire hemisphere rostral to the *central sulcus*.
- *parietal lobe* – limited rostrally by the *central sulcus*, caudally by a line on the external surface corresponding in position to the *parieto-occipital sulcus*, and ventrally by a line which prolongs the *lateral (Sylvian) sulcus* in a caudal direction.
- occipital *lobe* – located caudal to the *parieto-occipital sulcus*.
- *temporal lobe* – located ventral to the *frontal* and *parietal lobes* and extending caudally up to the *occipital lobe*.

(• *insula* – this lobe is buried deep within the *lateral fissure* and will be studied later.)

Fig. 1. (From Matt McCoyd, LUMC medical student, 2004)

Frontal Lobe

Locate and note the following on Figure 3 and identify on gross brain specimens:

- *precentral gyrus* – between the *central sulcus* and the *precentral sulcus*.
  - the *precentral gyrus* is the *primary motor area*.
- *superior, middle* and *inferior frontal gyri* and the intervening *superior* and *inferior frontal sulci*.
  - *Broca's area* (motor speech) is located (usually) in the left *inferior frontal gyrus*.
- *orbital gyri* – located lateral to the *olfactory bulb* and *tract*.
  - the *gyrus rectus* is found medial to the olfactory tract.

Imprecise boundaries

Do not be concerned if you cannot find the precise boundaries of some of the gyri. They are often ill-defined.

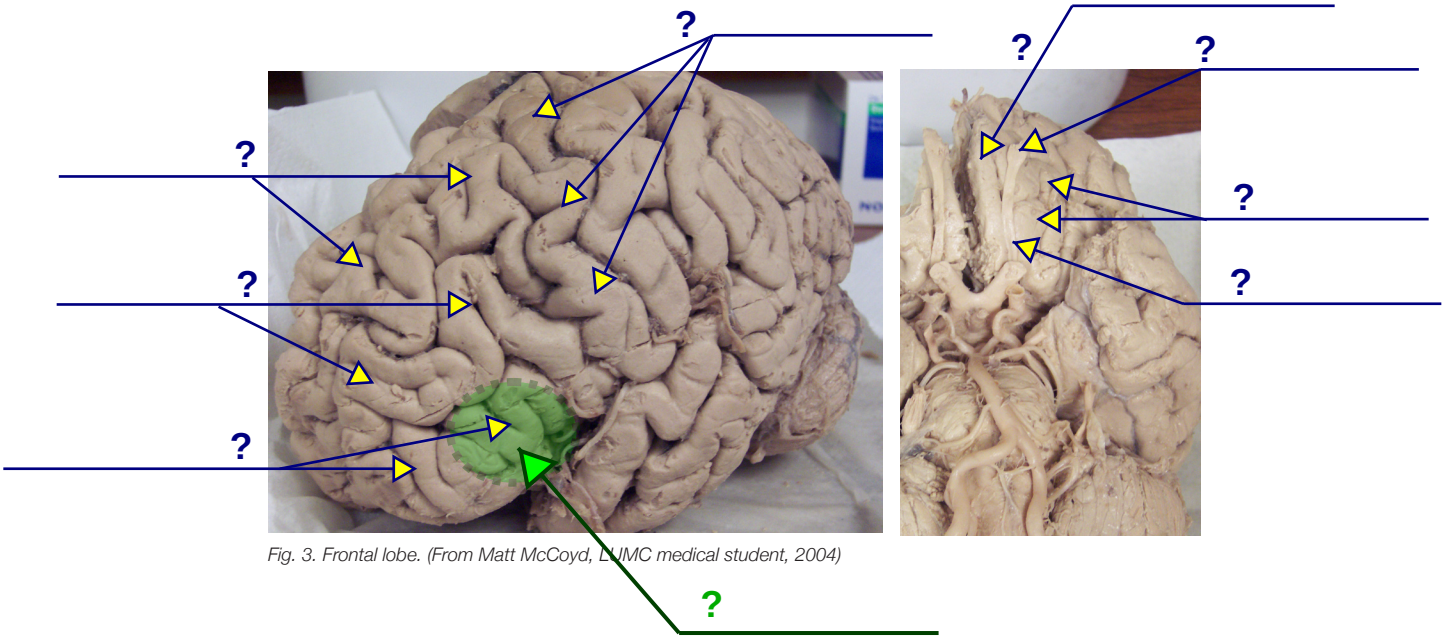


Fig. 3. Frontal lobe. (From Matt McCoyd, LUMC medical student, 2004)

Question classics

Which cortical lamina is especially well-developed in the precentral gyrus?

Does a lesion in Broca's area affect language comprehension or expression?

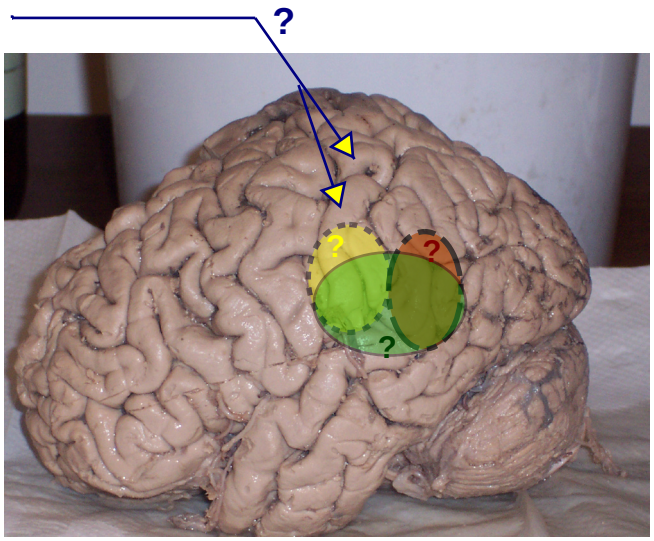
Parietal Lobe

Locate and note the following on Figure 4 and identify on gross brain specimens:

- *postcentral gyrus* – located posterior to the *central sulcus*.
  - is the primary somatosensory area of the brain.
- i*ntraparietal sulcus* – demarcates the *superior* and *inferior parietal lobules*.
  - is often continuous with the inferior portion of the *postcentral sulcus* and arches caudally towards the *occipital pole*, roughly parallel to the superior margin of the hemisphere.
- *supramarginal gyrus* – caps the upturned caudal end of the *lateral sulcus*.
- *angular gyrus* – caps the upturned caudal end of the *superior temporal sulcus*.

Wernicke's area – speech perception

- *angular and supramarginal gyri*
- *these gyri are always within the inferior parietal lobule and help to locate it*



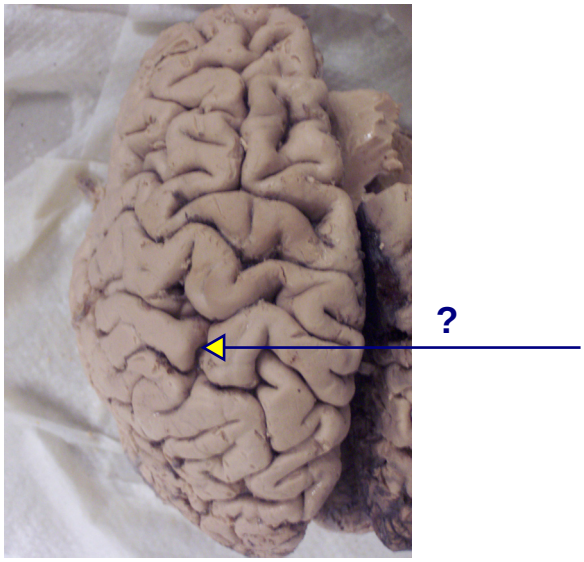


Fig. 4. Gross brain. (From Matt McCoyd, LUMC medical student, 2004)

Questions classics

Which cortical lamina is especially well-developed in the postcentral gyrus.

Which thalamic nucleus projects heavily to the postcentral gyrus.

Is Wernicke's area most typically associated with the left or right hemisphere?

Temporal Lobe

Locate and note the following on Figure 5 and identify them on gross brain specimens:

- *superior, middle* and *inferior temporal gyri* (Figure 4) and sulci.

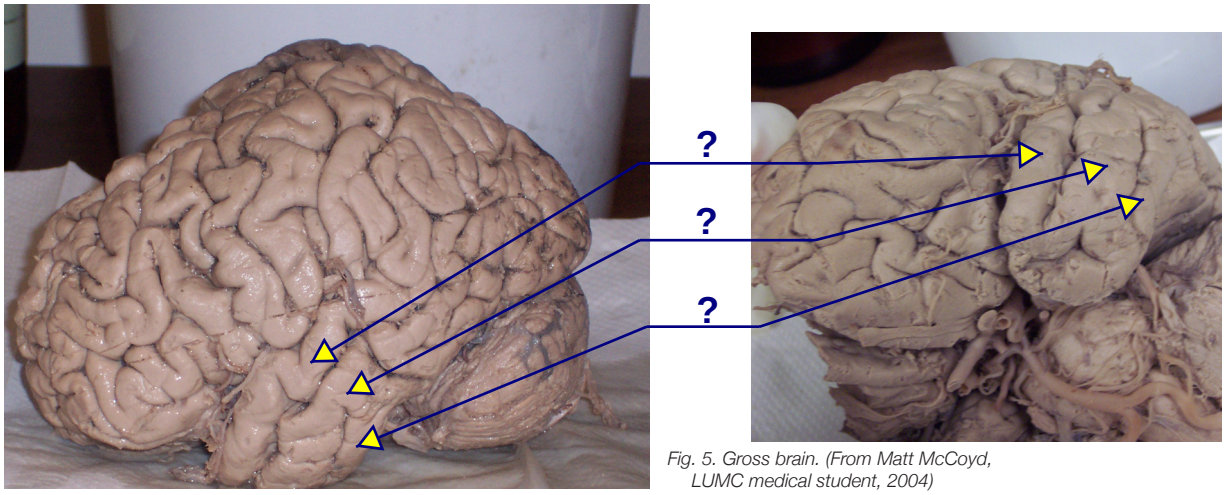


Fig. 5. Gross brain. (From Matt McCoyd, LUMC medical student, 2004)

Note the following on Figure 6:

- *tranverse temporal gyri* – found on the upper surface of the temporal lobe when spreading open the lateral sulcus.
  - *anterior transverse temporal gyrus* (Heschl's gyrus) - the largest of these gyri and the site of the *primary auditory area*.

Heschl's Cx

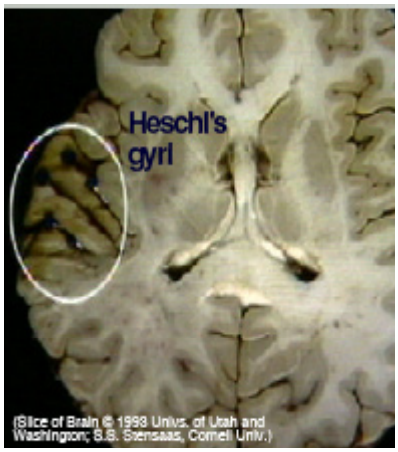


Fig. 6. Horizontal section showing the transverse gyri of Heschl. (From Slice of Life, SS Stensaas, 1993)

Label the following on Figure 7 and identify on gross brain specimens:

- *parahippocampal gyrus* – most medial gyrus adjacent to the brain stem on the ventral aspect of the temporal lobe
- *collateral sulcus* - on the ventral aspect of the temporal lobe forming the lateral boundary of the *parahippocampal gyrus*.
- *occipital-temporal gyrus* (*fusiform gyrus*) – lateral to the *parahippocampal gyrus* and medial to the *inferior temporal gyrus*.

Ventral brain

Fig. 7. Ventral view of the temporal lobe. (From E. Ross, Loyola School of Medicine).

Insula

- can be seen by gently pulling apart the borders (opercula) of the lateral fissure.
- is cone-shaped portion of the cortex that is sometimes referred to as an additional lobe of the cerebral cortex.

Label the following on Figure 8:

- *opercula* – those portions of the frontal, parietal and temporal lobes that cover the *insula*.
- *limen insulae* – apex or point of the insula
  - is found ventrally where the insula meets the orbital surface of the frontal lobe.
- *circular sulcus* – surrounds the *insula*.
- *gyri breves* and *gyrus longus* - the short and long gyri of the *insula*.

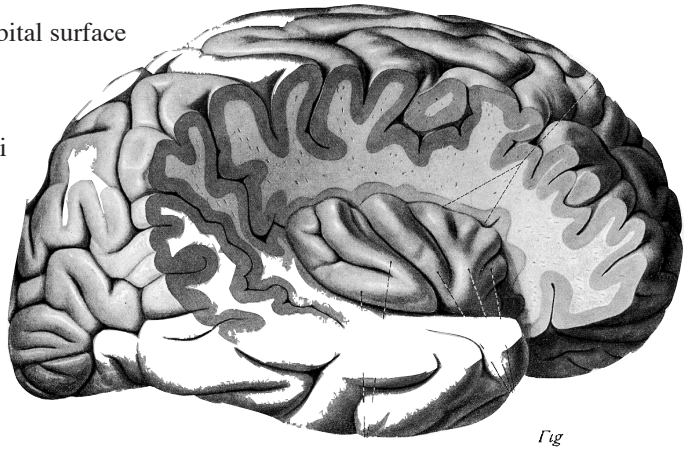


Fig.8. Insula. (From Sobotta, J and JP McMurrich, Atlas of Human Anatomy GE Stechert, New York, 1930)

Insula

Occipital Lobe

Label the following on Figure 9 and identify on gross brain specimens:

- *parieto-occipital sulcus* – observed prominently on the medial surface of the hemisphere.
- *calcarine sulcus* – extends from the *parieto-occipital sulcus* back to the *occipital pole*.
- *cuneus* – located above the *calcarine sulcus* forming the upper bank of the calcarine cortex.
- *lingula* – located below the *calcarine sulcus* forming the lower bank of the calcarine cortex. comprise the *primary visual cortex*.

Primary visual cortex...

...is composed of the upper and lower banks of the calcarine cortex.

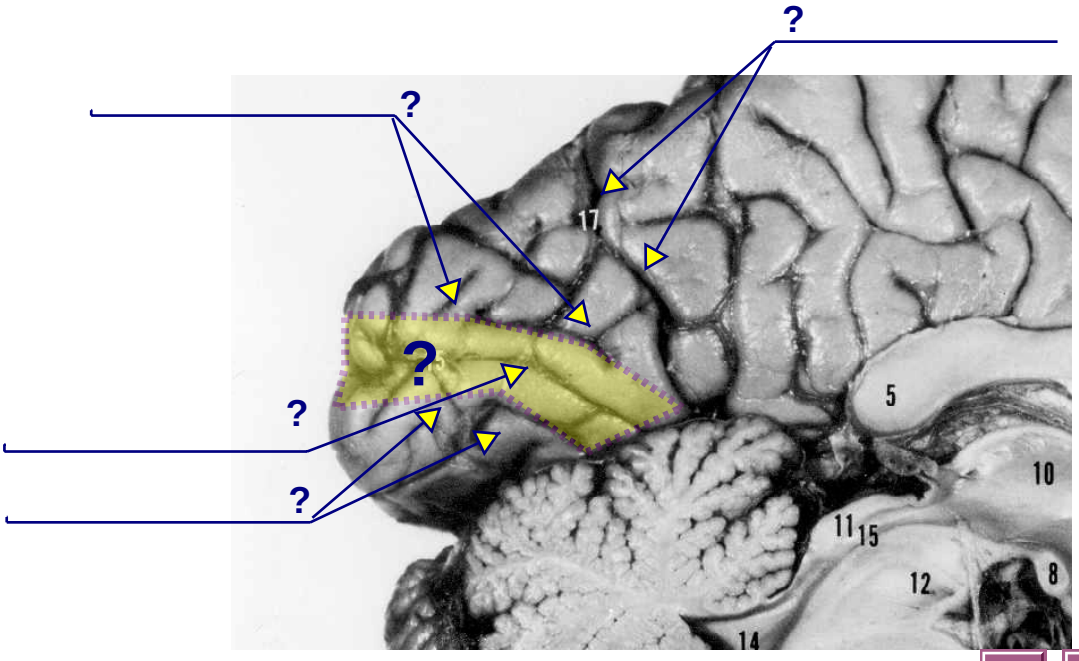


Fig.9. Occipital lobe. (From E. Ross, Loyola School of Medicine).

Medial Aspect of the Half Brain

Label the following on Figure 10 and identify on gross brain specimens:

- *superior frontal gyrus* – located rostral to the *paracentral sulcus*.
- *cingulate gyrus* – follows the contours of the *corpus callosum*.
- *cingulate sulcus* – surrounds the *cingulate gyrus* and has two ascending branches:
  - *marginal branch of the cingulate sulcus* caudally
  - *paracentral sulcus* more rostrally
- *paracentral lobule* – located between the *paracentral sulcus* and the *marginal branch of the cingulate sulcus*.
  - note that the extension of the *central sulcus* on to the medial aspect of the hemisphere is within the *paracentral lobule*
- *precuneus* – located between the *cingulate sulcus* and the *parieto-occipital sulcus*.
- *cuneus* – is limited by the *parieto-occipital sulcus* and the *calcarine fissure*; the medial aspect of the *occipital lobe* consists of the *cuneus* and part of the *lingual gyrus*; the banks of the *calcarine sulcus* are the site of the *primary visual cortical area*.
- *lingual gyrus* – found below the *calcarine fissure* and ends on the ventral surface at the *collateral sulcus*.
- *limbic lobe* – is composed of several structures on the medial and ventral aspects of the brain that are functionally related. On this medial view, you can see:
  - *cingulate gyrus* - above the *corpus callosum*.
  - *subcallosal gyrus* - immediately ventral to the *rostrum of the corpus callosum*

A suggestion

- *refer to Figure 1 of this section for help with these indentifications.*

Occipital lobe...medially

- *the medial aspect of the occipital lobe consists of the cuneus and part of the lingual gyrus.*
- *the banks of the calcarine sulcus are the site of the primary visual cortical area.*

Ventral brain

The following limbic structures are visible on the ventral surface of the gross brain (See Fig. 7):

- *parahippocampal gyrus* - on the medial ventral temporal lobe.
- *hippocampus* - is found deep to the *parahippocampal gyrus*.
- *uncus* - extends medially from the rostral end of the *parahippocampal gyrus*.
- *piriform (olfactory) cortex* - is found on the rostral surface of the *uncus*.

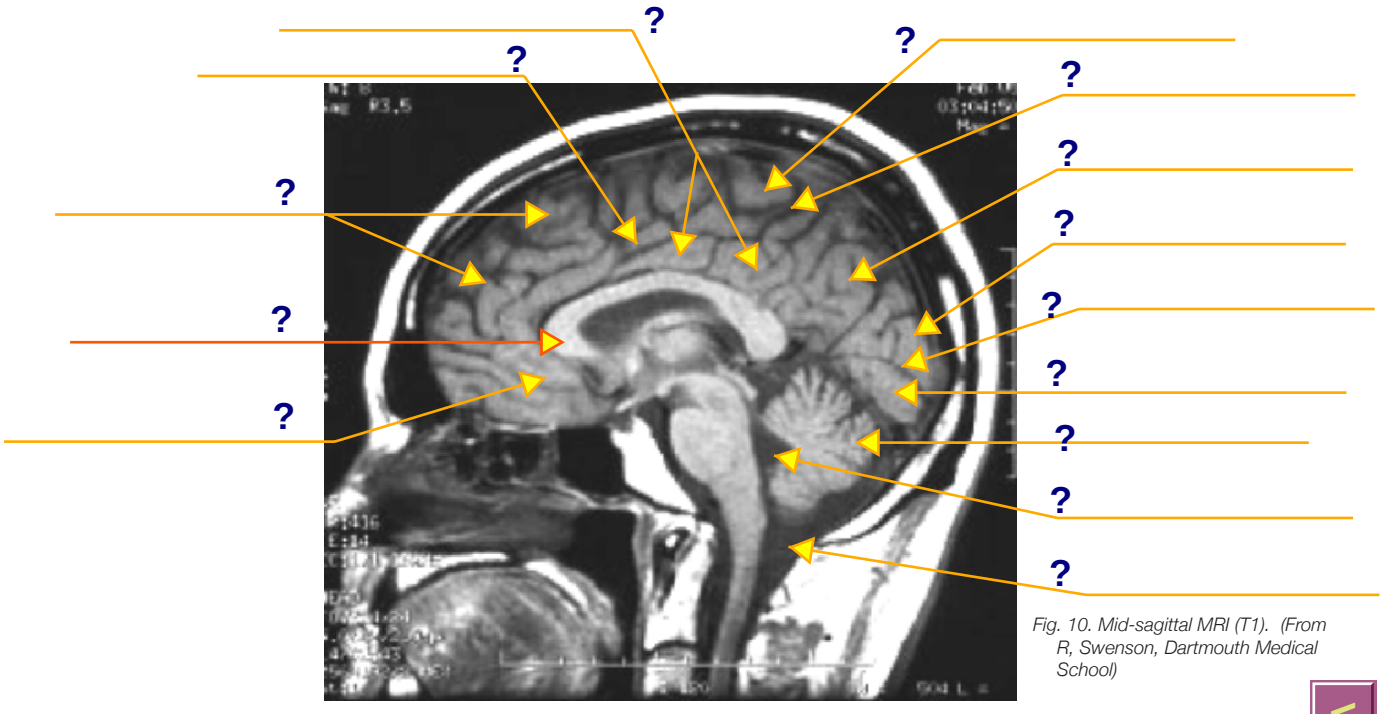


Fig. 10. Mid-sagittal MRI (T1). (From R, Swenson, Dartmouth Medical School)

Brodmann's Cytoarchitectural Numbering System

Add the Brodmann numbers to the cortical areas indicated below.	
? _____ *primary motor cortex (M1)*	? _____ *premotor cortex (M2)*
? _____ *primary somatosensory cortex (S1)*	? _____ *secondary somatosensory cortex (S2)*
? _____ *primary visual cortex (V1)*	? _____ *secondary visual cortex (V2, V3)*
? _____ *primary auditory cortex (A1)*	? _____ *secondary auditory cortex (A2)*

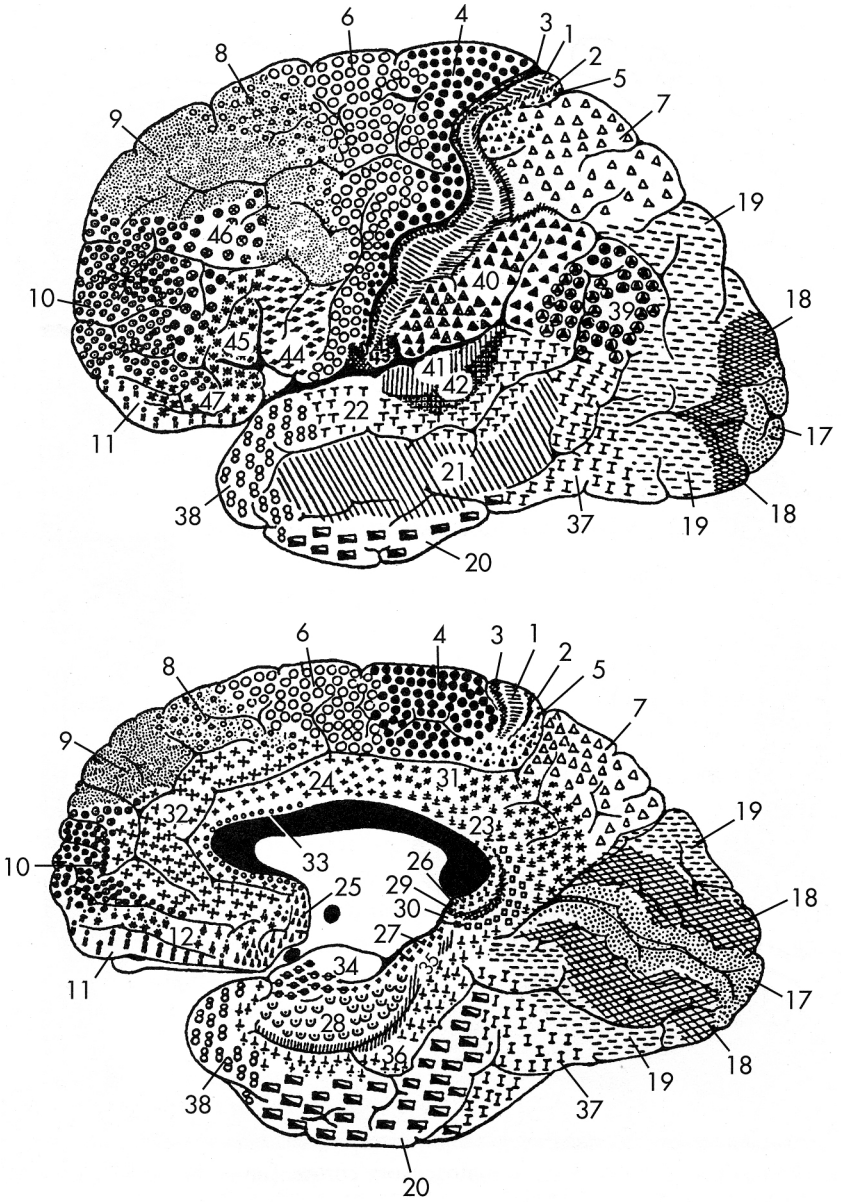


Fig. 11. From AJ Castro et al., Mosby 2002 as derived from: Brodmann, K. Vergleichende Lokalisationslehre der Grosshirnrinde in ihren Prinzipien dargestellt auf Grund des Zellenbaues (J. A. Barth, Leipzig, 1909).

Cerebellum

The *cerebellum* overlies the posterior aspect of the *pons* and *medulla* and extends laterally under the *tentorium*, thus occupying the greater part of the *posterior cranial fossa*.

Label the following on Figure 12 and identify on gross brain specimens:

- *vermis* - narrow midline portion.
- *hemispheres* – large lobes extending laterally from the *vermis*.
  - – the *vermis* and *hemispheres* can be readily distinguished, particularly on the inferior surface.
- *cerebellar folia* – numerous narrow, transversely-oriented, leaflike lamina observed on the surface of the cerebellum.
- *primary fissure* – relatively prominent fissure identified on the superior surface of the cerebellum about 2-3 cm from the leading edge.
- *anterior lobe* – portions of the cerebellum located anterior to the *primary fissure*.
- *posterior lobe* – lies between the *primary* and *posterolateral fissures* and represents the largest subdivision of the *cerebellum*.
- *posterolateral fissure* – can be identified on the inferior surface of the mid-sagittally-sectioned cerebellum
- *nodulus* –most inferior position of the *vermis* demarcated by the *posterolateral fissure*.
- *flocculus* – small, lateral hemispheric extension of the *nodulus* located adjacent to the inferior surface of the *middle cerebellar peduncle*.
- *vallecula cerebelli* – deep median fossa on the inferior side of the *cerebellum*.
- *cerebellar tonsils* – partially form the lateral walls of the *vallecula cerebelli* fossa.

Flocculo-nodular lobe

- *is composed of the flocculus and nodulus (obviously).*
- *is comparatively small in the human brain.*

[a] *functions as the vestibulocerebellum.*

Important clinical concept

When intracranial pressure rises, the cerebellar tonsils may be herniated into the foramen magnum, compressing the medulla's respiratory centers and causing death.

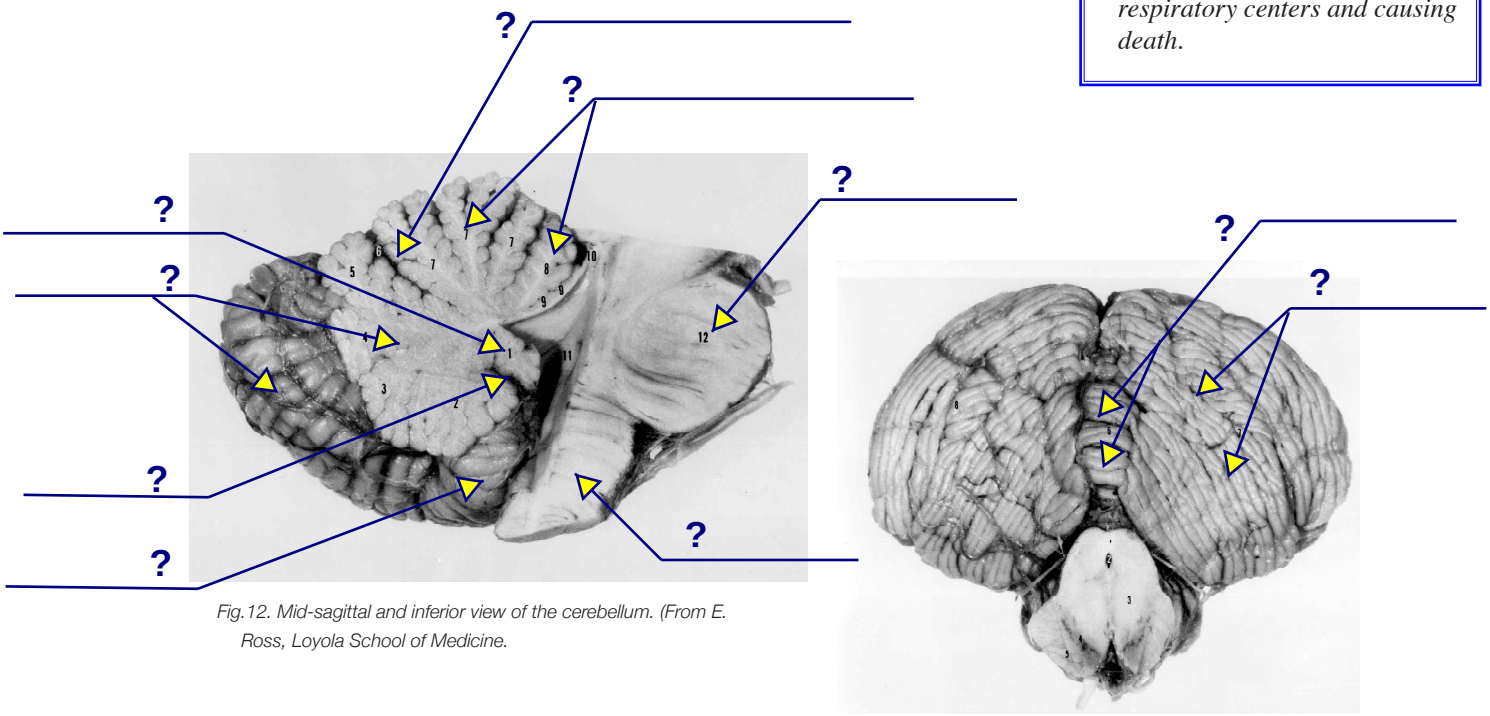


Fig.12. Mid-sagittal and inferior view of the cerebellum. (From E. Ross, Loyola School of Medicine.

Cerebellar Peduncles

• three paired cerebellar peduncles connect the cerebellum with the brain stem.

Label the following on Figure 13 and identify on gross brain specimens and models:

• *middle cerebellar peduncle* (brachium pontis) – by far the largest and originates from the transversely-oriented fibers of the *pons*.

• *inferior cerebellar peduncle* (restiform body) – curves from the *medulla* into the *cerebellum* on the medial aspect of the middle peduncle and thus forms part of the lateral wall of the *fourth ventricle*.

• *superior cerebellar peduncle* (brachium conjunctivum) – travels in the lateral margin of the *superior medullary velum* toward the *midbrain*.

Identify the following on Figure 13.			
• *sup cerebellar peduncle*	• *sup colliculus*	• *median eminence*	• *tuberculum gracilis*
• *mid cerebellar peduncle*	• *inf colliculus*	• *facial colliculus*	• *tuberculum cuneatus*
• *inf cerebellar peduncle*	• *CN IV*	• *stria medullares*	• *fasc. gracilis*
• *sup medullary velum*	*brachium of the inf collic.*	• *obex*	• *fasc. cuneatus*

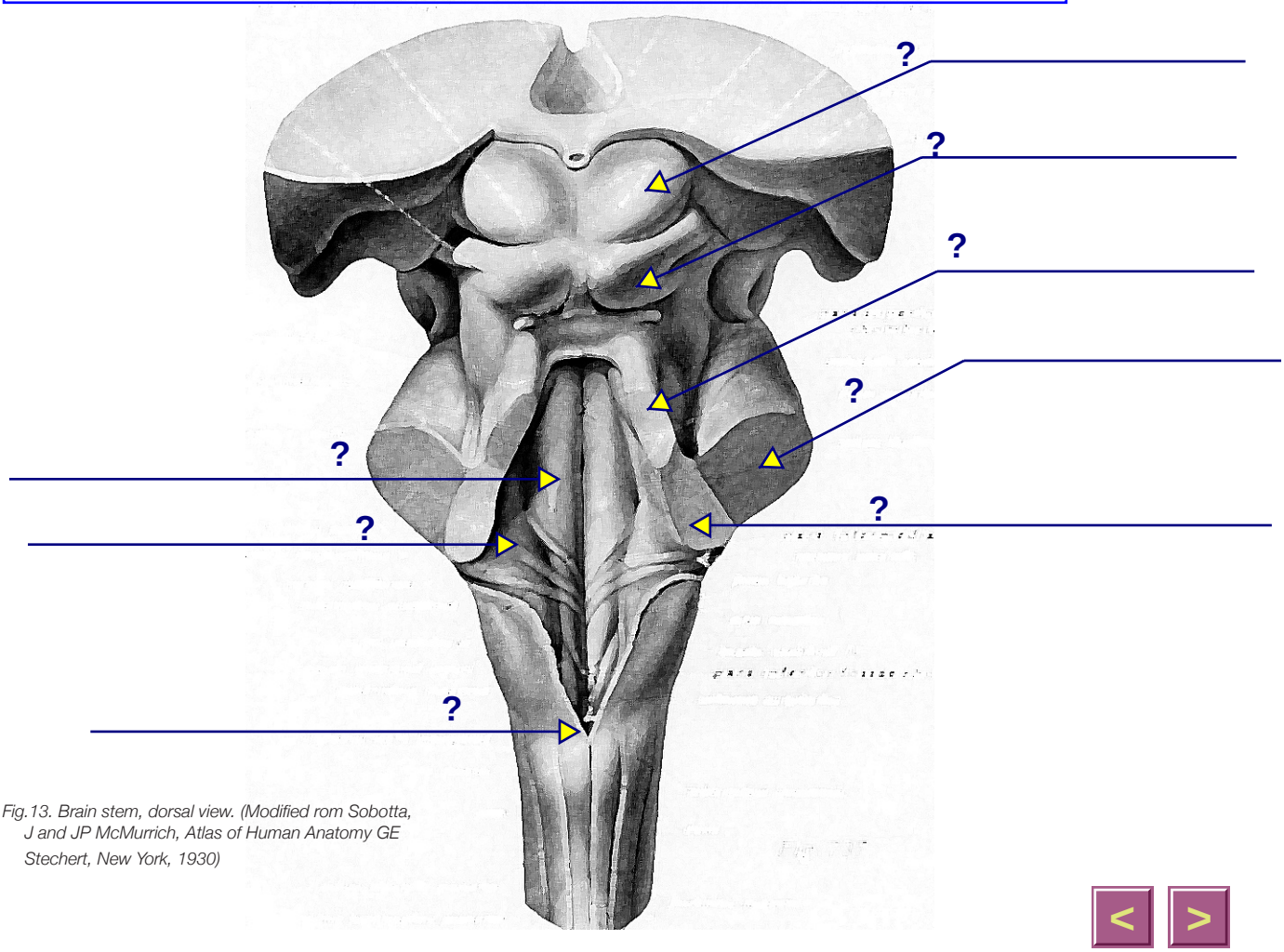


Fig.13. Brain stem, dorsal view. (Modified rom Sobotta, J and JP McMurrich, Atlas of Human Anatomy GE Stechert, New York, 1930)

Case break

1. What is an arteriovenous malformation? (R, p. 1313)

2. What is an arteriovenous anastomosis and is it pathological? (JC, p. 225)

3. What kind of tumor is found predominately in the cerebellum of children? From what tissue does it develop? (CMNW, p221; R, p. 1348)

4. Where is CSF produced? …absorbed? Describe the histology of these structures. (CMNW, p, 30: JC, p. 176)

5. What is normal CSF pressure and what conditions may alter it? (BL, p. 96)

6.
Define muscle sarcoplasmic reticulum and discuss it in relation to the regulation of cellular calcium ions. (BL, p. 292; A et al., pp. 184, 964)

Refs_____

A et al – Alberts, et al., "Molecular Biology of The Cell" Garland Science, 2002.
BL – Berne, RM and MN Levy, "Physiology, 3rd Edition" Mosby Year Book, 1993.
CMNW – Castro, AJ, MP Merchut, EJ Neafsey and RD Wurster, "Neuroscience: An Outline Approach" Mosby, 2002.
JC – Junqueira, LC and J Carneiro, "Basic Histology, 10th Edition" Lange, 2003.
MD – Moore, KL and AF Dalley, "Clinically Oriented Anatomy, 4th Edition" Lippincott Williams & Wilkins, 1999.
R – Cotran, RS, et al., "Robbins Pathologic Basis of Disease, 6th Edition" W.B. Saunders Company, 1999.

Inter-Course Q's

Study Questions – Cerebral Cortex

1. What are the Brodmann numbers of the...
   _____ primary motor cortex in the precentral gyrus?
   _____ primary somatosensory cortex in the postcentral gyrus?
   _____ primary auditory cortex in the transverse temporal gyri?
   _____ primary visual cortex in the banks of the calcarine fissure?

2. Where is the frontal eyefield?

3. What deficit would you expect with damage to the left inferior frontal gyrus in a right-handed individual? ...in a left-handed individual?

4. How could you test the laterality of language function in a patient?

5. How could temporal lobe lesions affect vision?

6. What is the topographic organization of bodily movements in the precentral gyrus?

7. Where is the striate cortex?

8. What deficits result from occlusion of the anterior cerebral artery? ...the middle cerebral artery? ...the posterior cerebral artery?

Study Questions – Cerebellum

1. Identify the areas of the cerebellum associated with its functional subdivisions:
   ...vestibulocerebellum

   ...spinocerebellum

   ...neocerebellum.

2. What are climbing fibers? ...mossy fibers?

3. Name the component tracts of each cerebellar peduncle.
   inferior

   middle

   superior

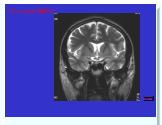
4. What is the posterior inferior cerebellar artery (PICA) syndrome?

5. Where do Purkinje cells axons terminate? Are they inhibitory, facilitatory, or mixed?

MRI Review

Label the following structures on Figure. 15.

• sup, middle and inf frontal gyri	• lateral fissure
• sup, middle and inf temporal gyri	• insula
• lateral ventricles	• internal carotid artery
• septum pellucidum	• middle cerebral artery
• corpus callosum	• superior sagittal sinus



Rand Atlas(T2)

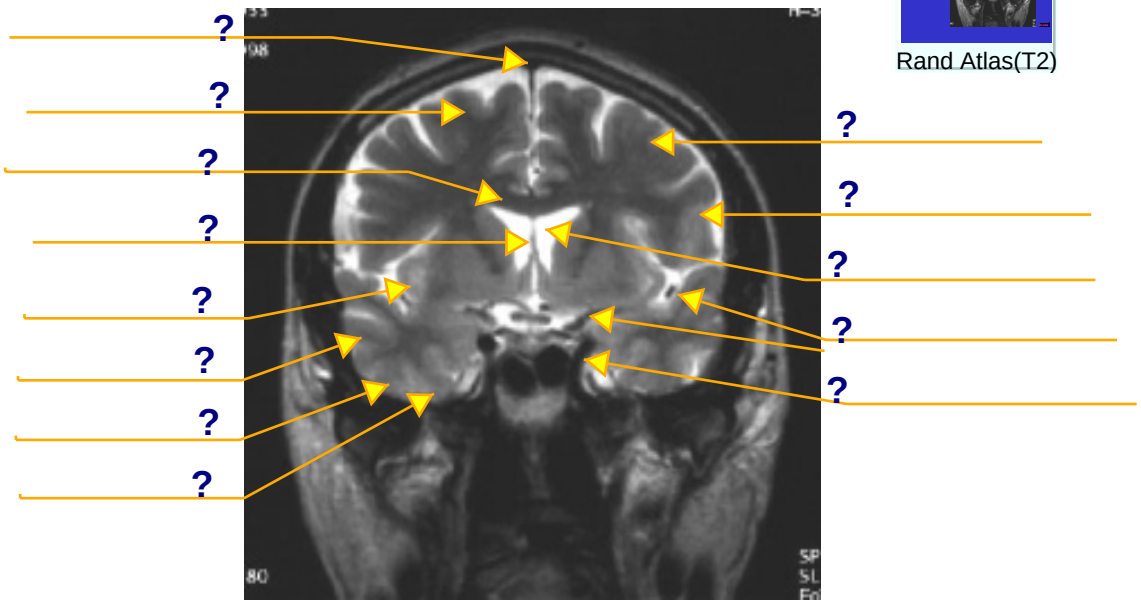


Fig. 15. Coronal MRI (T2) through the frontal lobe. (From R, Swenson, Dartmouth Medical School)

Label the following structures on Figure 16.

- *frontal pole*
- *occipital pole*
- *genu and splenium of the corpus callosum*
- *lateral ventricles*
- *septum pellucidum*
- *insula*
- *superior sagittal sinus*

Rand Atlas(T1

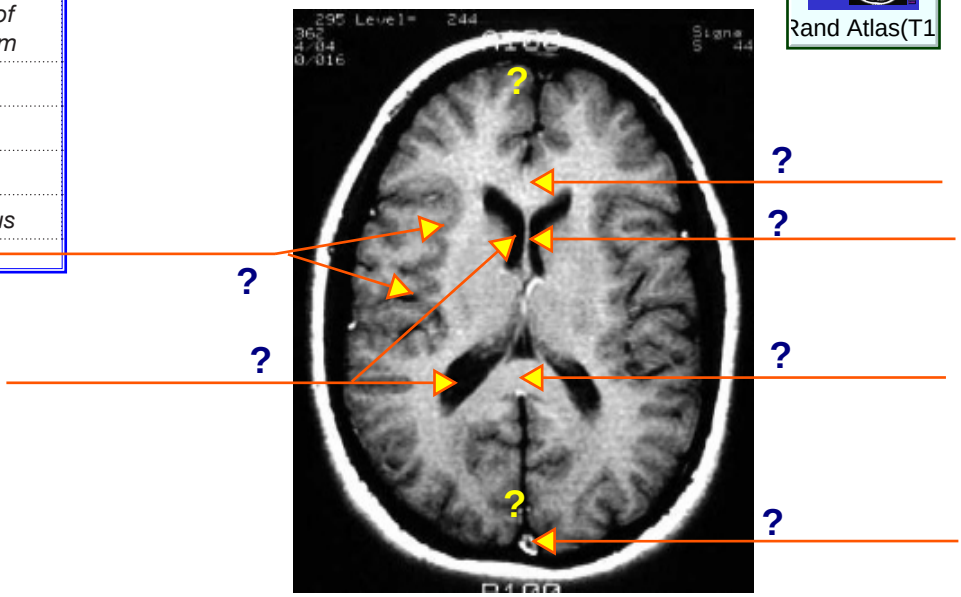
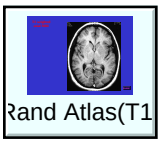


Fig. 16. Axial MRI (T1) through the hemisphere. (From R, Swenson, Dartmouth Medical School)

MRI Review (cont'd)

Label the following structures on Figure 17:

• *lateral ventricles*	• *foramen of Monroe*
• *fornix*	• *temporal lobe*
• *corpus callosum*	• *thalamus*
• *insula*	• *internal capsule*
• *sup sagittal sinus*	• *caudate*



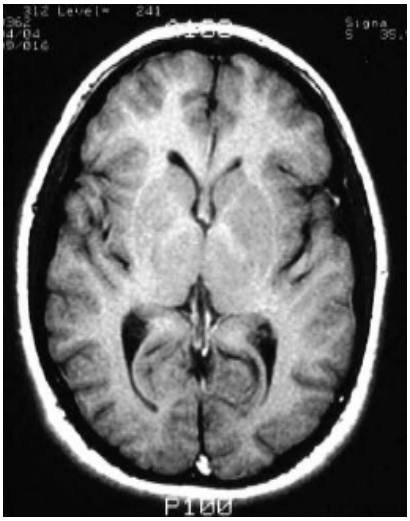


Fig. 17. Axial MRI's (T1) showing a more dorsal level of the temporal lobe as compared to figure . (From R, Swenson, Dartmouth Medical School)

Related Questions

On the Figure 17, can you identify the course of the optic radiations that project from the lateral geniculate at the caudal end of the thalamus to the calcarine cortex in the occipital lobe?

Also, what part of the frontal lobe is visible.

Label the following structures on Figure 18

• *cerebellum*	• *uncus*
• *middle cerebral artery*	• *mammillary body*
• *cerebral aqueduct*	• *uncus*
• *pituitary stalk (infundibulum)*	• *orbital gyrus of the frontal lobe*

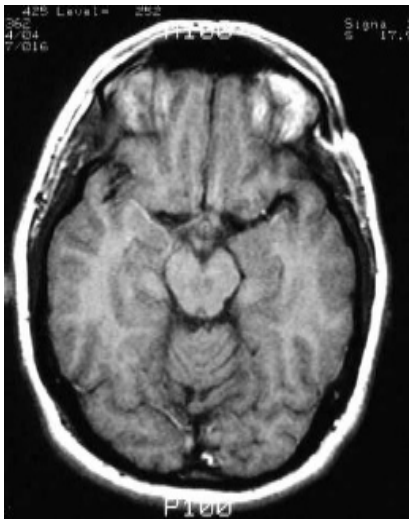


Fig. 18. Axial MRI's (T1) showing a more ventral level of the temporal lobe as compared to figure . (From R, Swenson, Dartmouth Medical School)

Related questions

What cranial nerves emerge from this level of the brain stem?

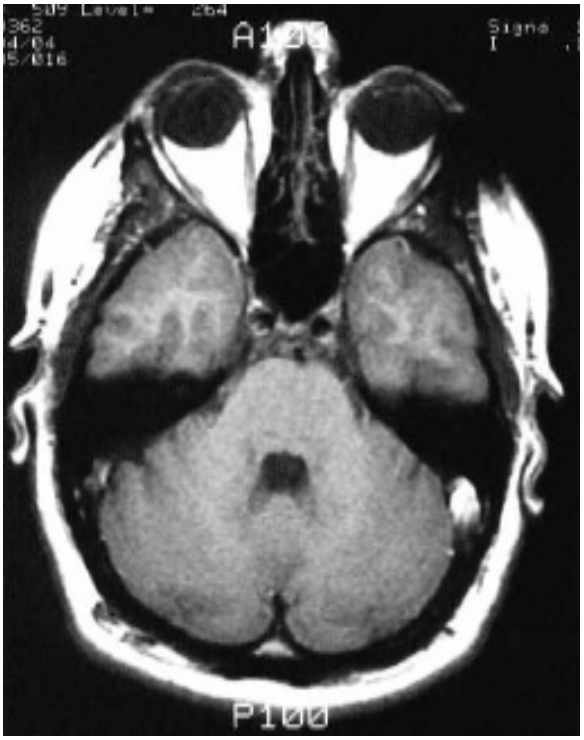
What do they innervate?

Can you trace their course? What part of the temporal lobe might they course by? (hint: uncus)

MRI Review (cont'd)

Label the following structures on Fig. 19.

- *internal carotid*
- *mid cerebellar peduncle*
- *fourth ventricle*
- *cerebellar hemisphere*
- *cerebellar vermis*
- *superior sagittal sinus*
- *basilar artery*
- *pons*



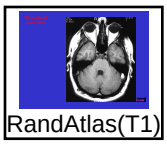


Fig. 19. Axial MRI (T1) through the cerebellum. (From R, Swenson, Dartmouth Medical School)

Label the following structures on Fig. 20:

- *cerebellum*
- *straight sinus*
- *calacarine sulcus*
- *superior sagittal sinus*
- *transverse sinus*
- *occipital lobe*

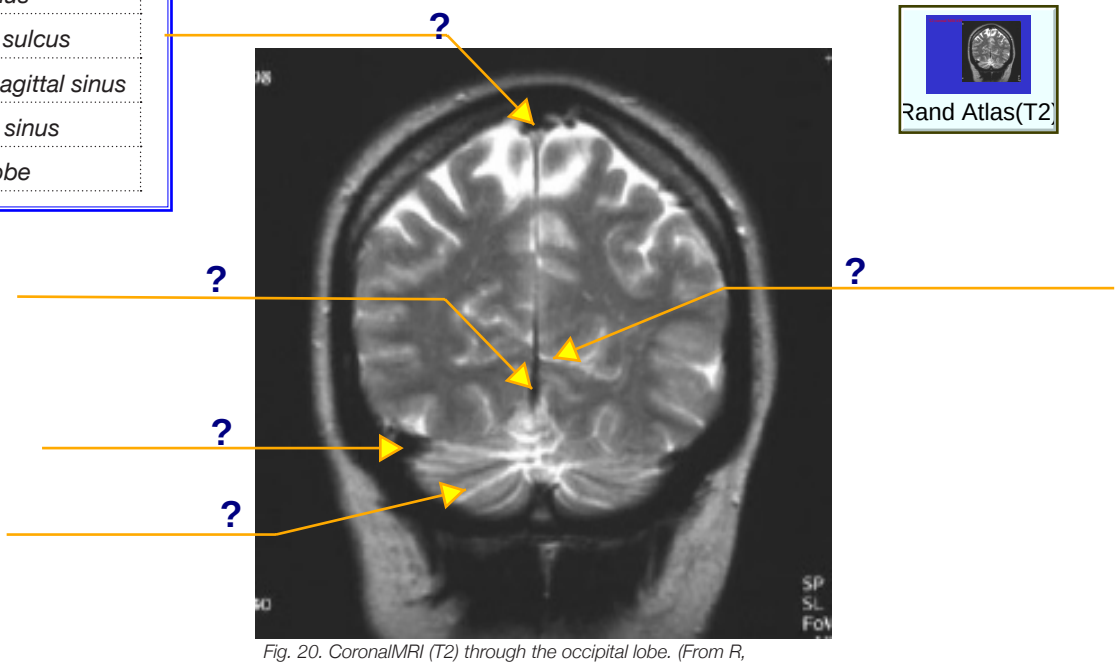


Fig. 20. CoronalMRI (T2) through the occipital lobe. (From R, Swenson, Dartmouth Medical School)

Patient Puzzle

Patient 5.1. Case of the clumsy man

Patient: Mr. Sam Anella Age: 62 Occupation: Lepidopterist

Signs and Symptoms:

- Mr. Anella demonstrates a progressively worsening uncoordinated gate.
- You observe clumsy arm movements as well.
- He complains most of "losing his balance" and therefore often uses a wheelchair.
- No somatosensory loss is detected and he shows no paralysis.
- You learn that he had a uncle who passed away with the same symptoms.

Diagnosis:

1. Is this a vestibular nerve problem? If so, what else would you look for?

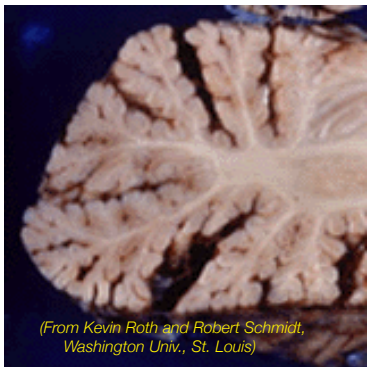
2. Do you suspect Sam had a stroke? What's the evidence for and against?

3. What about his uncle? What does this suggest?

Related questions:

1. The image to the right corresponds to this case. Do you notice anthing unsusual?

2. Would a pathology in this part of the cerebellum cause somatosensory deficits?


(From Kevin Roth and Robert Schmidt, Washington Univ., St. Louis)

3. Would a pathology in this part of the cerebellum cause any motor paralysis?

6. Name the spinocerebellar pathways related to the leg? What are their origins, course and laterality? How do they enter the cerebellum?

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