

Analysis of Functional Magnetic Resonance Imaging (fMRI) Neuroanatomy and Image Atlas

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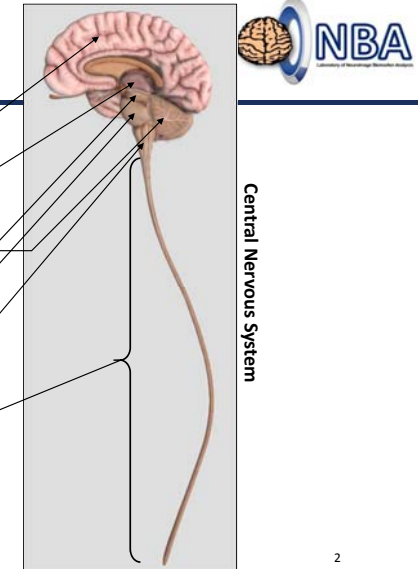
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March 12, 2019

Regional Neurobiology

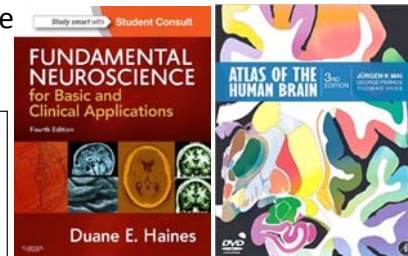
- Telencephalon (Cerebrum)
- Diencephalon (Thalamus)
- Rhombencephalon (Cerebellum)
- Brain stem
 - Midbrain
 - Pons
 - Medulla oblongata
- Spinal cord



Textbooks

- Gross Anatomy
- Lobes of the Cerebral Cortex
- White Matter of the Cerebral Hemisphere
- Basal Nuclei

- Fundamental Neuroscience (4th edition)
 - Chapter 16: The Telencephalon
- Atlas of the Human Brain (3rd edition)

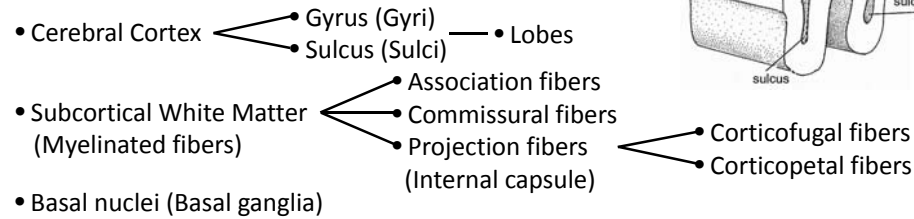


Lobes of the Cerebral Cortex

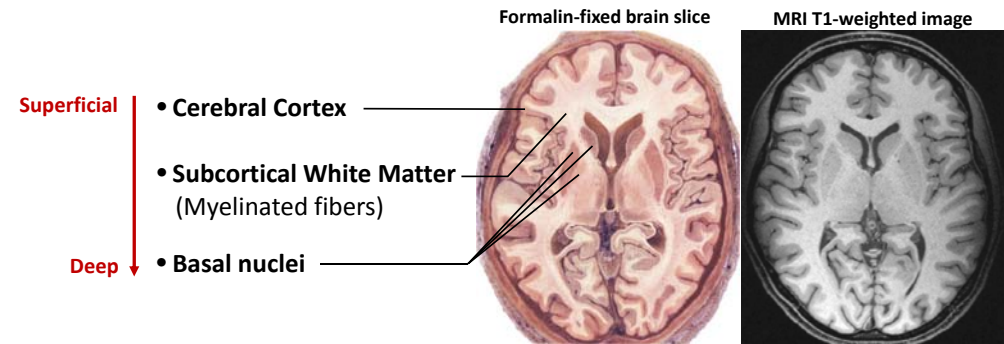
Frontal, parietal, temporal, occipital, insular, and limbic lobes

Telencephalon 端腦

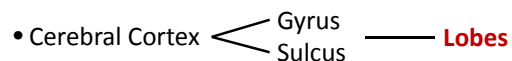
The largest part of human brain (~ 85% of total brain weight)








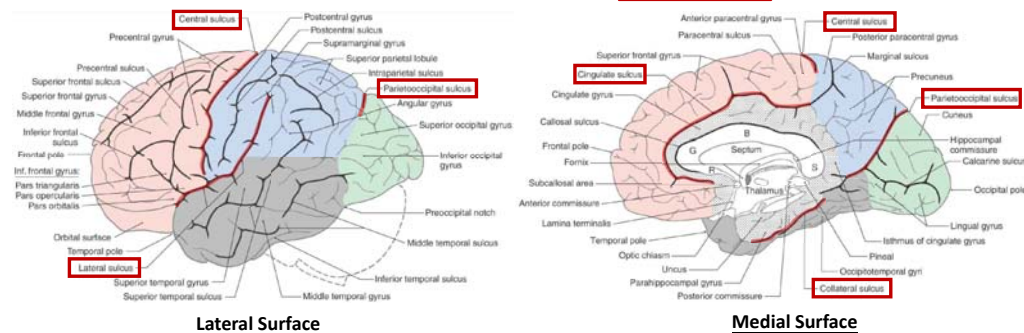
Telencephalon (Cerebrum)



Sulci & Lobes of cerebrum



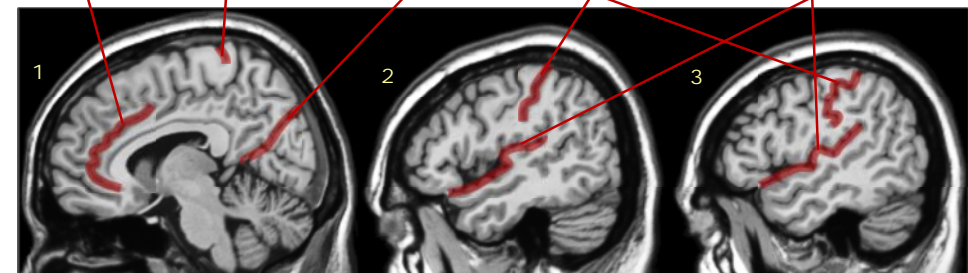
Frontal lobe	
Parietal lobe	
Occipital lobe	
Temporal lobe	
Limbic lobe	



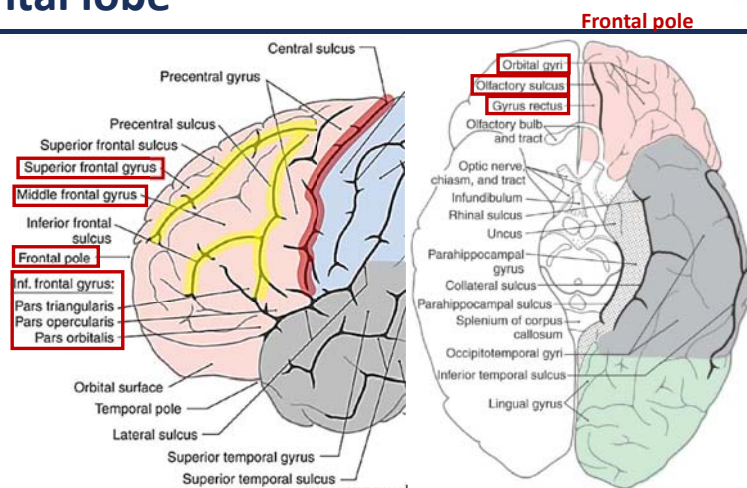
Sulci & Lobes of cerebrum



Cingulate sulcus Central sulcus Parietooccipital sulcus Central sulcus Lateral sulcus (sylvian fissure)



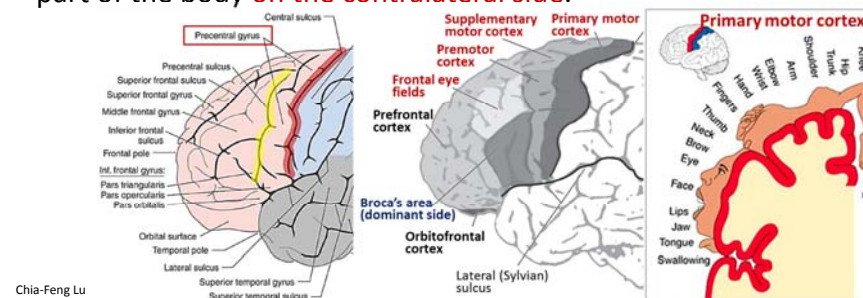
Frontal lobe



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Frontal lobe - motor cortex (labeled in red)

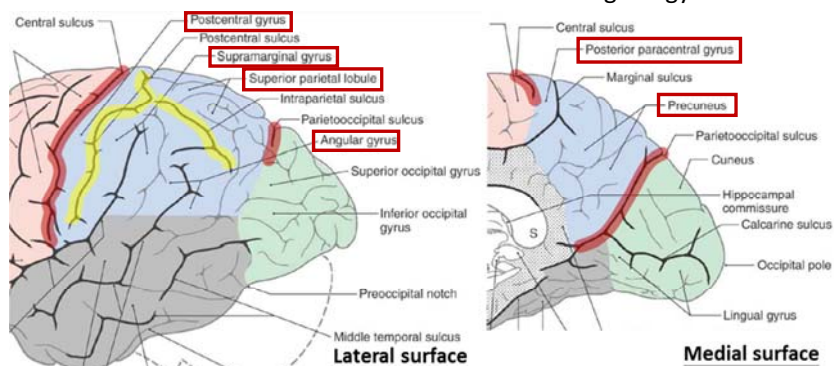
- Involvement of the **planning, control (preparation), and execution** of voluntary movements.
- Lesions of these areas: **weakness or paralysis** of the corresponding part of the body **on the contralateral side**.



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Parietal lobe

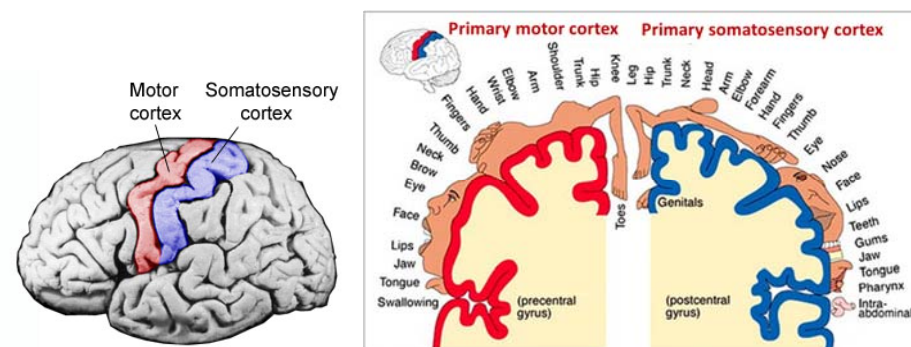
- Postcentral gyrus & Posterior paracentral gyrus
- Superior parietal lobule & Precuneus
- Inferior parietal lobule
 - Supramarginal gyrus
 - Angular gyrus



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Parietal lobe – Primary somatosensory cortex

Postcentral gyrus + posterior paracentral gyrus

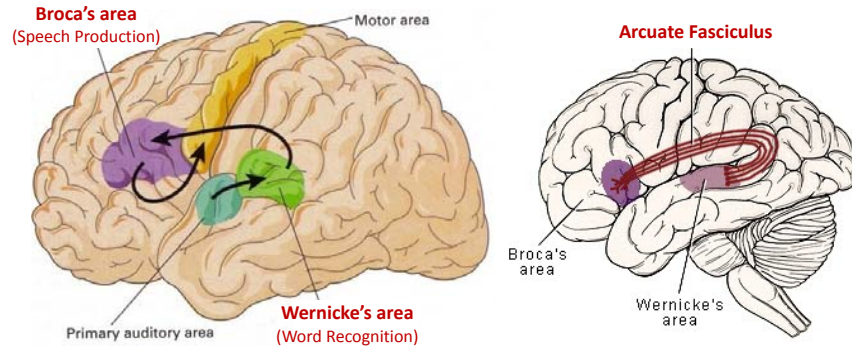


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Parietal lobe – Wernicke's area

- Supramarginal gyrus
- Angular gyrus

Circuits of language communication

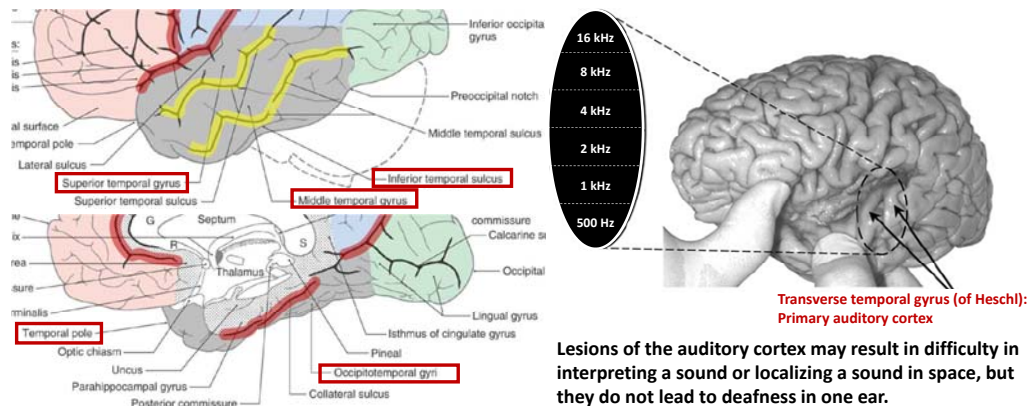


Aphasia

- **Broca aphasia (expressive aphasia):** These patients do not have paralysis of the speech apparatus but have **great difficulty translating thoughts and concepts into coherent sentences.**
- **Wernicke aphasia (receptive aphasia):** These patients cannot understand what they hear, cannot read or write, and speak in a jumble of words that makes no sense. **Information is received but it cannot be understood or used to express coherent thought.**

Temporal lobe

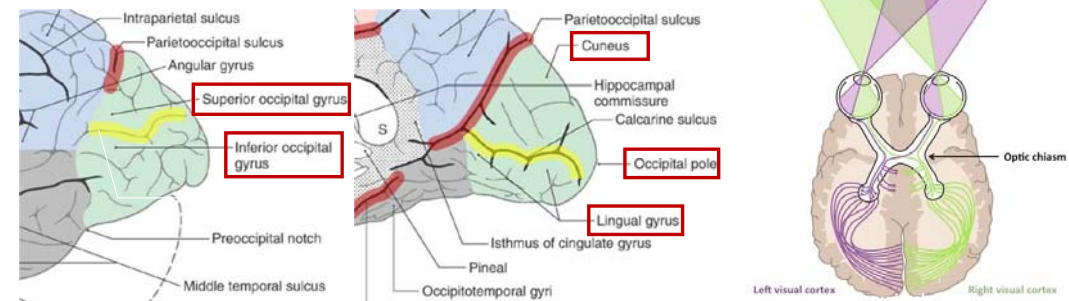
Between the **lateral sulcus** and the **collateral sulcus**



Lesions of the auditory cortex may result in difficulty in interpreting a sound or localizing a sound in space, but they do not lead to deafness in one ear.

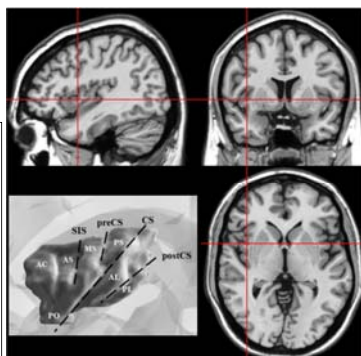
Occipital lobe

- **Homonymous hemianopia:** A lesion of the primary visual cortex of one occipital lobe results in a loss of visual input from the contralateral half of the visual field of each eye.

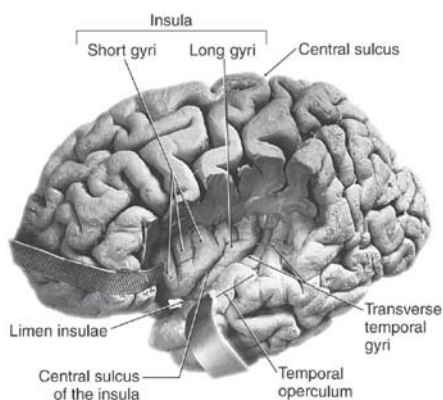


Insular lobe receives nociceptive and viscerosensory input

- Cerebral Cortex
 - Gyrus
 - Sulcus
- Lobes

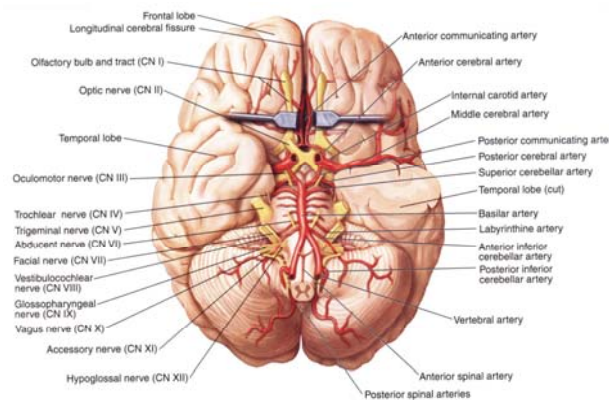


- CS: Central sulcus
- PreCS: Precentral sulcus
- PostCS: Postcentral sulcus
- SIS: Short insular sulcus
- AC: Accessory gyrus
- AS: Anterior short gyrus
- MS: Middle short gyrus
- PS: Posterior short gyrus
- AL: Anterior long gyrus
- PL: Posterior long gyrus
- PO: pole of insula



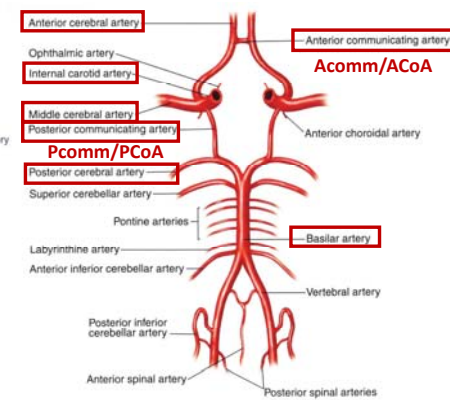
Chia-Feng Lu <http://www.ym.edu.tw/~cflu>

Vasculature of cerebrum

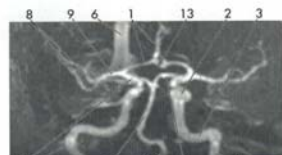


Chia-Feng Lu <http://www.ym.edu.tw/~cflu>

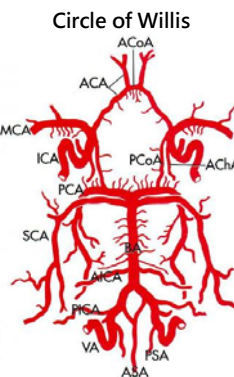
Circle of Willis



MR Angiography

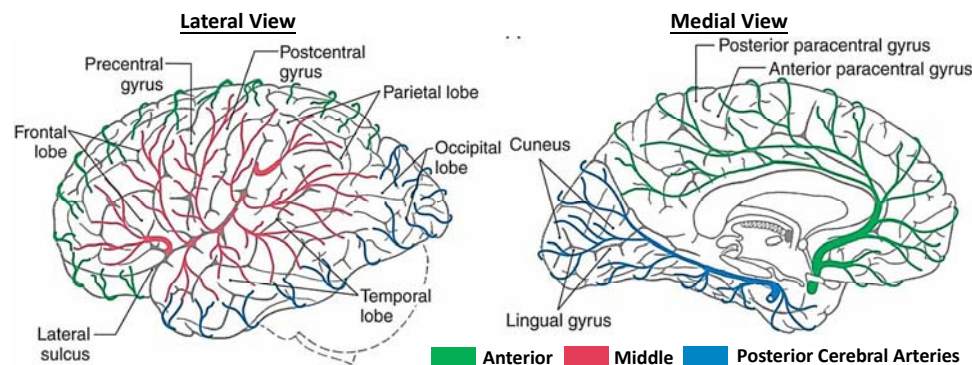


1. Anterior cerebral a. (ACA)
2. Cavernous sinus part
3. Temporal bone part
4. Posterior cerebral a. (PCA)
5. Basilar a. (BA)
6. Superior sagittal sinus
7. Posterior communicating a. (PCoA)
8. Branch on the surface of the insula
9. Middle cerebral a. (MCA)
10. ophthalmic a.
11. Internal carotid a. (ICA)
12. Vertebral a. (VA)
13. Anterior communicating a. (ACoA)



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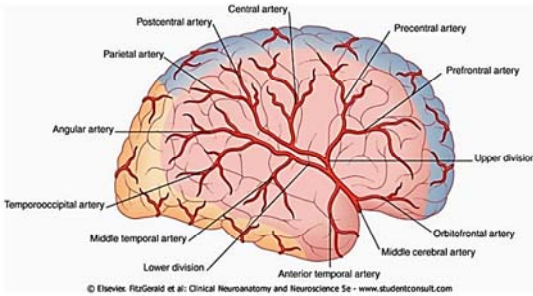
Vasculature of cerebrum



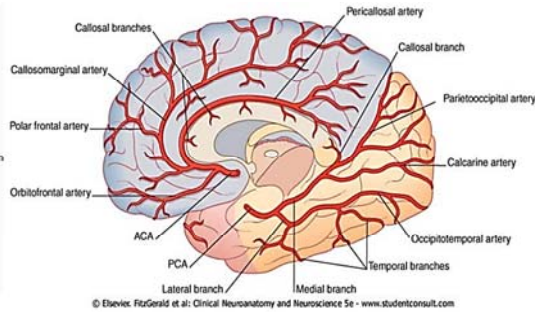
Chia-Feng Lu <http://www.ym.edu.tw/~cflu>

Vasculature of cerebrum

Lateral View



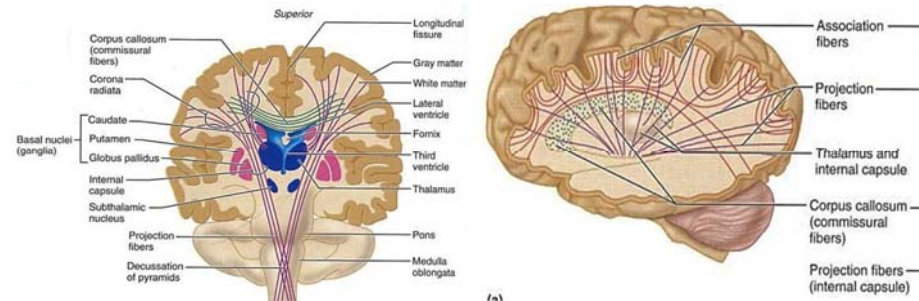
Medial View



White Matter of the Cerebral Hemisphere

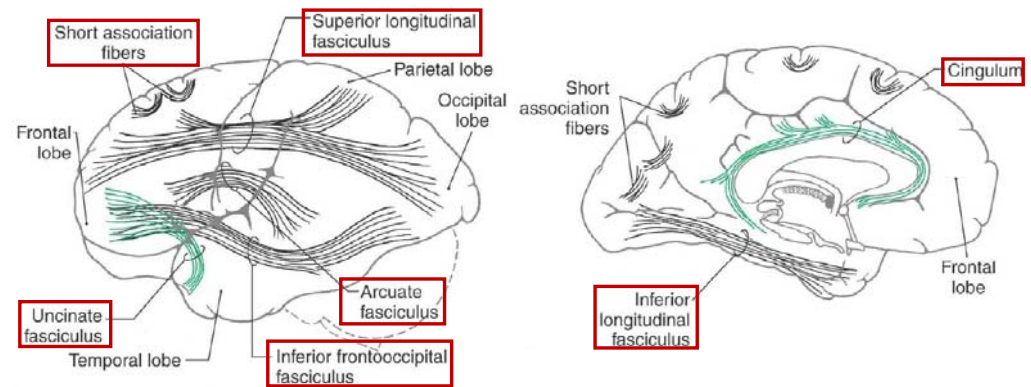
White Matter

- Myelinated fibers
 - Association fibers
 - Commissural fibers
 - Projection fibers



Association Fibers

Interconnect various cortical areas within the same hemisphere.



Association Fibers

MR-Diffusion Tensor Tractography

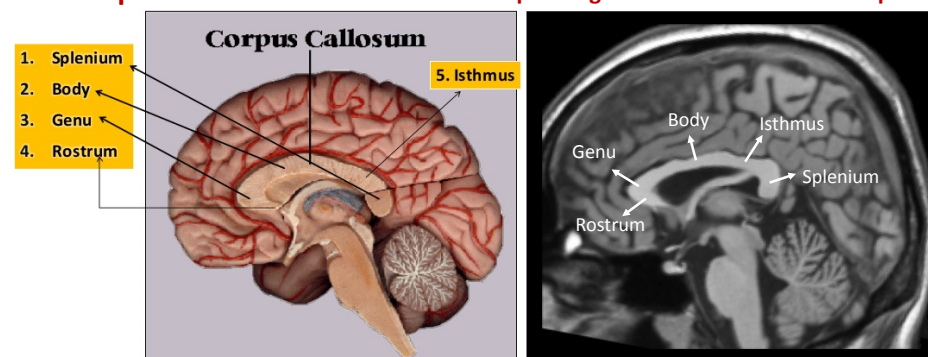
- Superior longitudinal fasciculus (yellow)
- Inferior longitudinal fasciculus (brown)
- Uncinate fasciculus (red)
- Superior fronto-occipital fasciculus (light yellow)
- Inferior fronto-occipital fasciculus (orange)



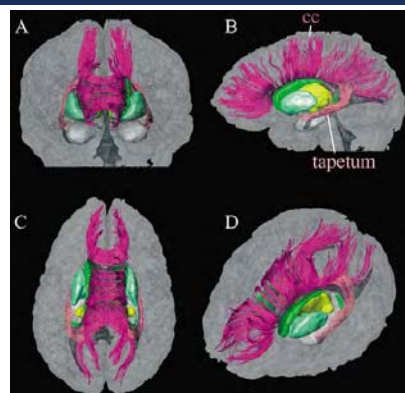
Mori et al. MRI Atlas of Human White Matter, Elsevier, 2005.

Commissural Fibers

The Corpus Callosum: interconnects corresponding structures on either hemisphere.

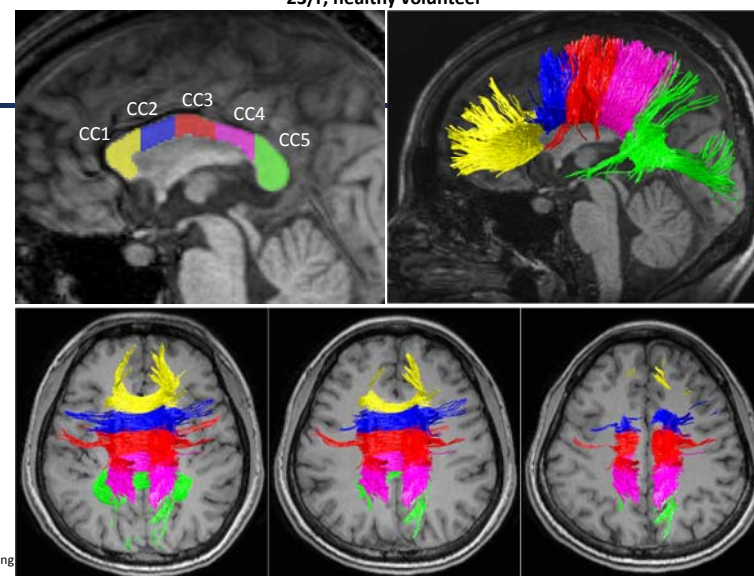


Commissural Fibers

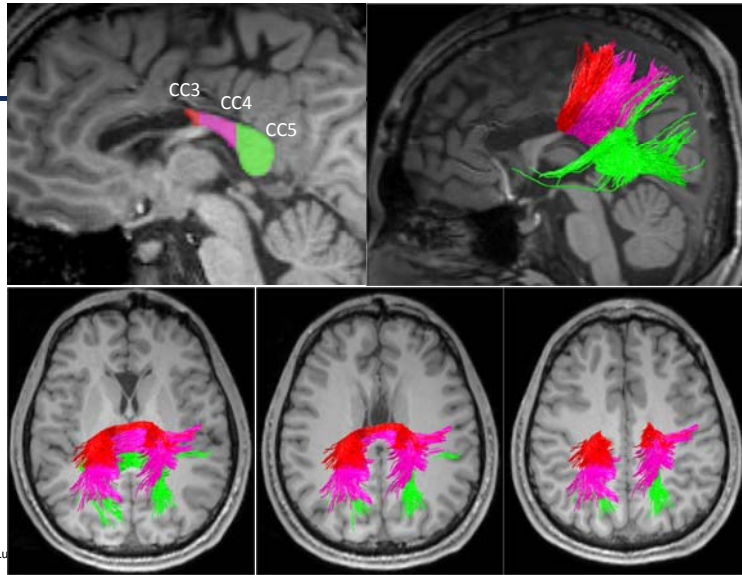


- **Corpus callosum (cc)**
 - Contains more than 300 million axons
 - The largest fiber bundle in the human brain
 - Interconnect homologous cortical area between hemispheres
- MR-DTI tractography often fails to reveal commissural connections to the lateral areas of the hemispheres.

23/F, healthy volunteer



21/M, with anterior corpus callosotomy



Projection Fibers

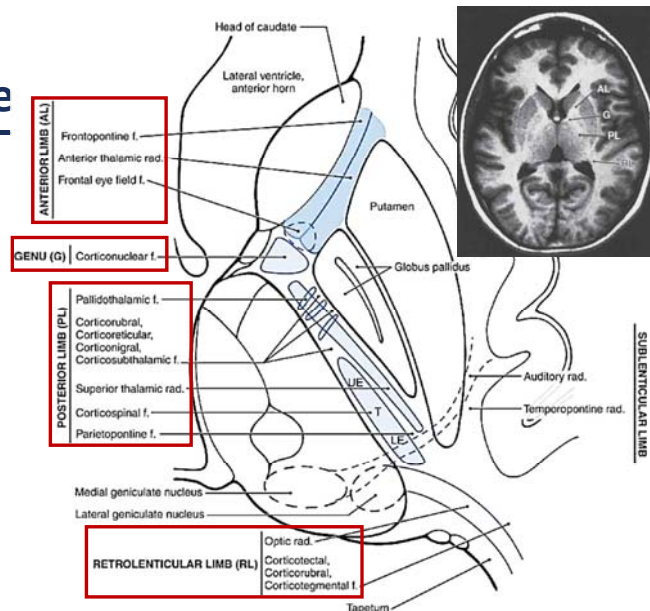


Projection fibers are organized into a large, compact bundle called the **internal capsule**.

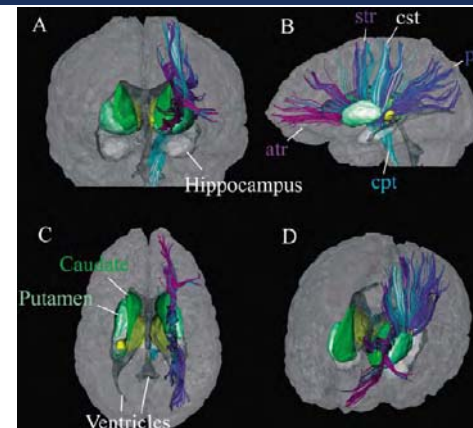
- **Corticopetal fibers (afferent)**: the axons that originate outside the telencephalon and project to the cerebral cortex.
 - Thalamocortical fibers
- **Corticofugal fibers (efferent)**: the axons that arise from cerebral cortical cells and project to downstream targets.
 - Corticospinal, corticopontine, and corticothalamic fibers

Internal Capsule

- Anterior limb
- Genu
- Posterior limb
- Retrolenticular limb

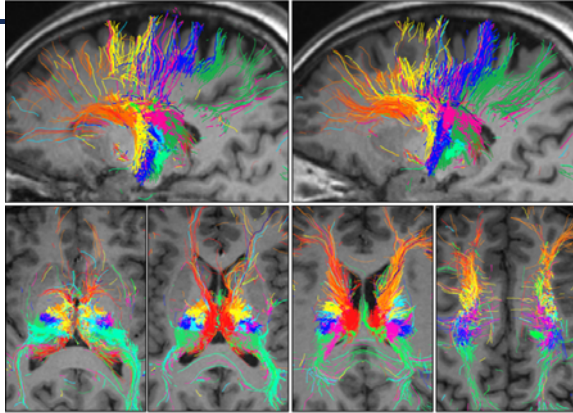


Projection Fibers

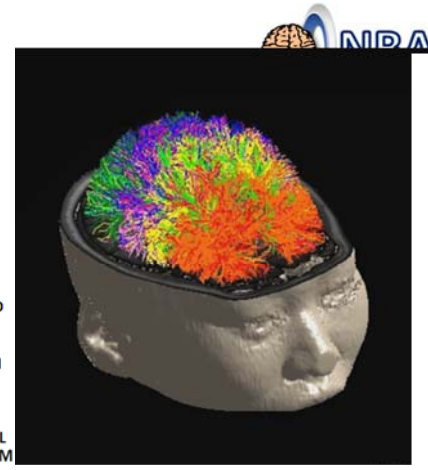


- Anterior thalamic radiation (atr)
- Superior thalamic radiation (str)
- Posterior thalamic radiation (ptr)
- Corticospinal tract (cst)
- Corticopontine tract (cpt)

Cross-sectional Thalamocortical Tracts

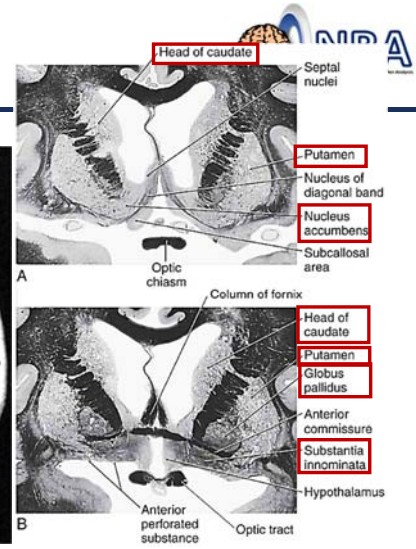
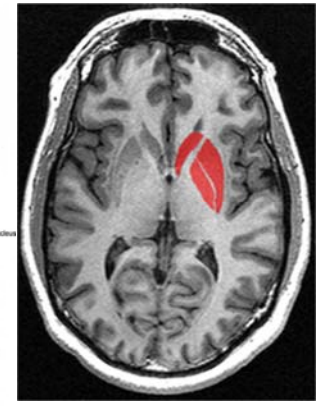
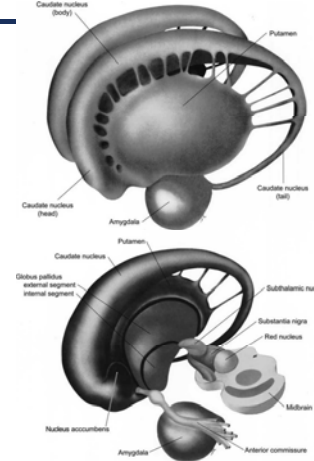


- MD
- LD
- LP
- CM
- AN
- VA
- VL
- VPM
- VPL
- PU
- MG



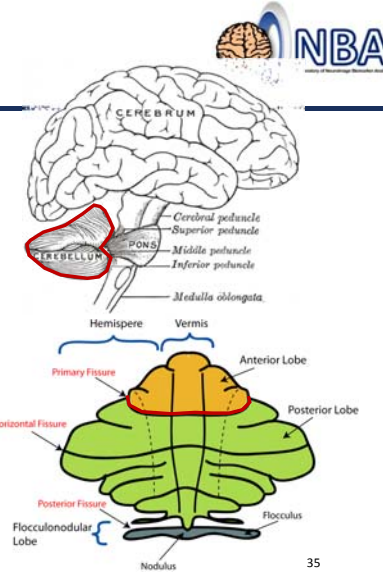
Constructed by Chia-Feng Lu, using 3T MRI, 64-channel head coil

Basal Nuclei Caudate Nucleus, Putamen, and Globus Pallidus



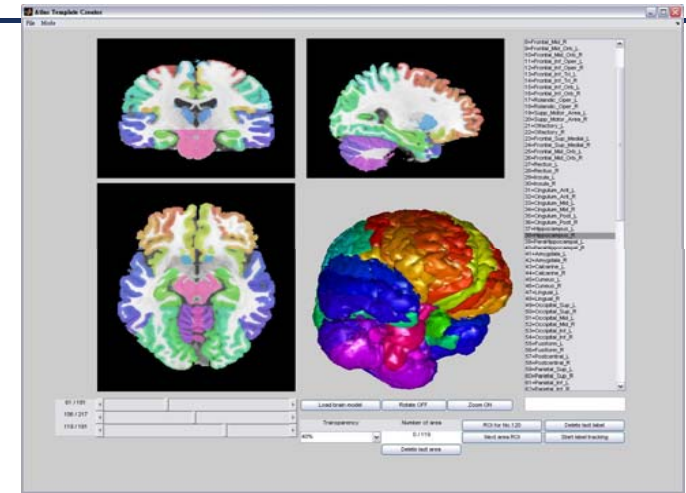
Cerebellum

- The cerebellum plays an important role in **motor control**.
- The human cerebellum does not initiate movement, but contributes to **coordination, precision, and accurate timing**.
- It may also be involved in some cognitive functions such as **attention and language** as well as in **regulating fear and pleasure responses**.



<https://en.wikipedia.org/wiki/Cerebellum>

ImageAtlasUI www.ym.edu.tw/~cflu/ImageAtlasUI.zip Developed by Chia-Feng Lu



AAL 116 atlas



THE END

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Teaching Materials: http://www.ym.edu.tw/~cflu/CFLu_course_fMRIana.html