open.michigan

Author(s): Peter Hitchcock, PH.D., 2009

Citation Key

for more information see: http://open.umich.edu/wiki/CitationPolicy

Use + Share + Adapt

{ Content the copyright holder, author, or law permits you to use, share and adapt. }

Public Domain – Government: Works that are produced by the U.S. Government. (USC 17 § 105)

Public Domain – Expired: Works that are no longer protected due to an expired copyright term.

Public Domain – Self Dedicated: Works that a copyright holder has dedicated to the public domain.

Creative Commons – Zero Waiver

Creative Commons – Attribution License

Creative Commons – Attribution Share Alike License

Creative Commons – Attribution Noncommercial License

Creative Commons – Attribution Noncommercial Share Alike License

GNU – Free Documentation License

Make Your Own Assessment

{ Content Open.Michigan believes can be used, shared, and adapted because it is ineligible for copyright. }

Public Domain – Ineligible: Works that are ineligible for copyright protection in the U.S. (USC 17 § 102(b)) *laws in your jurisdiction may differ

{ Content Open.Michigan has used under a Fair Use determination. }

Fair Use: Use of works that is determined to be Fair consistent with the U.S. Copyright Act. (USC 17 § 107) *laws in your jurisdiction may differ

Our determination **DOES NOT** mean that all uses of this 3rd-party content are Fair Uses and we **DO NOT** guarantee that your use of the content is Fair.

To use this content you should **do your own independent analysis** to determine whether or not your use will be Fair.

Cerebral Cortex

M1 – CNS Sequence

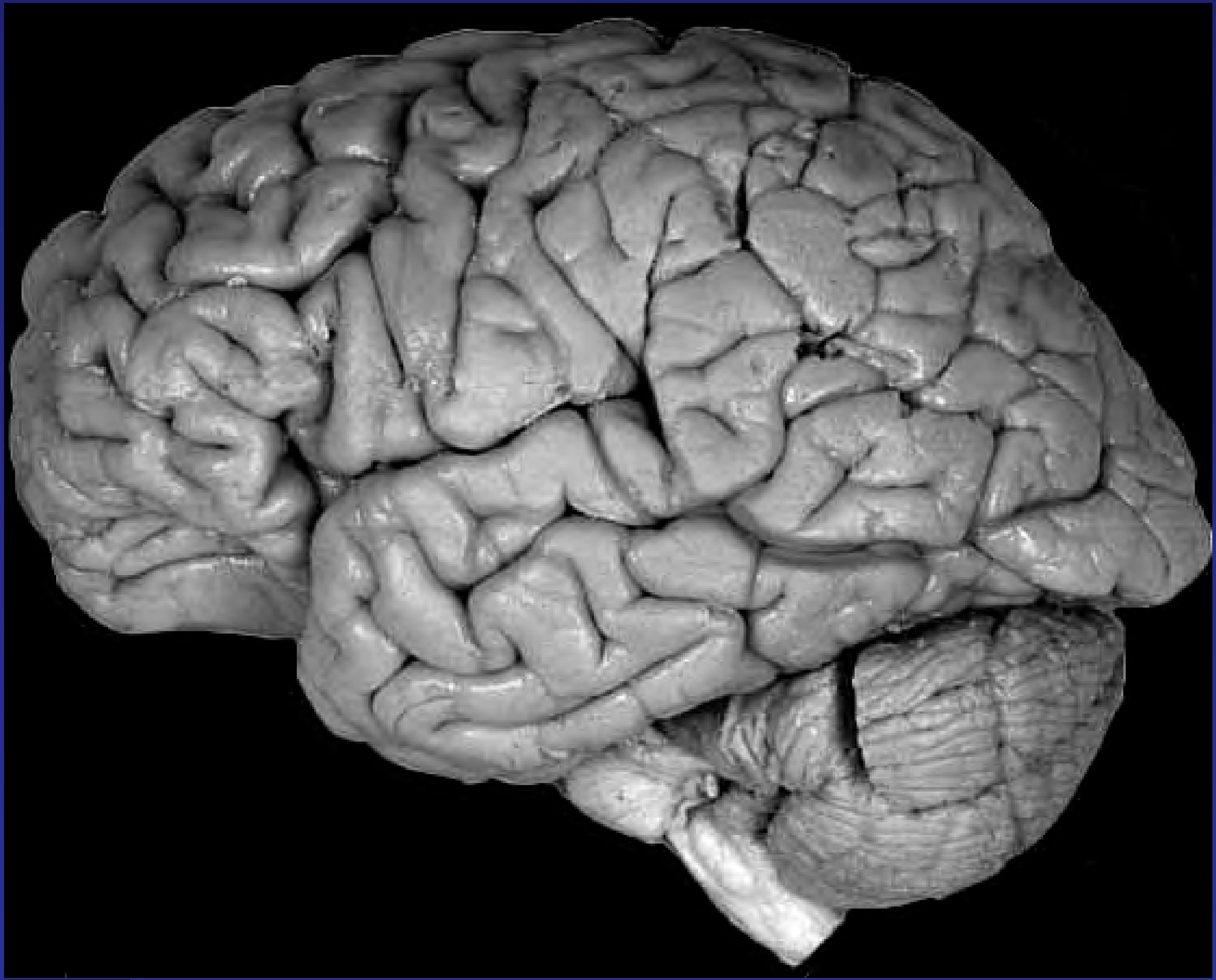
Peter Hitchcock, Ph.D.

Winter, 2009

University of Michigan
Medical School

The topic of today' s lecture is the cerebral hemispheres-the cerebral cortex and the underlying subcortical white matter.

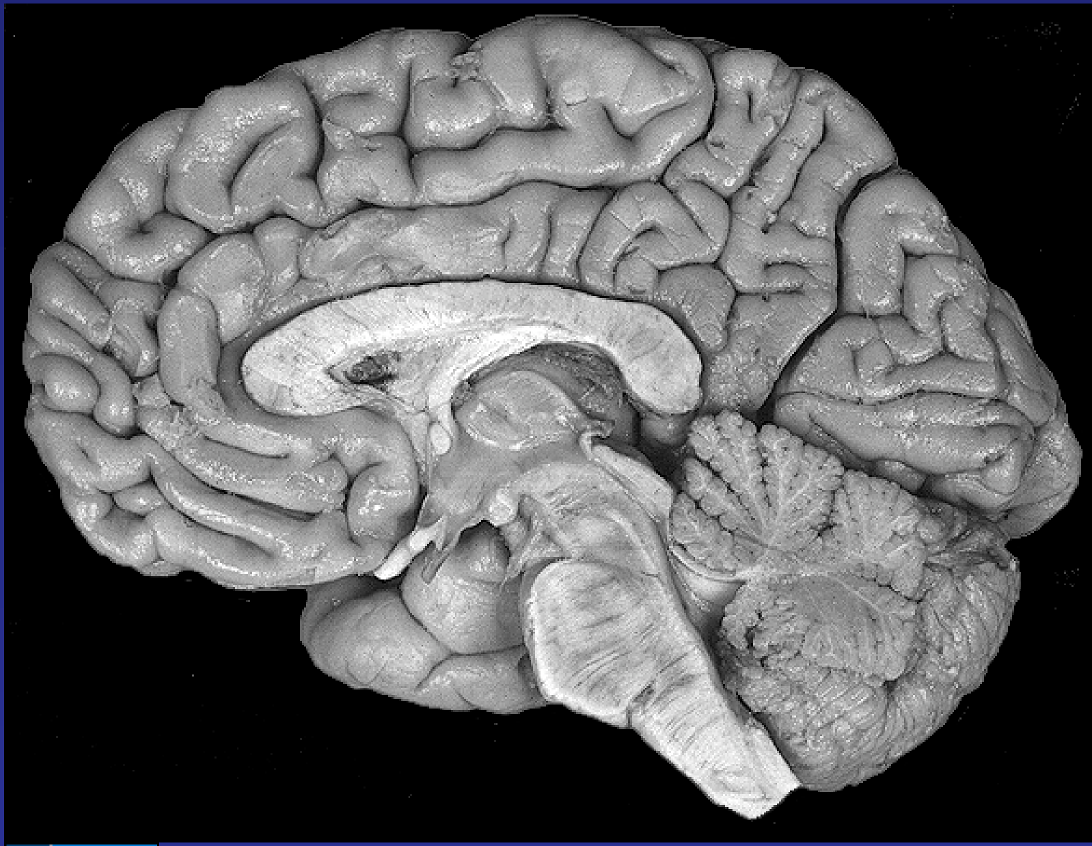
I. subdivisions of cerebral cortex
II. cellular anatomy of neocortex
III. anatomical subdivisions of neocortex
IV. functional subdivisions of neocortex
V. specializations of each hemisphere; hemispheric dominance
VI. subcortical white matter
VII. genetic defects in cortical development
VIII. imaging electrical activity in the cerebral cortex
IX. blood supply to the cerebral hemispheres
X. a word about consciousness



PD-INEL Source Undetermined

The cerebral cortex is the site of the highest order integration of sensory, motor and consciousness activities.

- The cerebral cortex in 80% of the mass of the brain.
- The surface area is roughly equivalent to a page of newspaper (2.5ft^2).
- The gray matter consists of cell bodies of neurons that are arranged in layers
- Underlying the gray matter is a large area of white matter.
- There are three basic types of cortex:
  - Neocortex (new)
  - Mesocortex (middle)
  - Allocortex (other)
- cortical areas.



PD-INEL Source Undetermined


Neocortex (90%)
Meso- and Allo-cortex (10%)

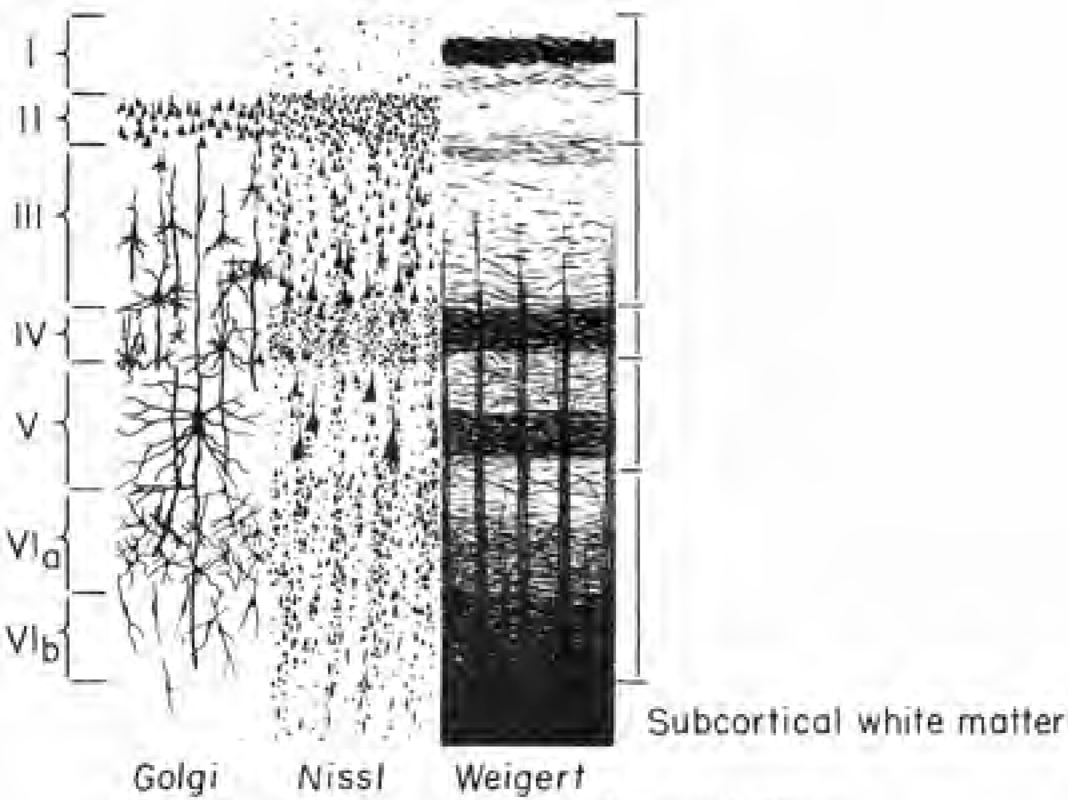
Tabulated data on the different types of cortex:

neocortex (new cortex) - 6 layers
- a. ideotypic cortex - 1° motor and sensory cortex
- b. homotypic cortex - association areas
  - 1. unimodal association cortex -
  - 2. multimoldal association cortex -

mesocortex (middle cortex) - 3-6 layers - related to limbic system -
- a. cingulate gyrus
- b. parahippocampal gyrus

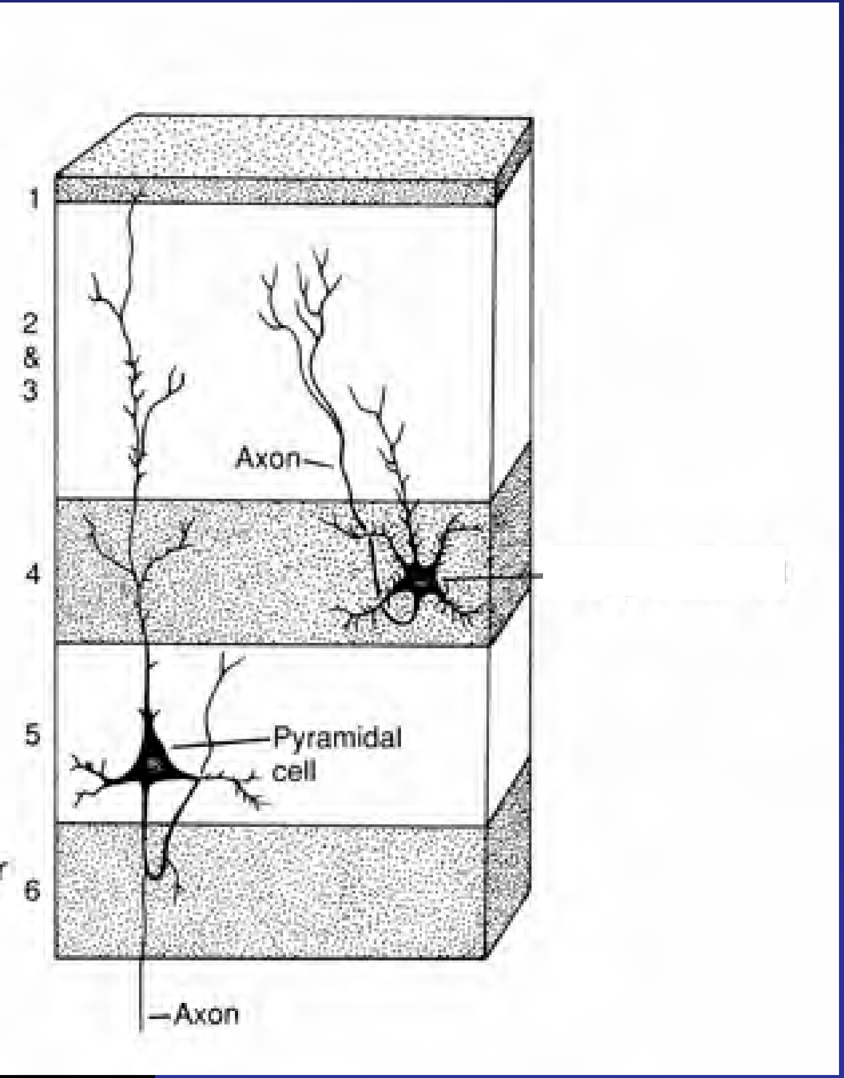
allocortex (other cortex) - 3 layers
- a. archicortex - hippocampal formation
- b. paleocortex – piriform cortex

Neocortex constitutes approximately 90% of all cortex and contains 6 identifiable cellular layers. The major neuronal types in neocortex are the pyramidal cells and granule cells.



The cell layers and fiber arrangement of the human cerebral cortex

PD-INEL Source Undetermined



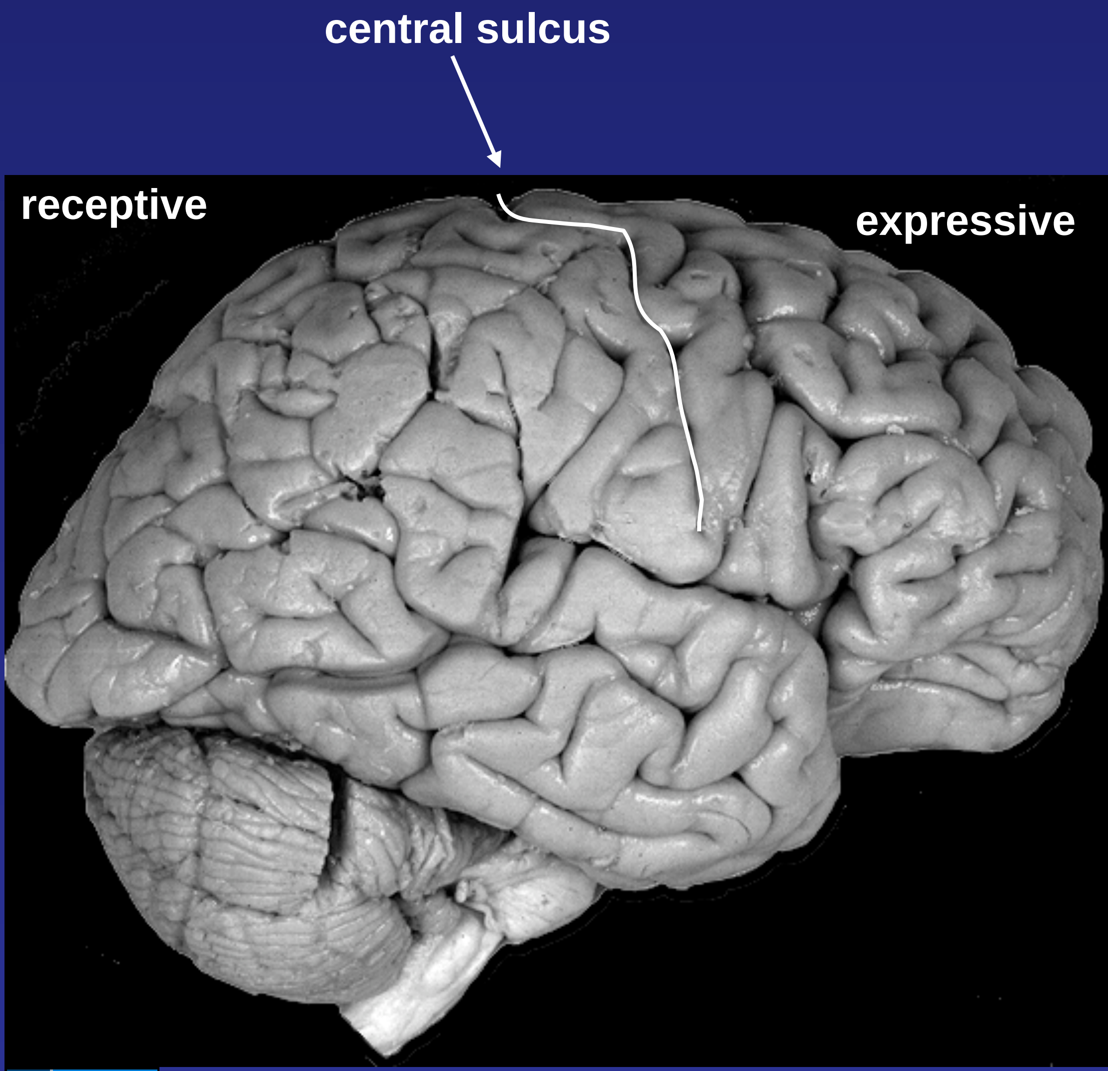
PD-INEL Source Undetermined

Layer 4 is the recipient zone of thalamocortical axons. Layers 3, 5 and 6 are the output layers, sending axons to other cortical or subcortical targets. Layer 5 is the principal output layer to subcortical targets.

- **The cerebral cortex is responsible for the perception and conscious understanding of all sensations and the integration of different sensory modalities. It is involved in higher cognitive and advanced intellectual functions. It is responsible for features such as emotion, personality and intellect.**

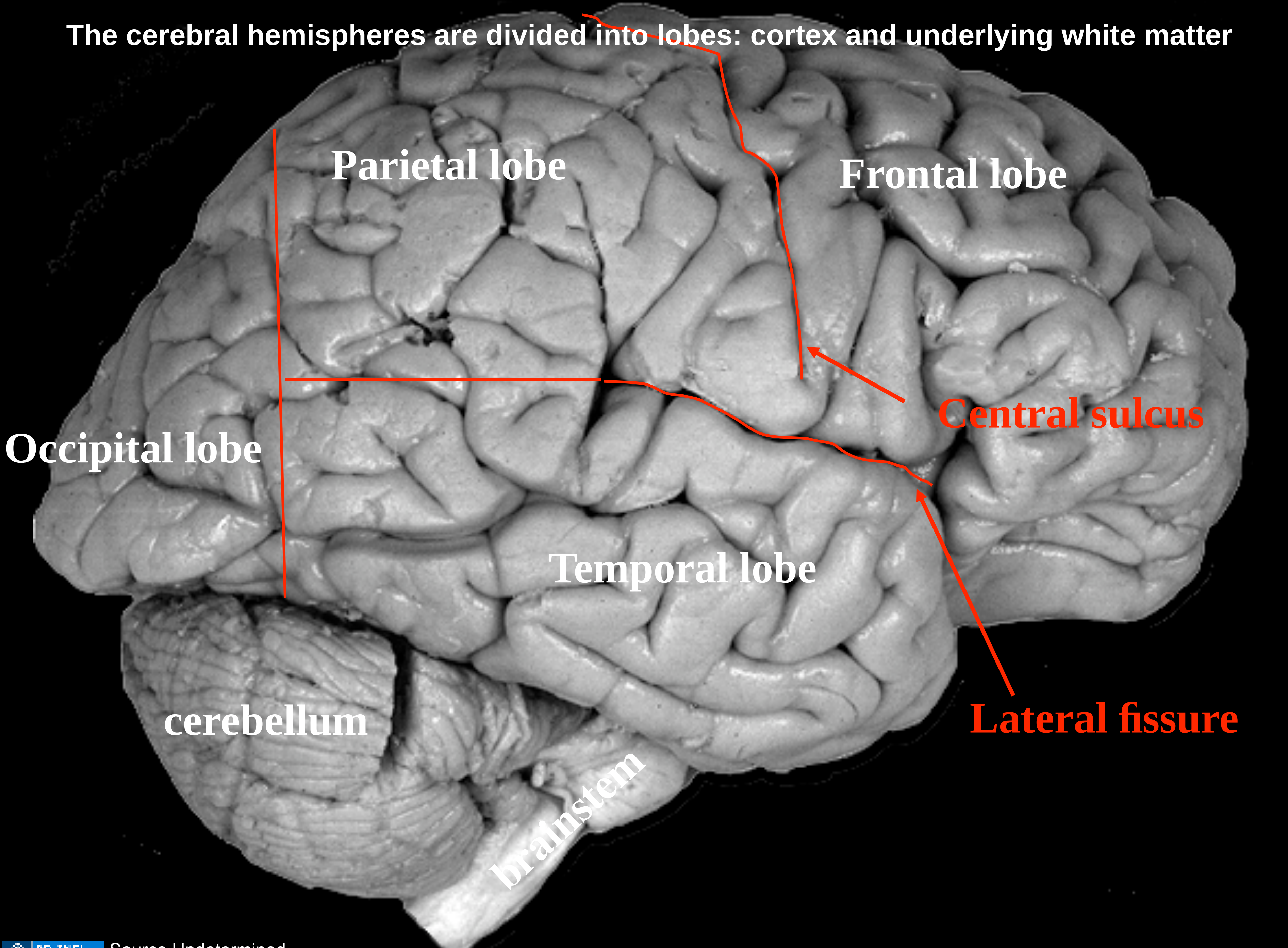
- **The cerebral cortex is also involved in planning and executing complex, voluntary motor activities.**

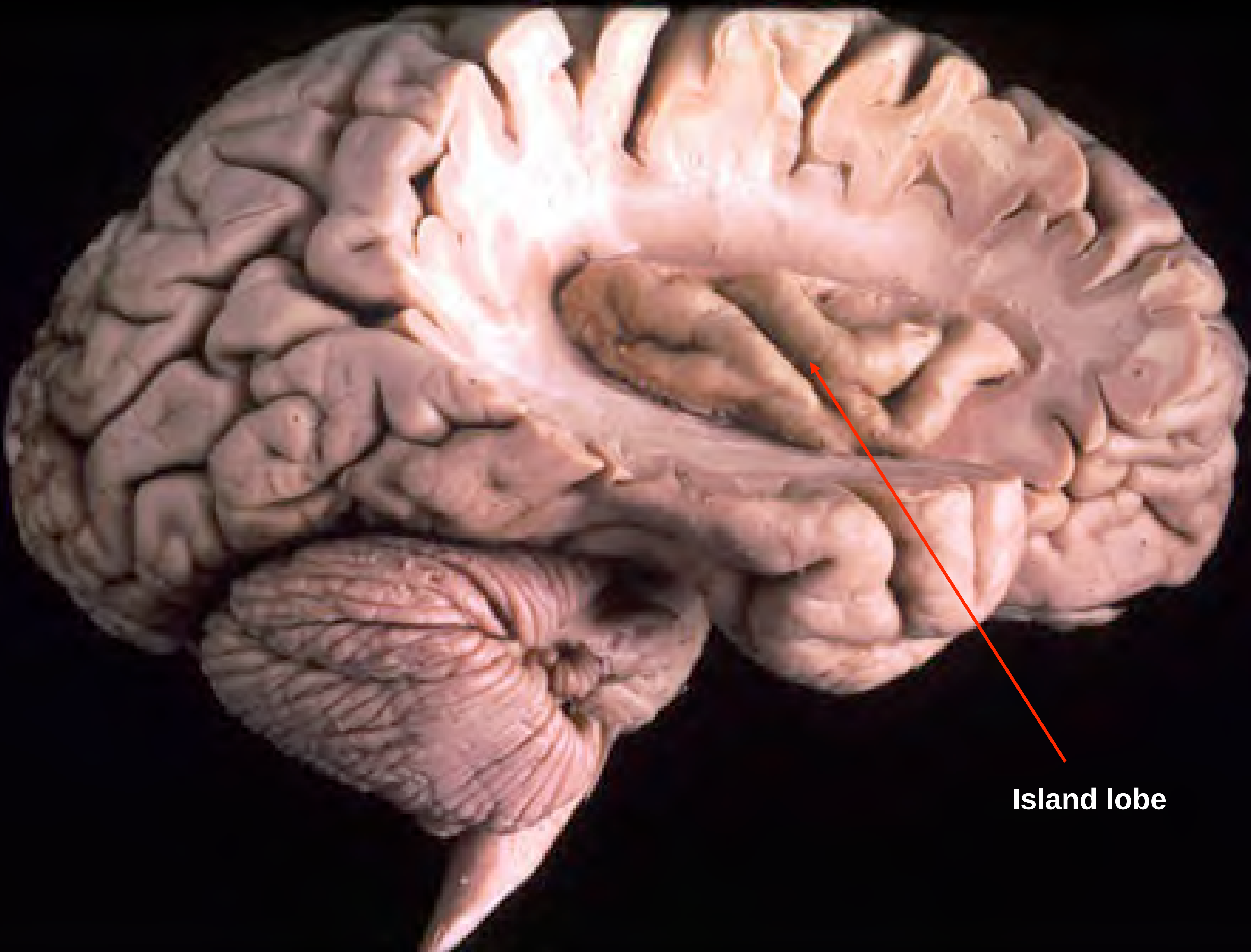
- **One can divide the cerebral cortex into an anterior 'expressive' region and a posterior 'receptive' region.**



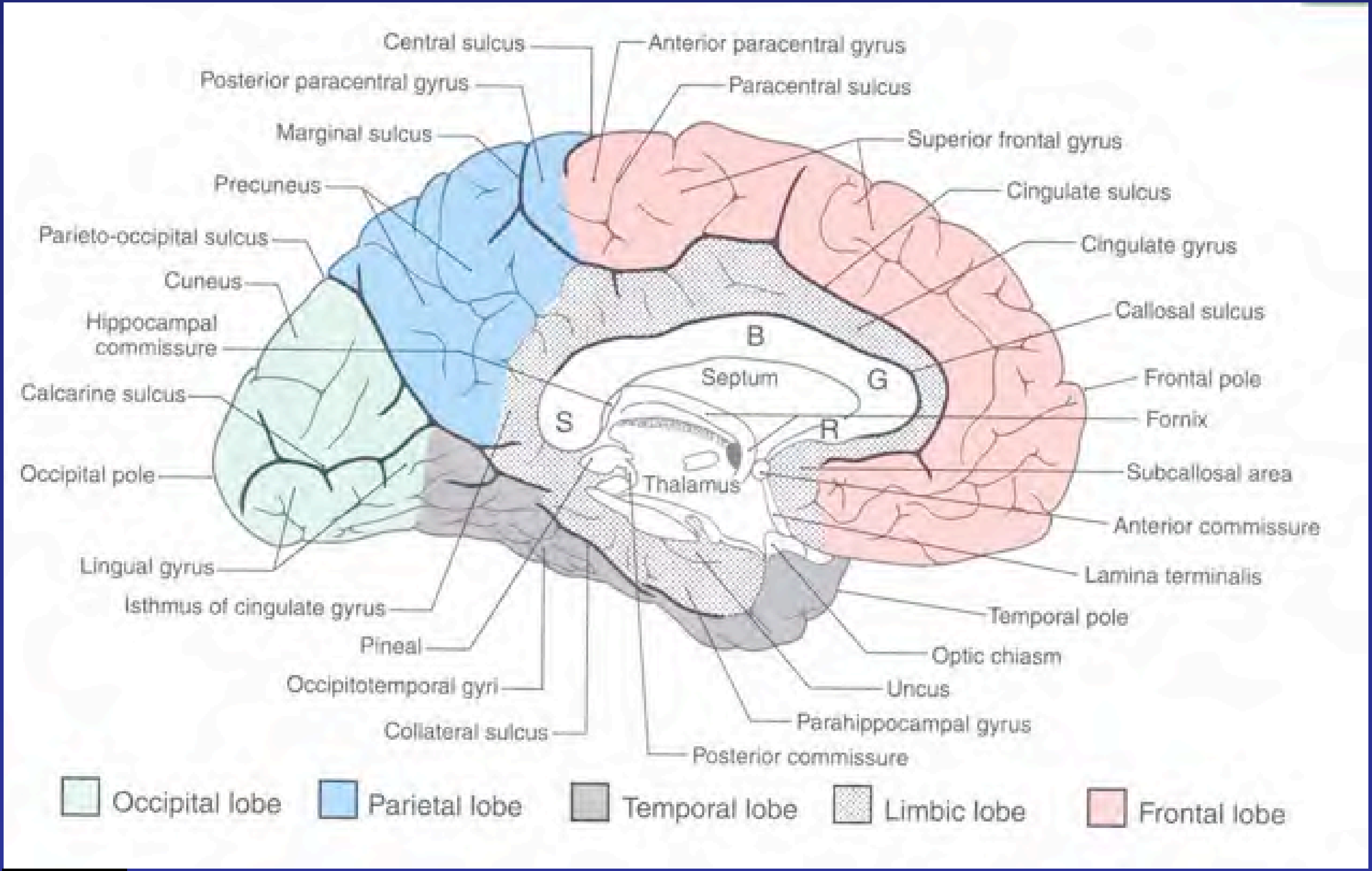
PD-INEL Source Undetermined

The cerebral hemispheres are divided into lobes: cortex and underlying white matter

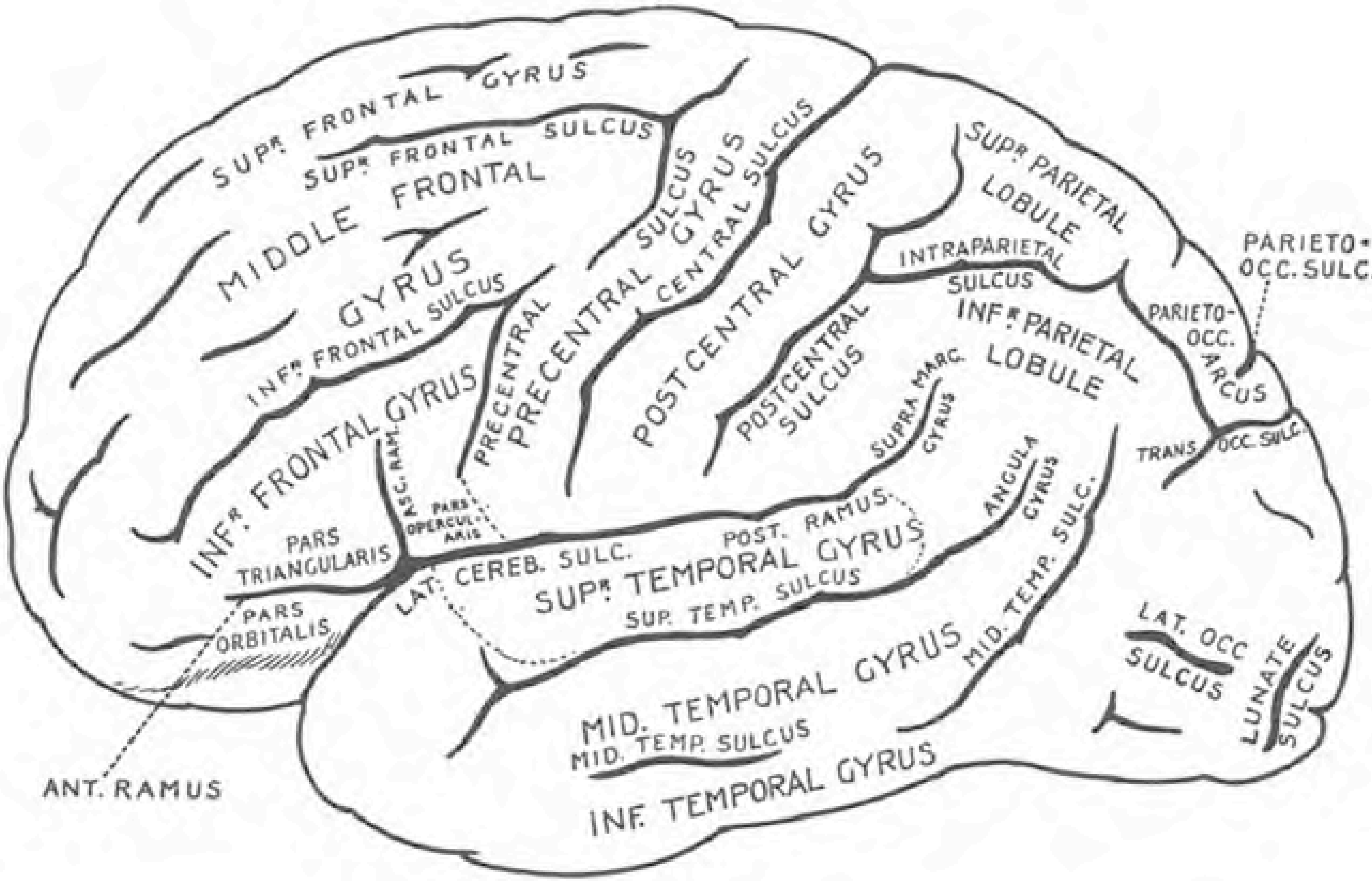



Island lobe

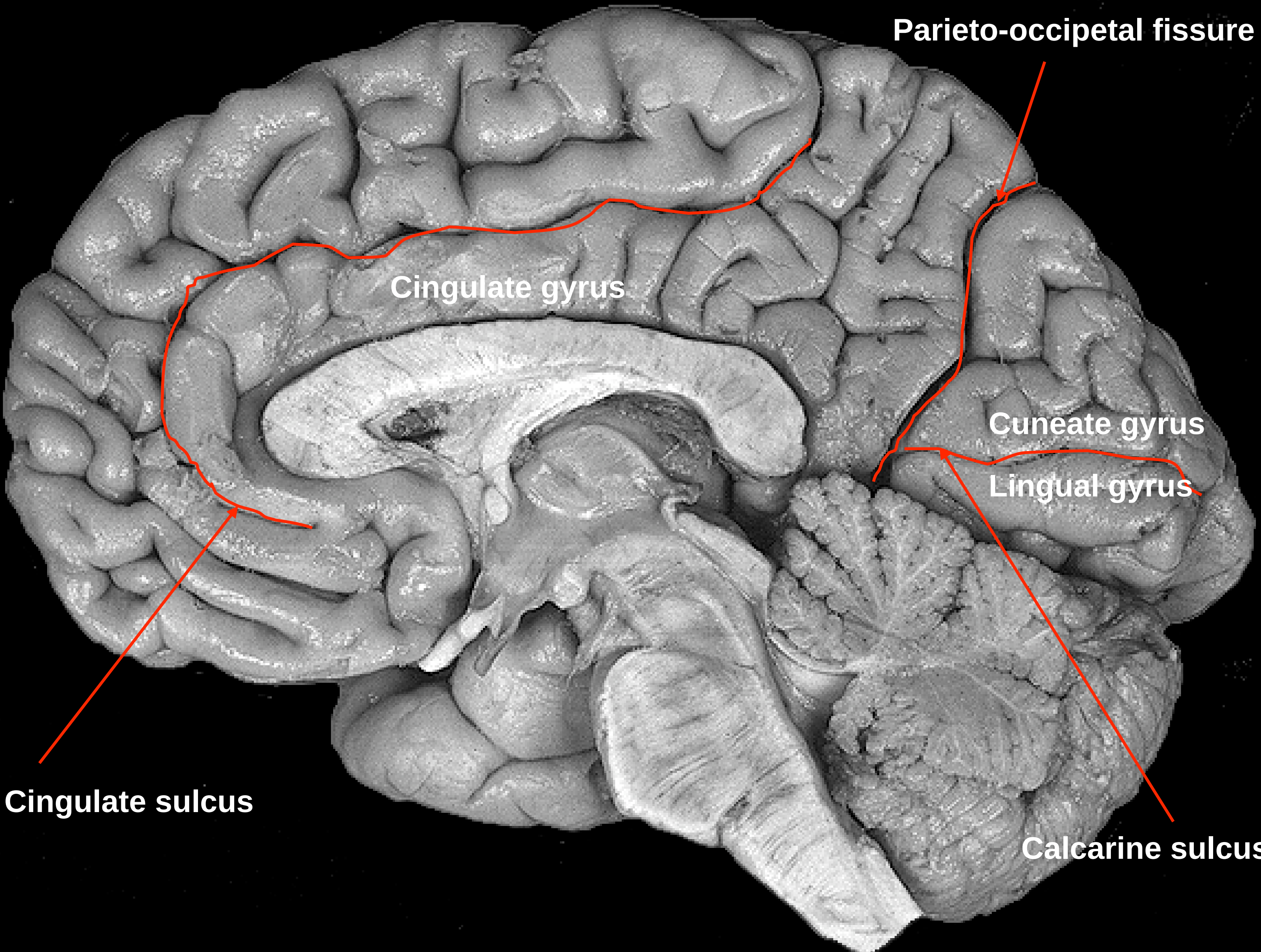
The limbic lobe lies on the medial wall of the cerebral hemisphere



Further anatomical subdivisions of the lateral surface of the cerebral hemisphere



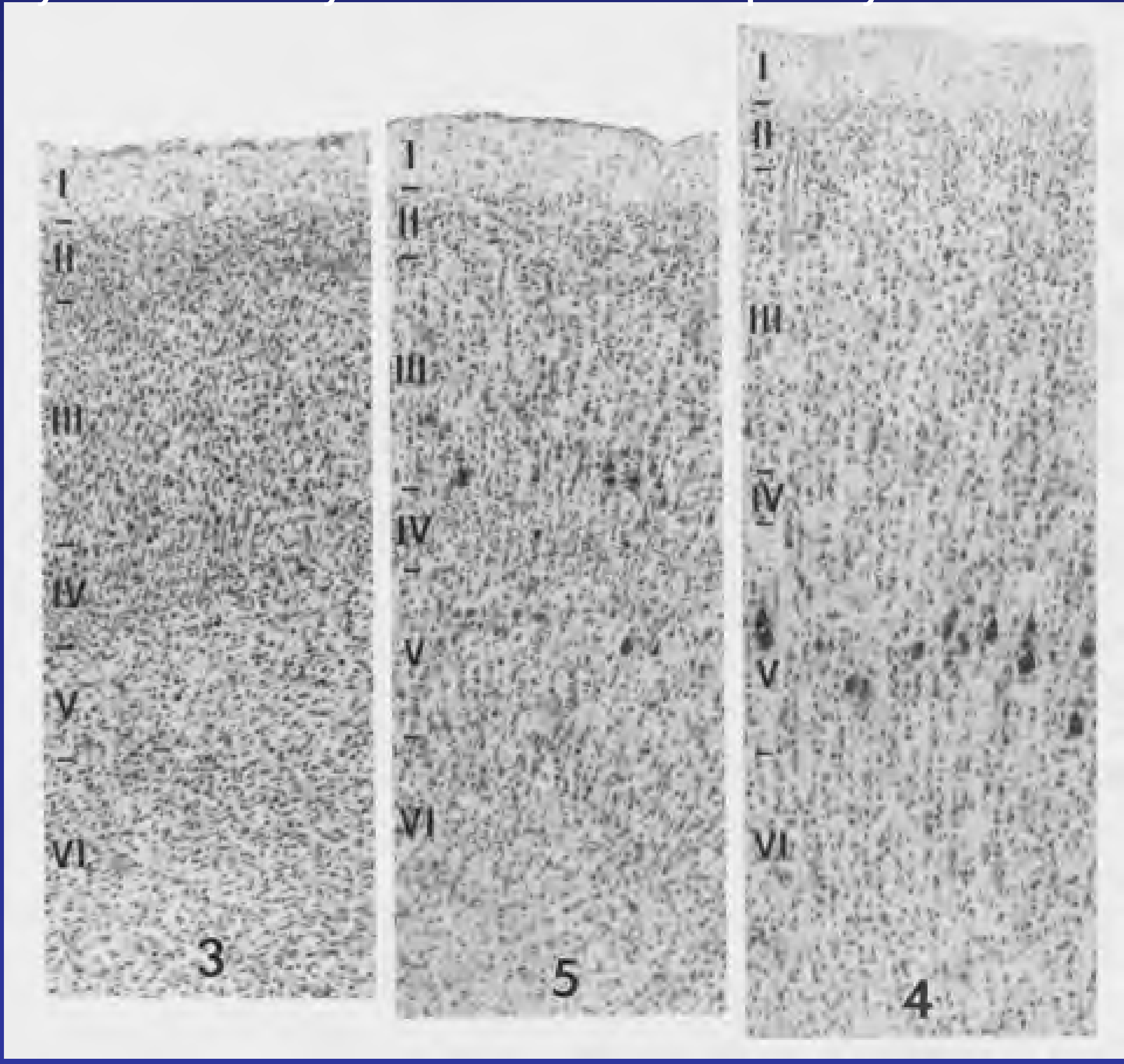
Further anatomical subdivisions of the medial surface of the cerebral hemisphere

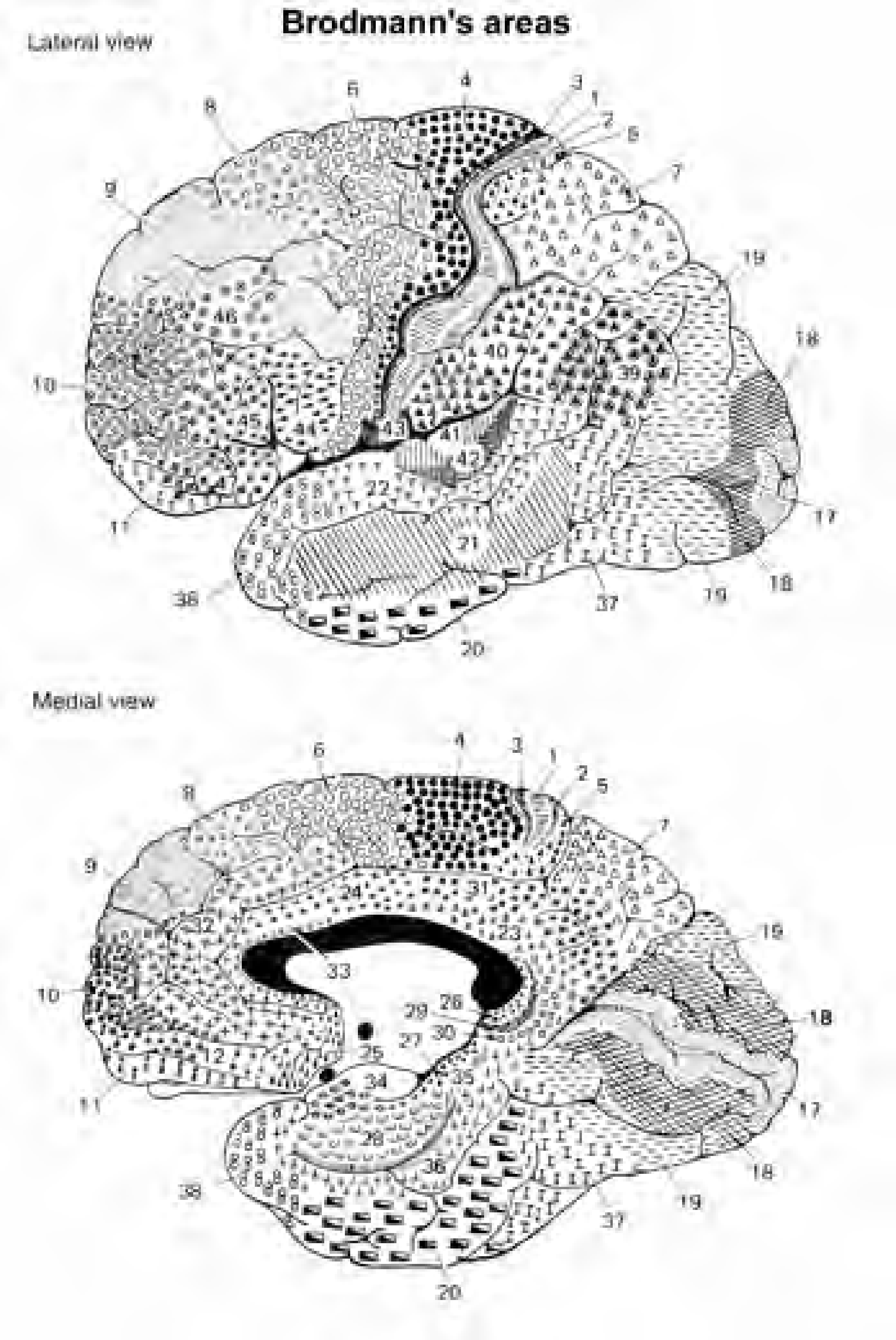


Cerebral cortex is inhomogeneous

Different areas of neocortex vary as to overall thickness, thickness of the individual layers, differences in cell size and dif-ferences in cell density.

primary somatosensory cortex **primary motor cortex**



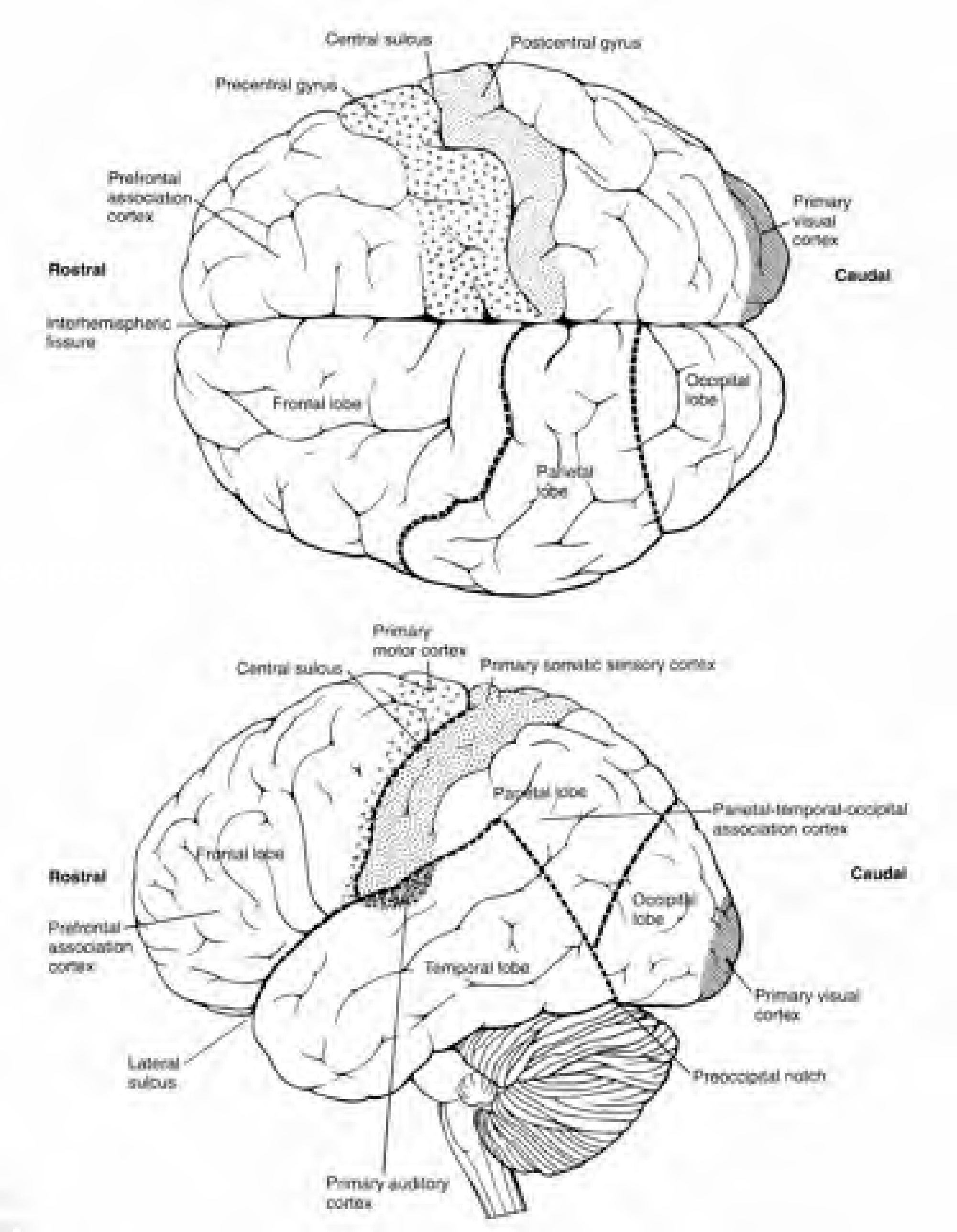


Brodmann, wikimedia commons

In a paper published in 1909, Brodmann identified more than 40 cortical areas based on cellular and laminar histology of cerebral cortex.

This is the most widely reproduced figure in the fields of neurology and neuroanatomy. Brodmann's nomenclature is still used today, e.g., area 17 is primary visual cortex.

Functional subdivisions of cerebral cortex



Source Undetermined

Cerebral cortex can be broadly divided into an anterior, expressive region (anterior to central sulcus) and a posterior receptive region (posterior to central sulcus)

Cortex is also divided into discrete regions subserving sensory and motor functions.

Primary cortical areas occupy specific sites:

olfactory cortex - preamygdaloid and parahippocampal gyrus

somatosensory cortex - postcentral gyrus

auditory cortex - transverse temporal gyrus

visual cortex - cortex surrounding the calcarine sulcus - area 17, primary visual cortex

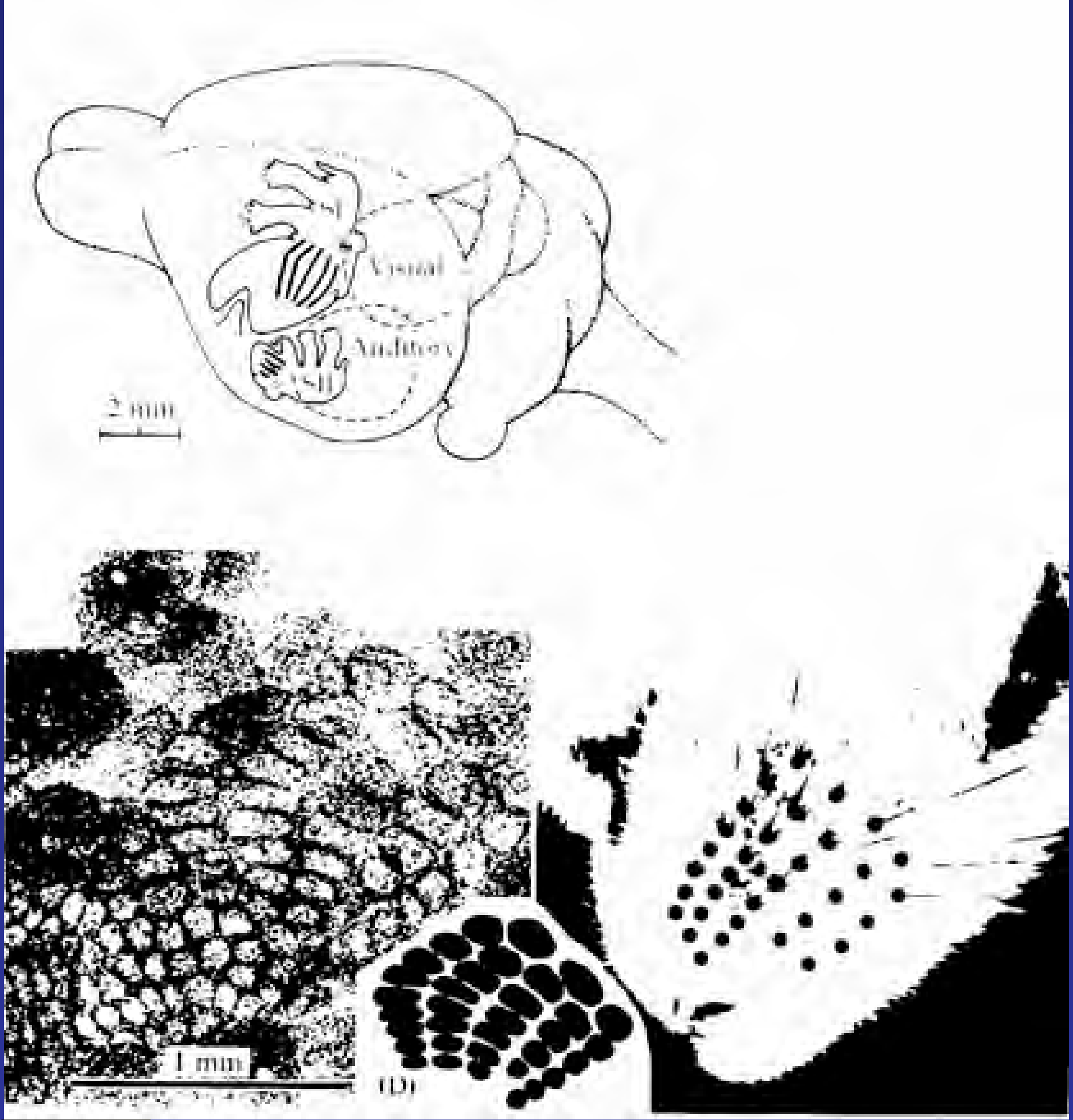
motor cortex - precentral gyrus

The primary sensory and motor areas of the cerebral cortex are precisely topographically organized. This topographic organization reflects the organization of the ascending sensory pathways and nuclei within the dorsal thalamus as well as the descending motor pathways.

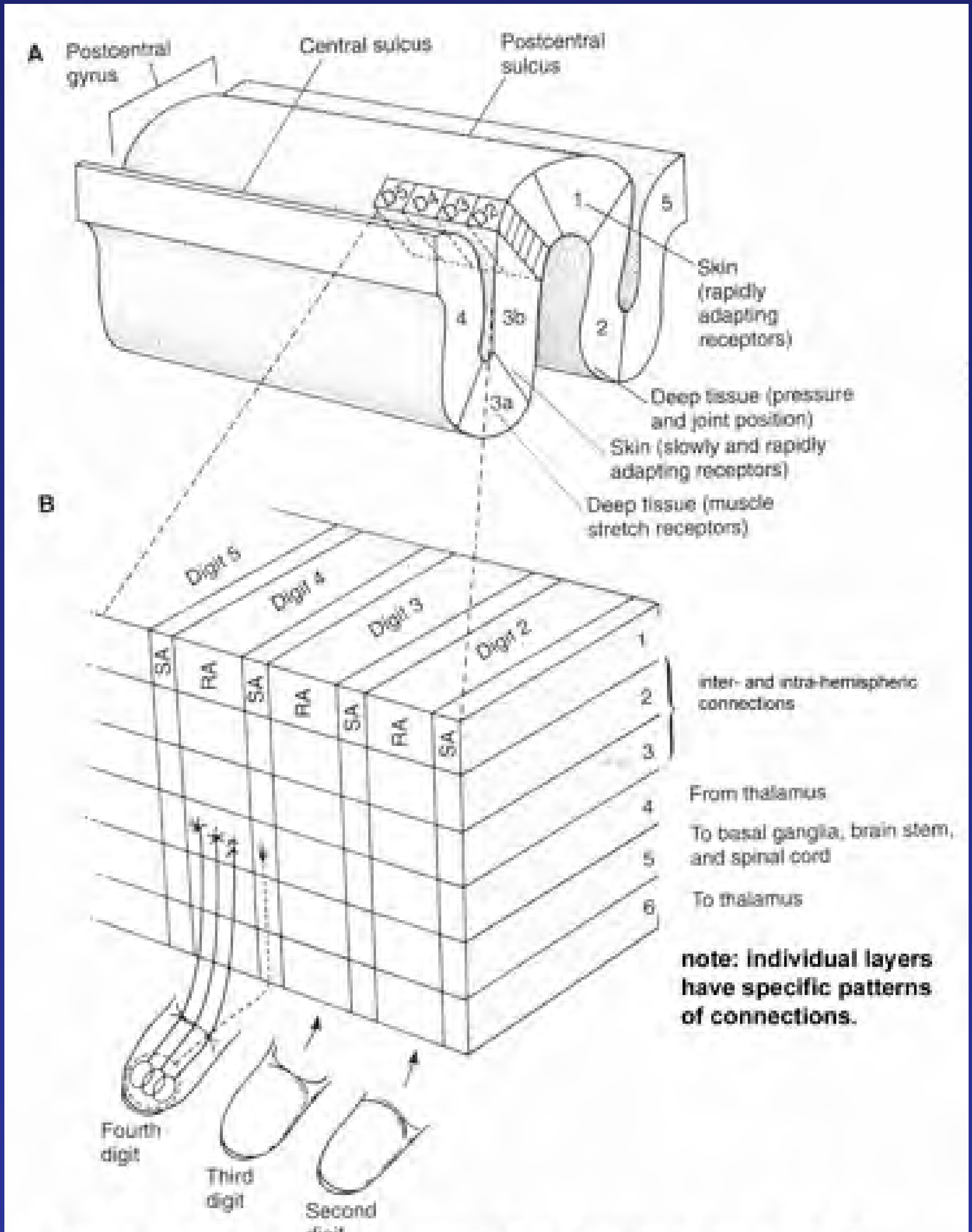
These topographic "maps" are distorted, reflecting sensory specializations of the periphery, such as the fine somatosensory discrimination of the hands and peri-oral regions.

The organization of primary cortical areas are species-specific and reflect the specialized use of the sensory and motor periphery.

In rodents, individual whiskers on the face are represented in primary somatosensory cortex by complex ‘barrels’ of cells.



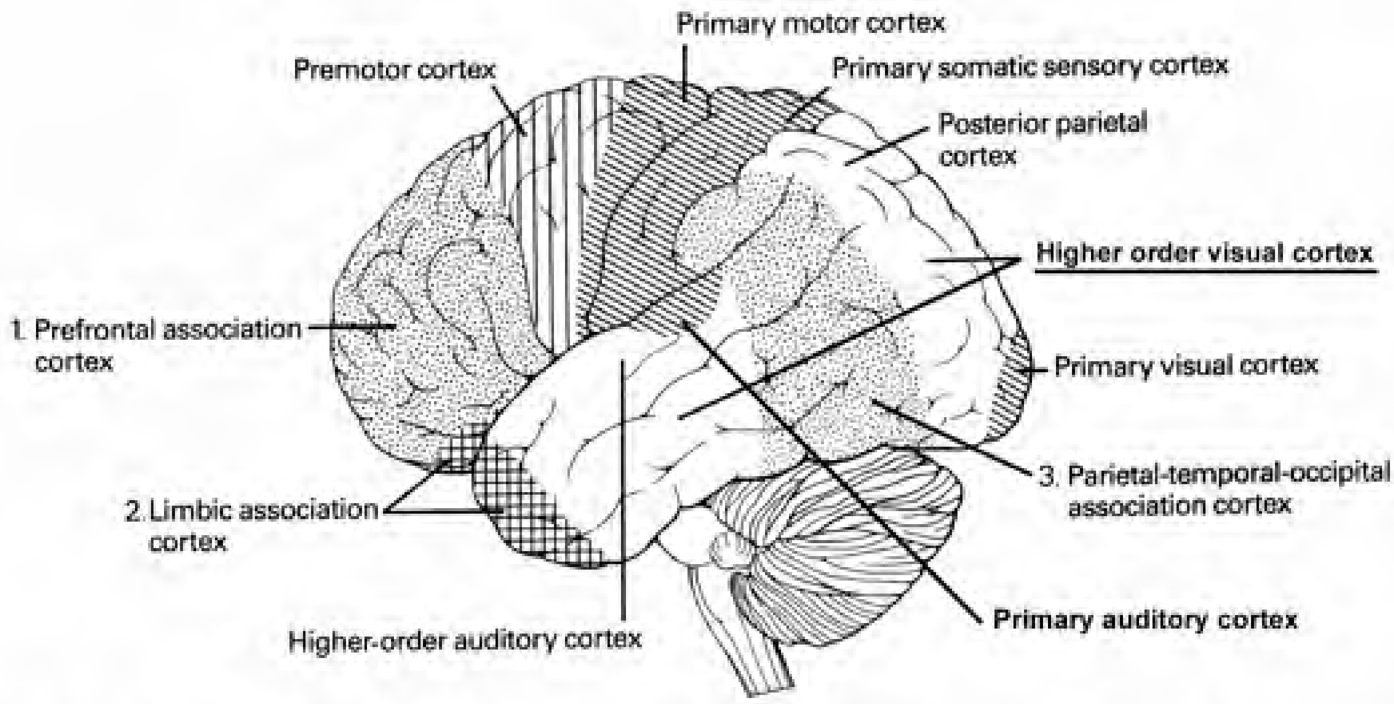
PD-INEL Source Undetermined



Sensory and motor cortex are organized into functional columns. In this example all neurons in a vertical segment (column) of cortex receive information from the same receptive field.

In primary sensory areas, each cortical neuron has a receptive field that corresponds to a location on the sensory sheet (body surface in this instance).

Sensory ‘maps’ extend throughout the depth of the cortex and are functionally organized based on the specificity of the receptors.



Higher-order visual cortex consists of the **inferior temporal lobe**, important for object recognition, and the **parietal lobe**, important for perceiving spatial relations between objects.

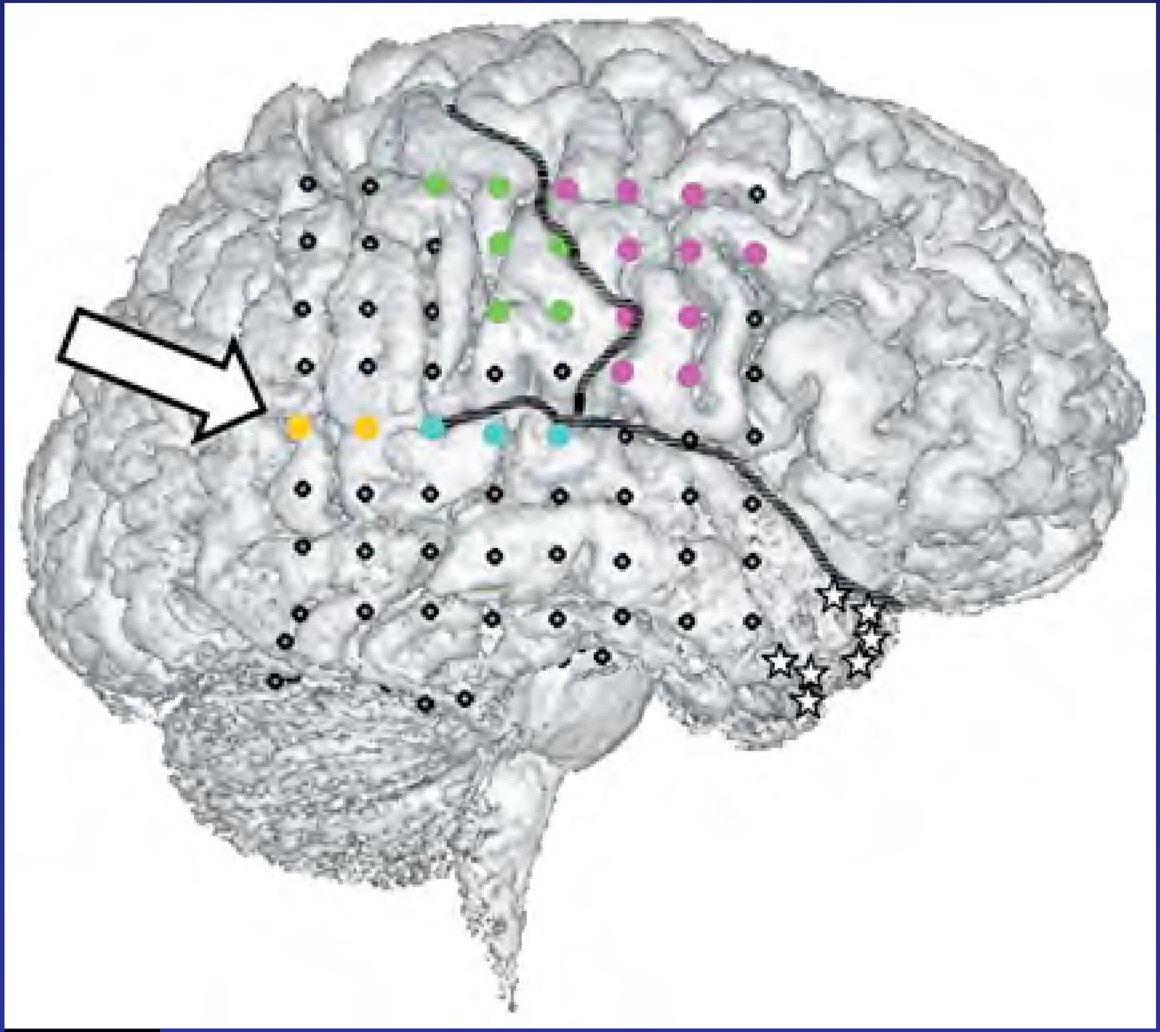
Association cortical areas surround the primary cortical areas, and can be divided into unimodal and multimodal regions. Unimodal association cortex relates to a single primary region only, whereas multimodal cortex intergrates information relating to multiple primary and unimodal regions.

Stimulating illusory own-body perceptions

behavioral responses

- movement
- somatic sensation
- auditory sensation
- out-of body experience

★ epileptic focus



PD-INCL Source Undetermined

The relative amounts of association cortex can be ordered phylogenetically.

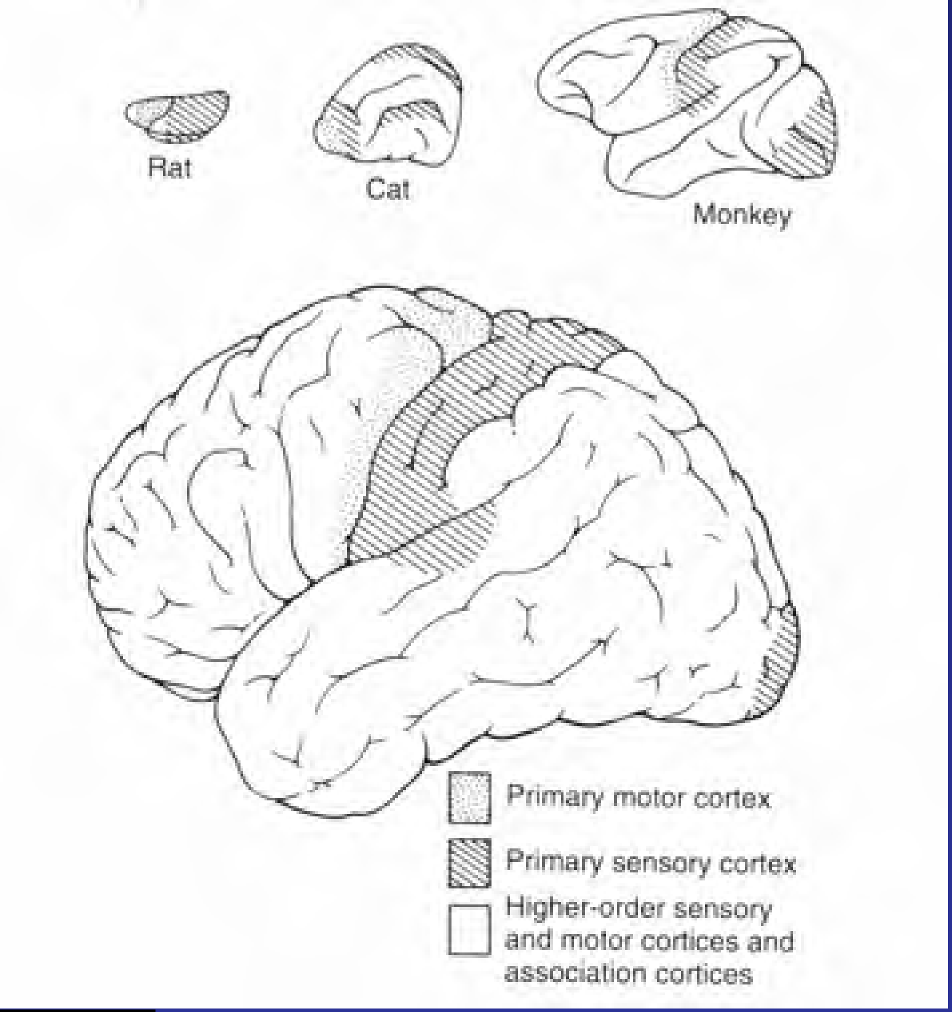


Image of hemispheric dominance removed

Hemispheric dominance: Higher-order perceptual and motor functions are performed predominantly in one hemisphere or the other:

Right brain: left visual field, drawing, music, spatial perception

Left brain: right visual field, language, calculation

Chimeric image removed

In this chimeric image, the left hemi-sphere, which is dominant for speech 'sees' the man, whereas the right hemisphere, which generally has no capacity for speech 'sees' the woman.

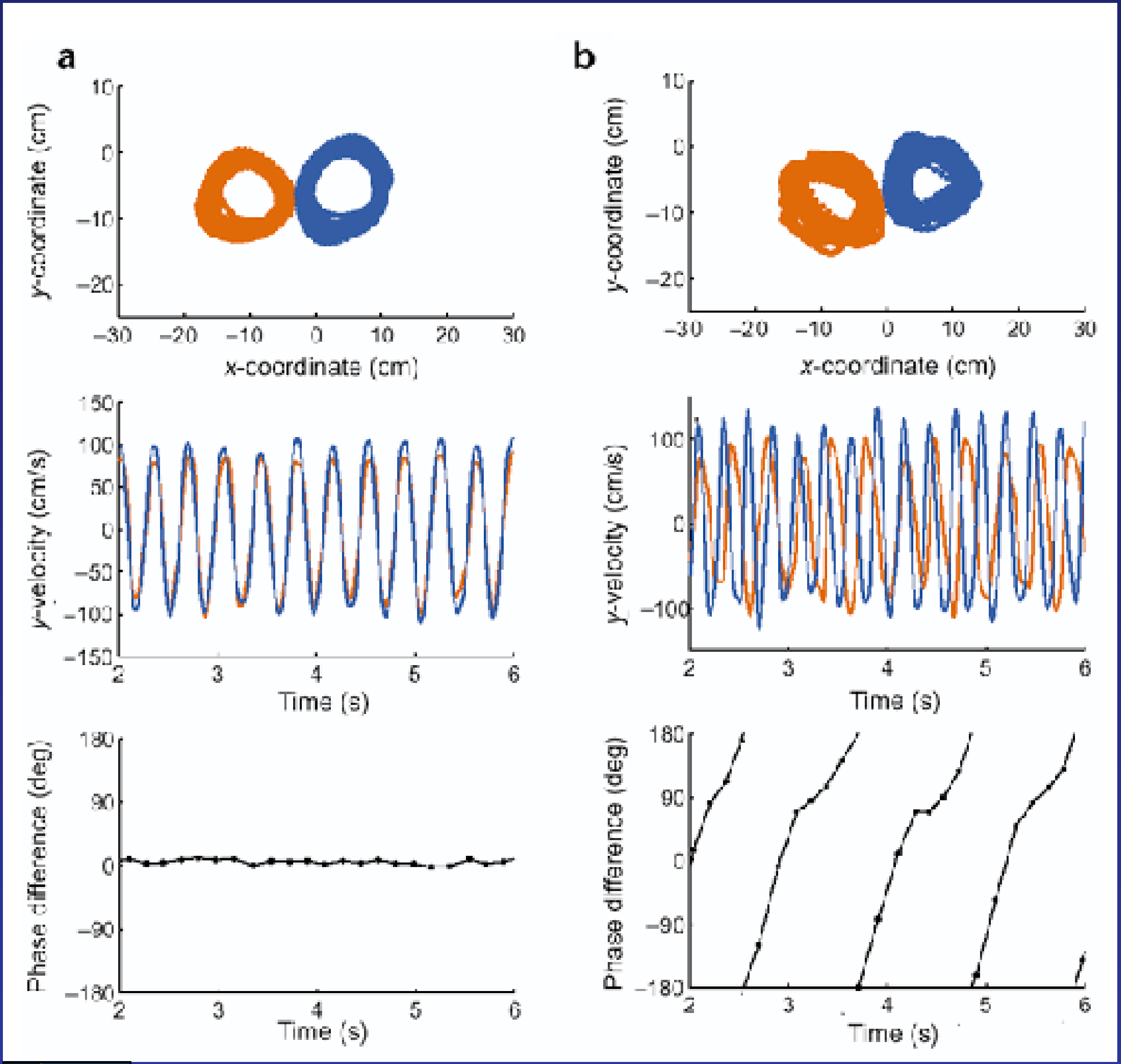
In patients in which the hemispheres are disconnected by sectioning the corpus callosum and anterior commissure, one can selectively query one hemisphere or the other.

When asked, a split-brain patient will report seeing a man.

If asked to use the left hand and point to separate photographs, in a split-brain patient the left hand will select the woman's face.

A: normal control

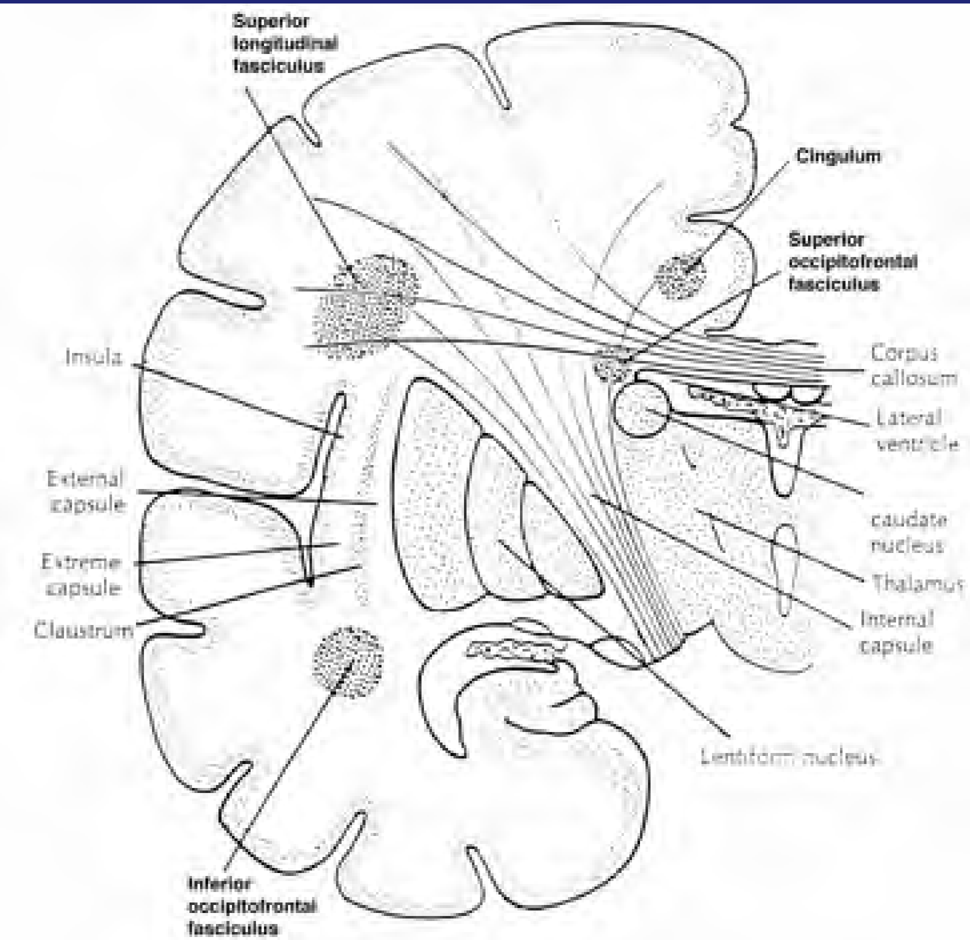
B: split brain patient



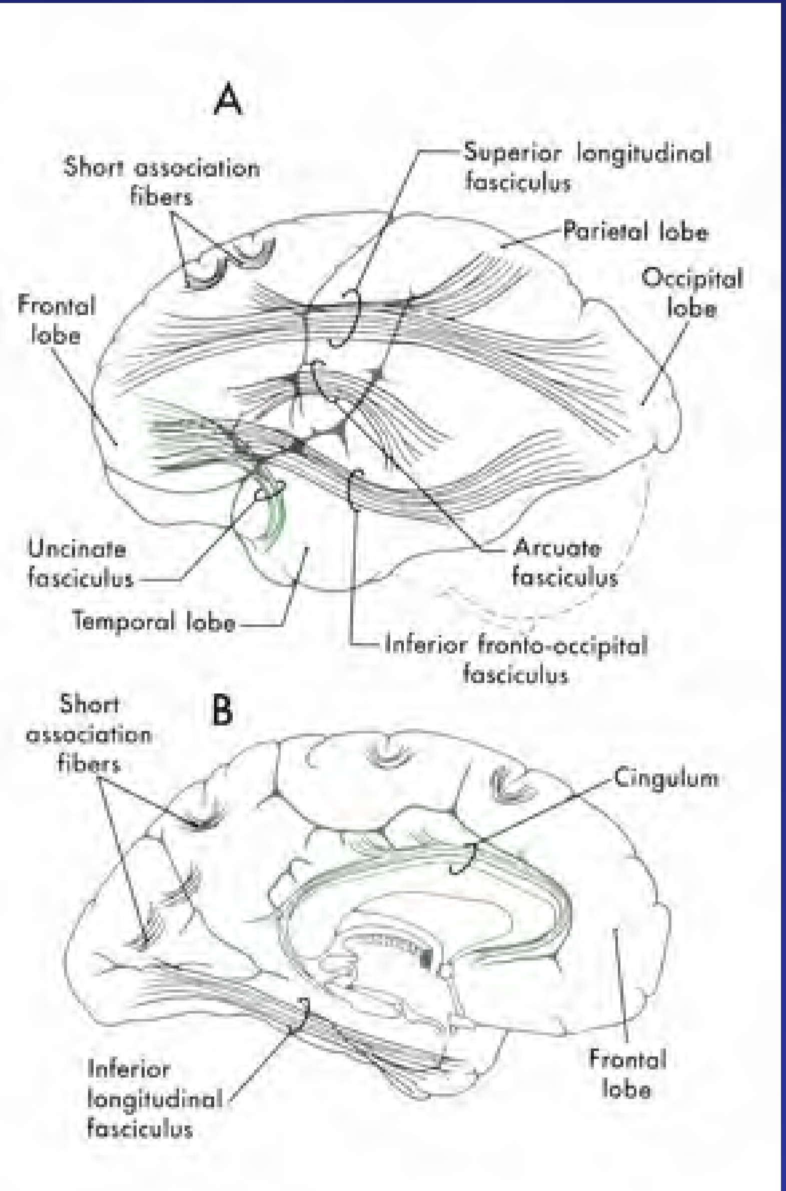
PD-INEL Source Undetermined

Much of the cerebral hemispheres is occupied by subcortical white matter, which is anatomically organized.

There are three types of fibers in the subcortical white matter:
1) projection fibers - leave the hemisphere for subcortical targets
2) commissural fibers - interconnect the two hemispheres, L-R and R-L
3) association fibers (2 types) - interhemispheric connections, L-L and R-R



PD-INEL Source Undetermined



PD-INEL Hanes. Fundamental Neuroscience. Churchill Livingstone, 2002. 2nd ed.

This dissected brain illustrates projection fibers, that innervate subcortical targets, e.g., thalamus, brainstem and spinal cord.

corona radiata

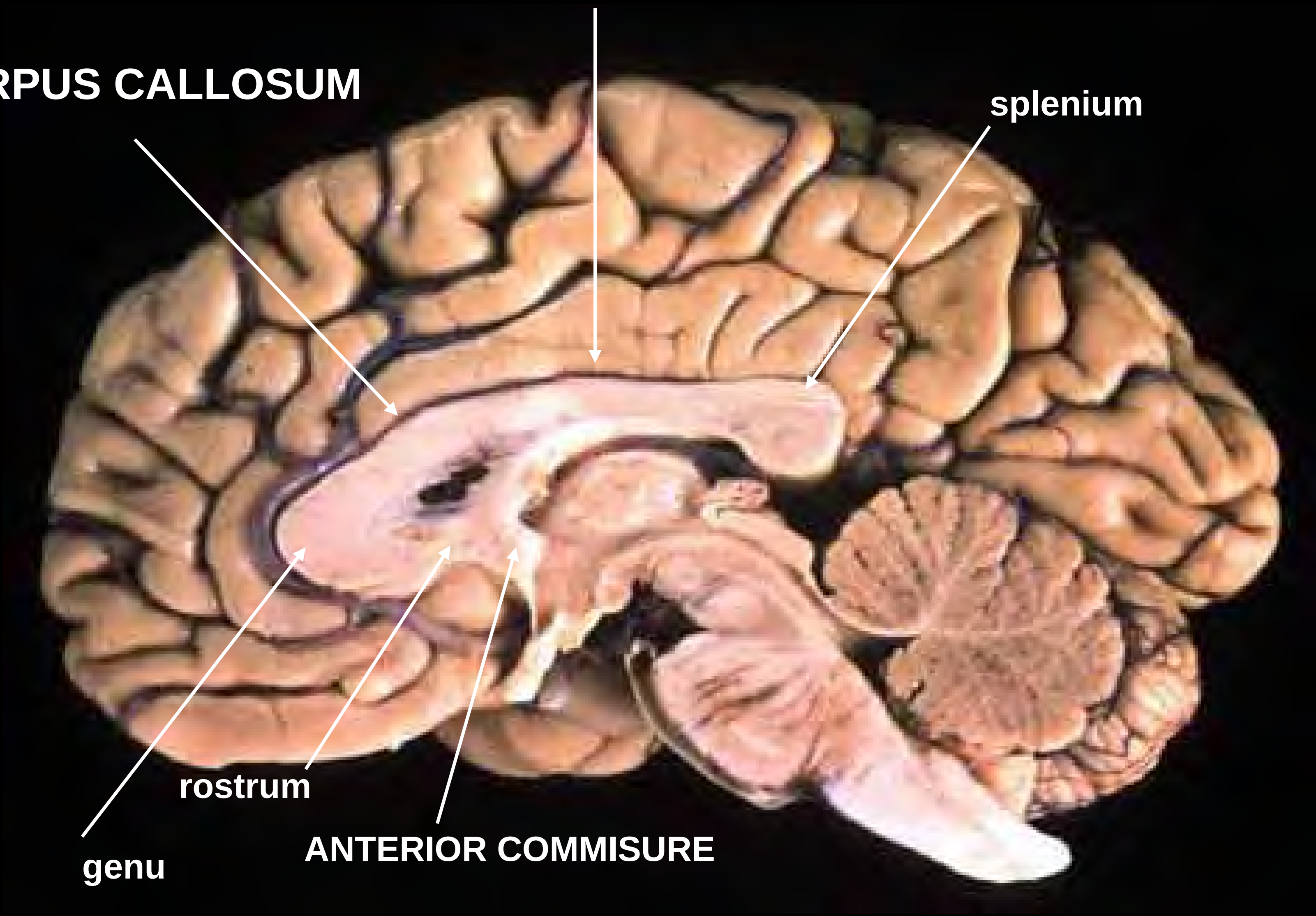
internal capsule

Commissural Fibers

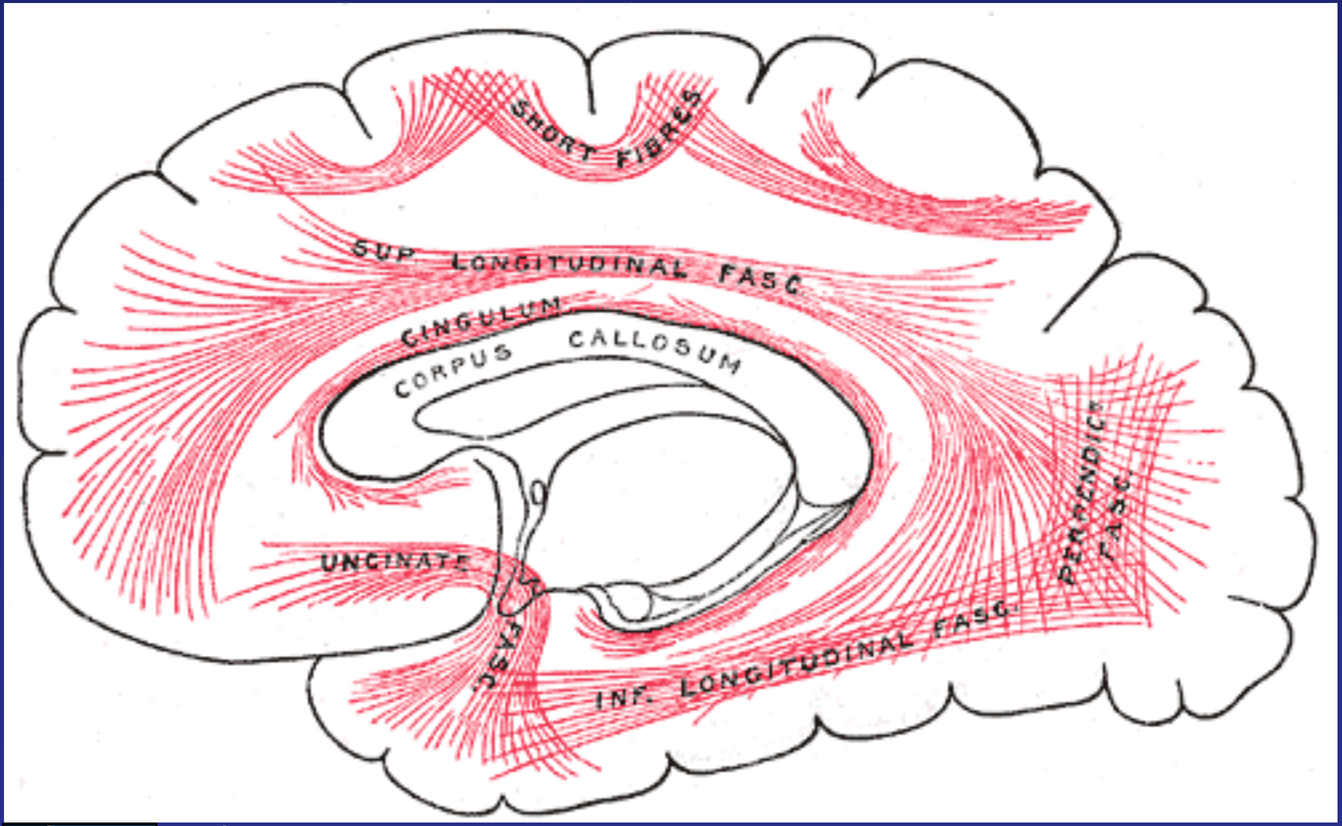
The corpus callosum is the largest of the two structures that contain commissural fibers.

Commissural fibers interconnect both homologous and heterologous areas of the two hemispheres.

Commissural Fibers

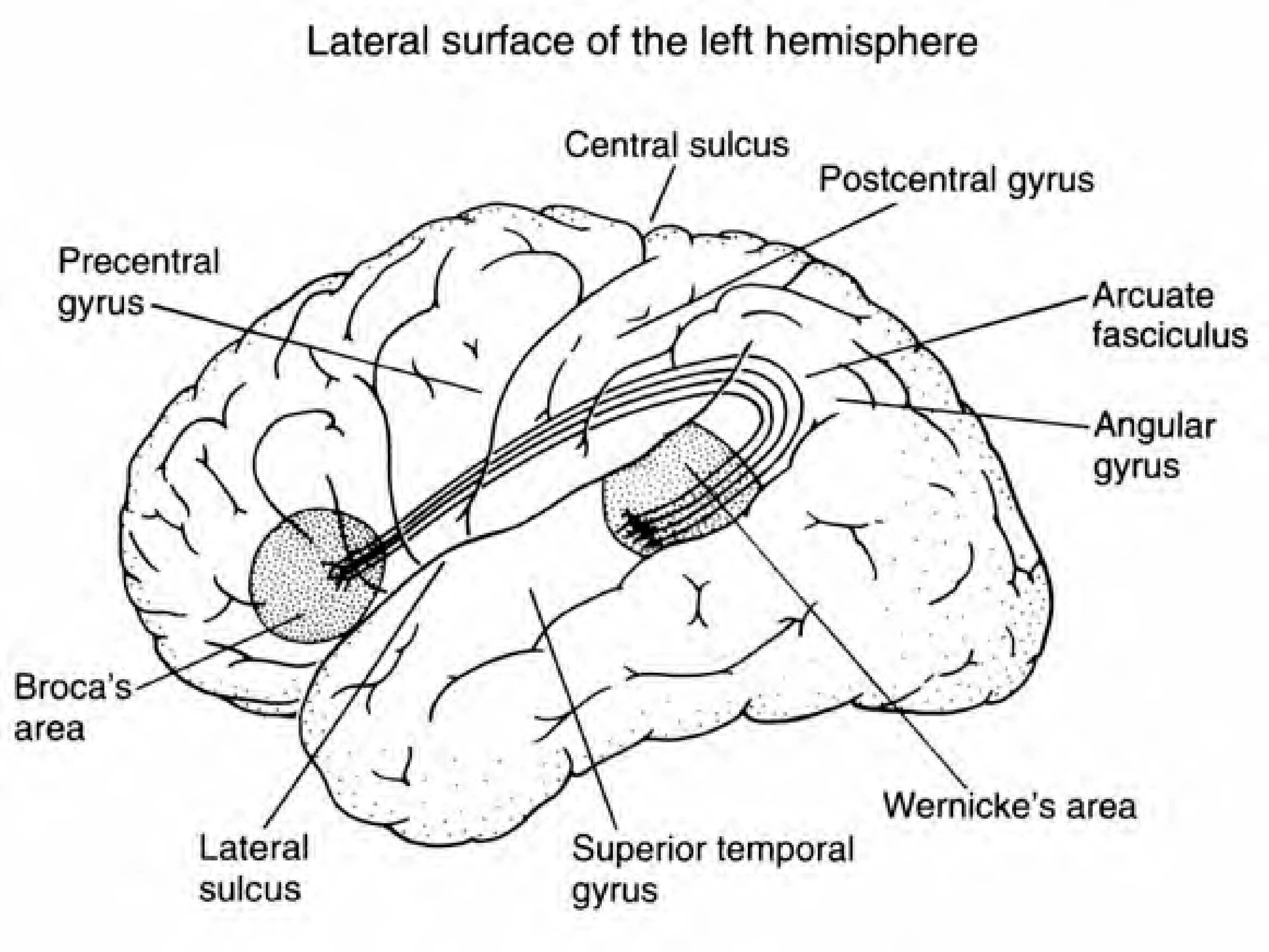


The anterior commisure is the second major structure that contains commissural fibers.

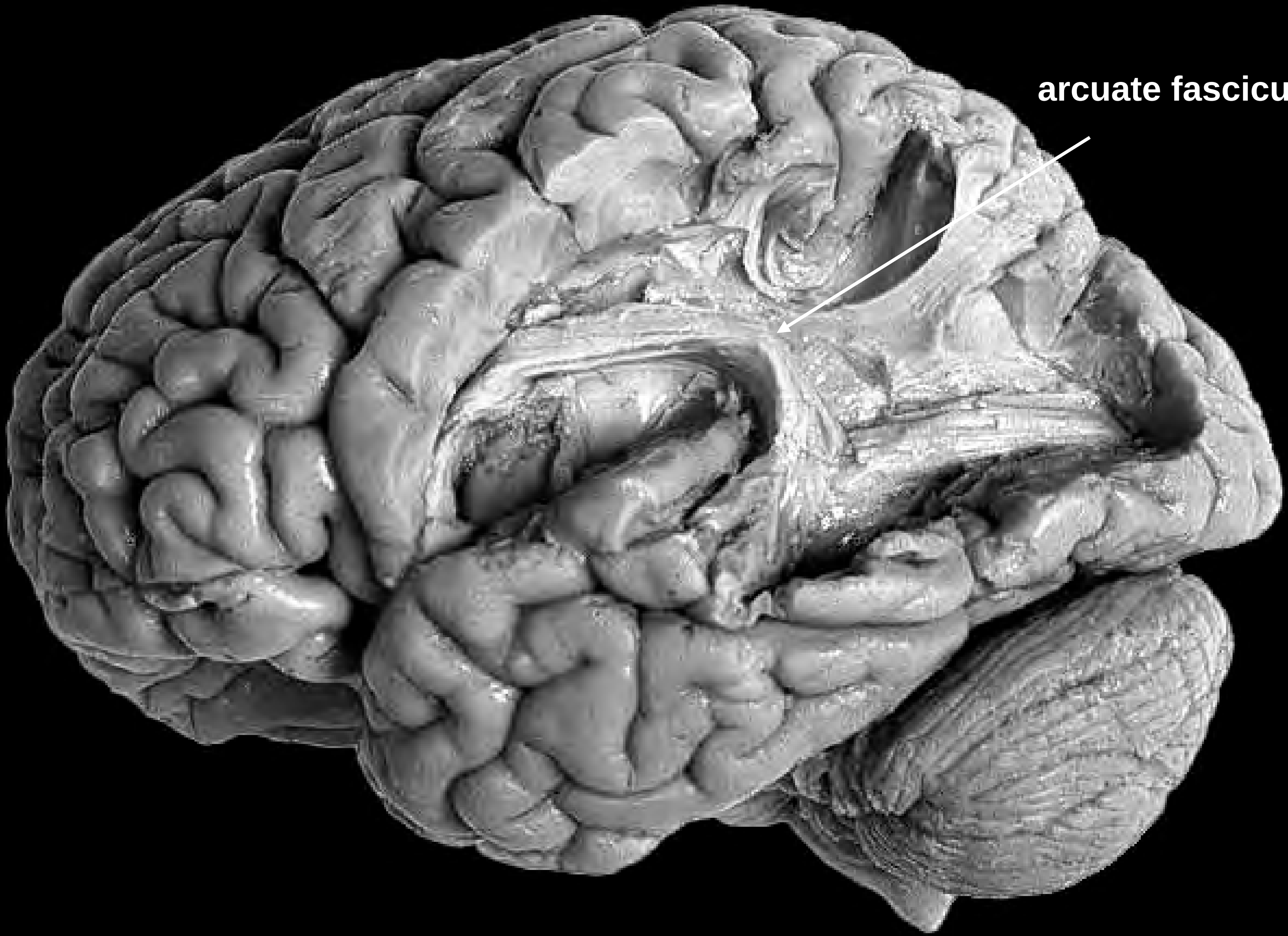


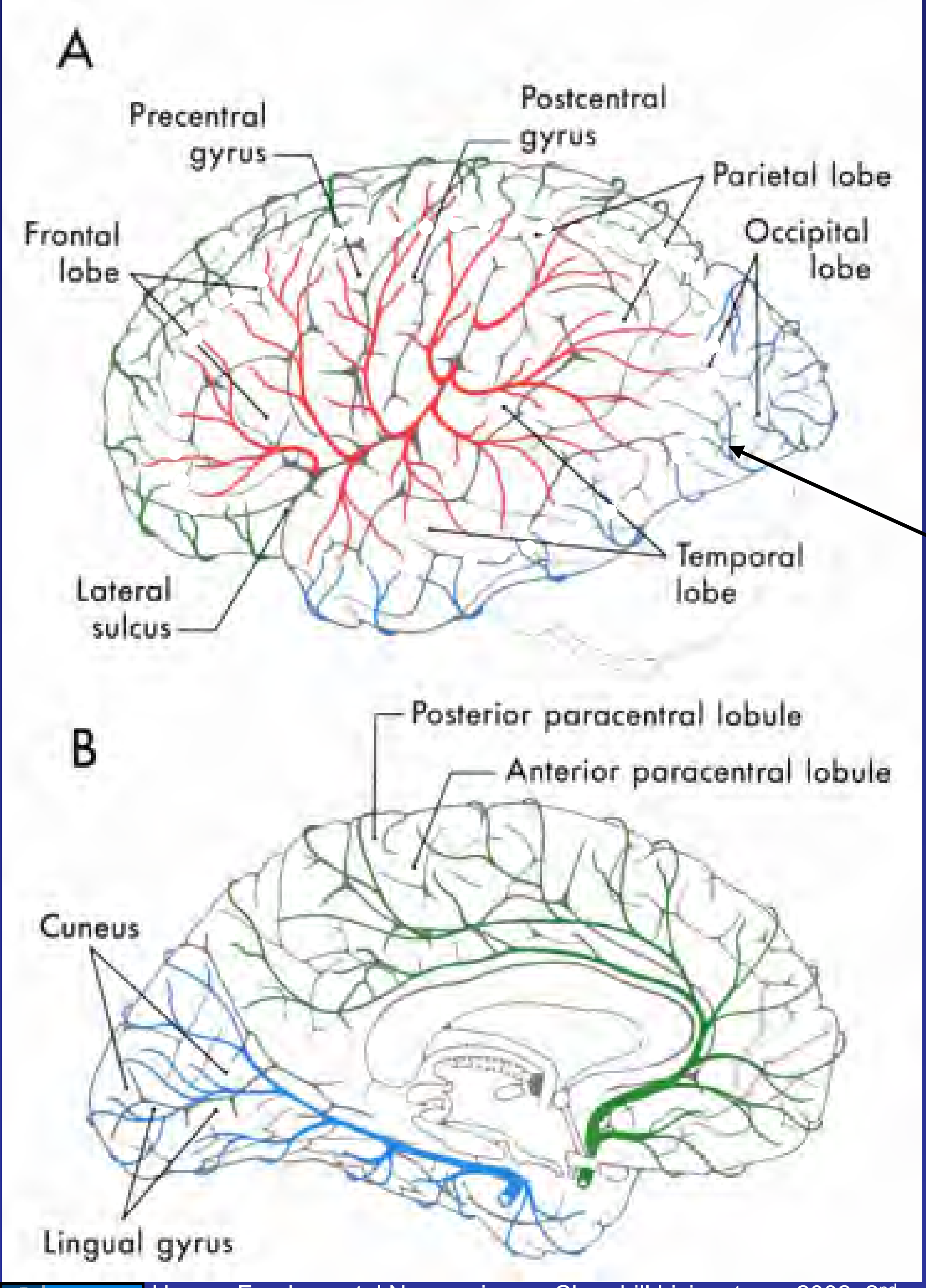
PD-INEL Gray's Anatomy

Association fibers do not leave the cerebral hemisphere, and can be classified as either long or short.



Lateral surface of the left hemisphere
Central sulcus
Postcentral gyrus
Precentral gyrus
Arcuate fasciculus
Angular gyrus
Broca's area
Lateral sulcus
Superior temporal gyrus
Wernicke's area


arcuate fasciculus



Cerebral arteries supply the cortex and superficial white matter

middle cerebral artery

anterior cerebral artery

posterior cerebral artery

border zones

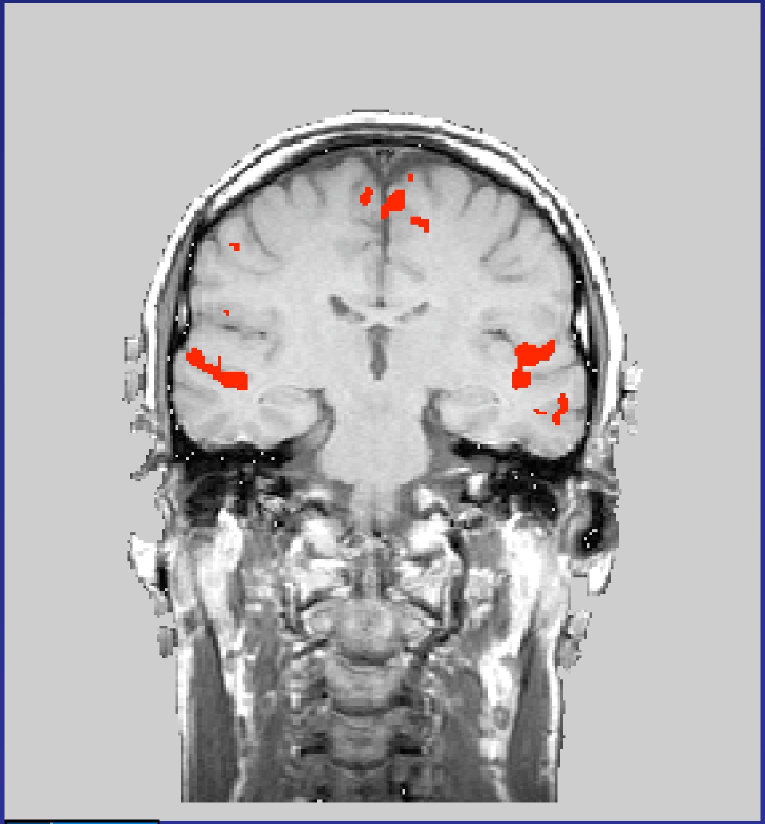
Cerebrovascular disease is a common form of cortical injury and disability.

Hanes. Fundamental Neuroscience. Churchill Livingstone, 2002. 2nd ed.

Imaging electrical activity in the brain with fMRI

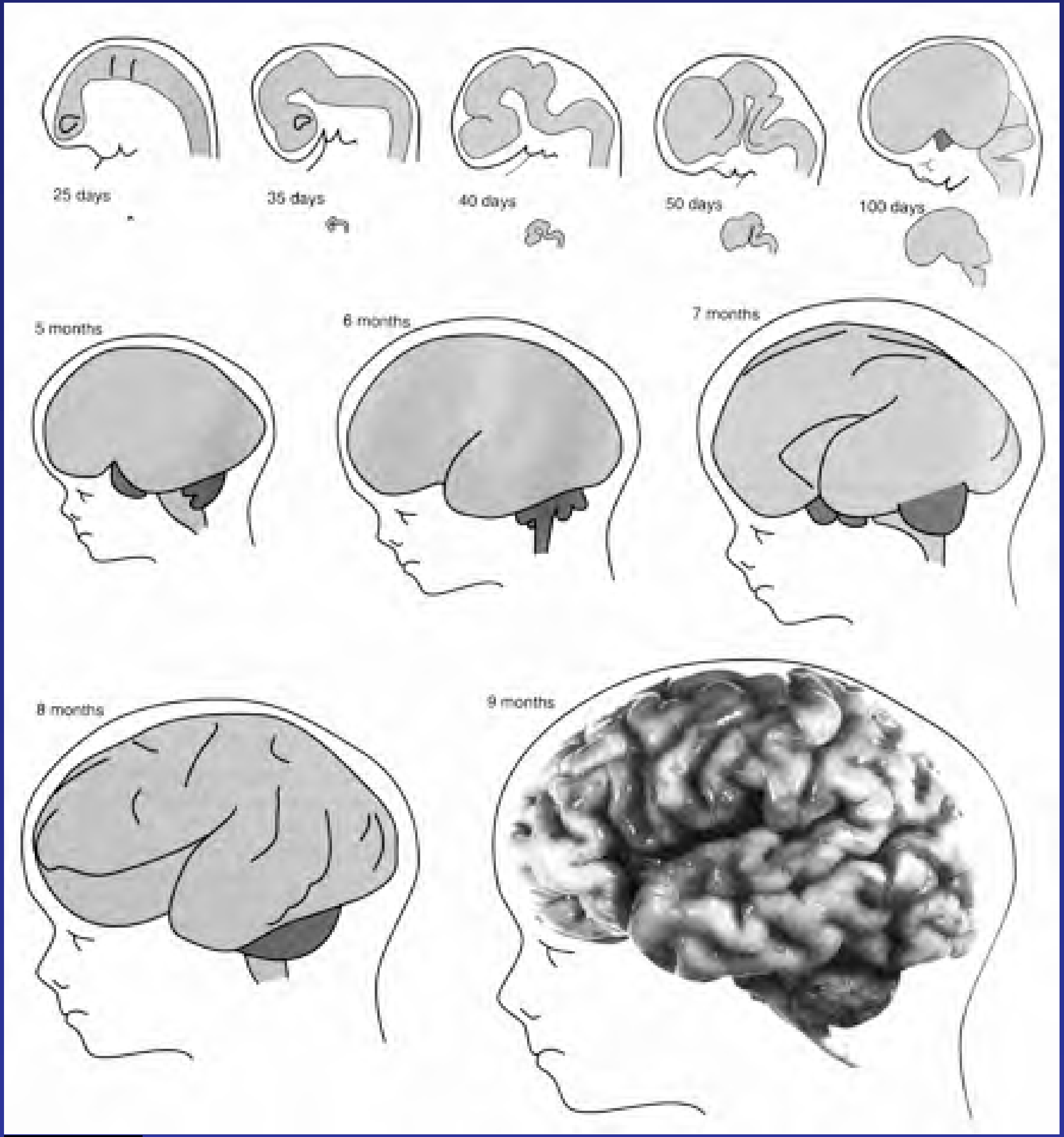
Regional cerebral blood flow - 0.5% difference in blood flow

Language mapping in normal volunteers



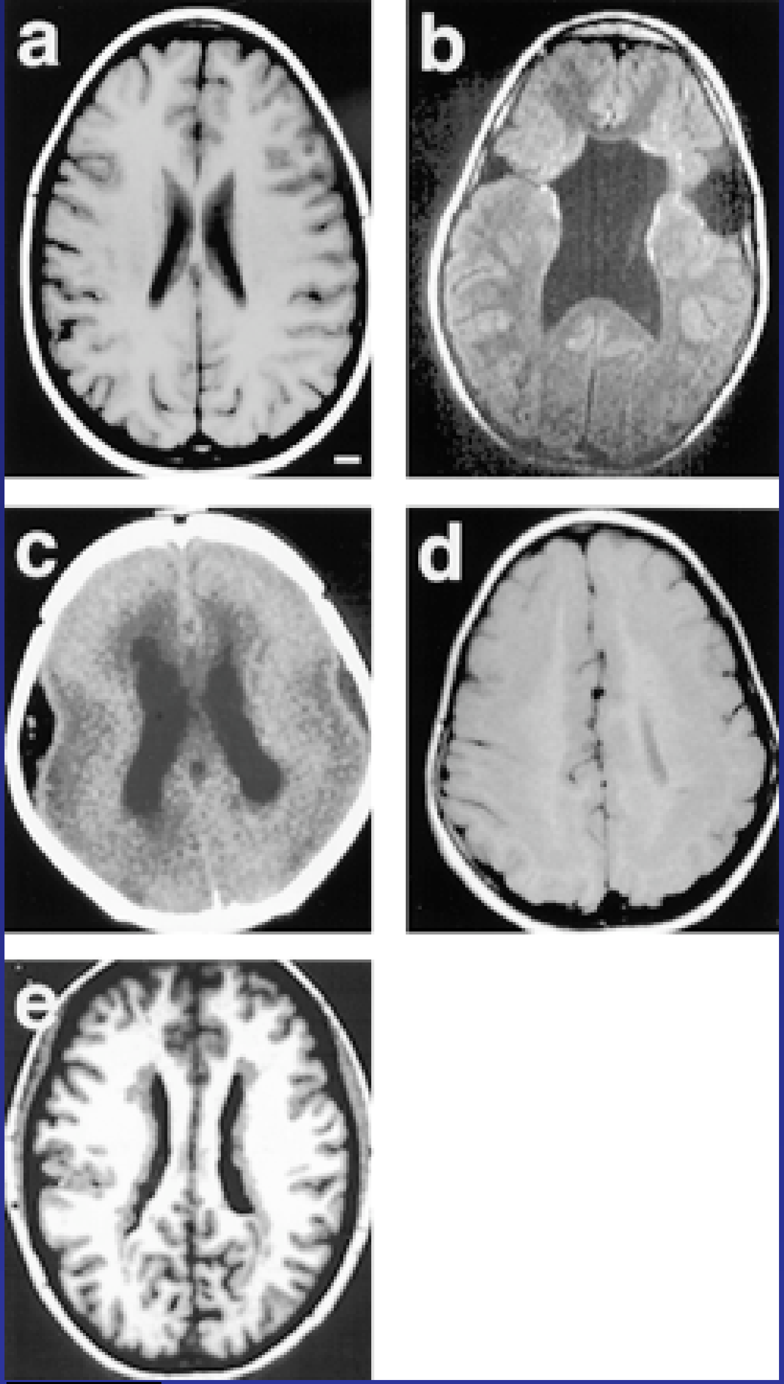
Development of the central nervous system - 25 days to 9 months.

Note the enormous growth of the cerebral hemispheres relative to other brain regions.



Genetic disorders can dramatically affect cortical development.

a. normal
b. schizencephaly
c. lissencephaly
d. double cortex
e. heterotopia



Consciousness: def - ‘an awareness of one’s surroundings, of the self and of one’s thoughts and feelings.’

What are the mechanisms that modulate consciousness and unconsciousness?

Normal states of consciousness and unconsciousness, i.e., wakefulness and sleep, are due to normal alterations in the modulation of cortical activity controlled by circuits that originate in brainstem and nuclei in the base of the forebrain

Abnormal states of consciousness, i.e., halucination, concussion, coma, persistent vegetative state, are due to disruption (temporary or permanent) to either the neuromodulatory systems that control cortical activity or direct injury to the cerebral hemispheres themselves.

Additional Source Information

for more information see: http://open.umich.edu/wiki/CitationPolicy

Slide 5: Source Undetermined
Slide 6: Source Undetermined
Slide 7: Source Undetermined
Slide 9: Sources Undetermined
Slide 10: Source Undetermined
Slide 11: Source Undetermined
Slide 12: Source Undetermined
Slide 13: Source Undetermined
Slide 14: Source Undetermined
Slide 15: Source Undetermined
Slide 16: Source Undetermined
Slide 17: Brodmann, Wikimedia Commons, http://commons.wikimedia.org/wiki/File:Brodmann-areas.png, PD-INEL
Slide 18: Source Undetermined
Slide 19: Original sources, tristram, Wikispaces, http://tristram.wikispaces.com/file/view/homunculus.gif, CC:BY:SA http://creativecommons.org/licenses/by/3.0/
Slide 20: Source Undetermined
Slide 21: Source Undetermined
Slide 22: Source Undetermined
Slide 23: Source Undetermined
Slide 24: Source Undetermined
Slide 27: Source Undetermined
Slide 28: Source Undetermined
Slide 29: Source Undetermined; Hanes. Fundamental Neuroscience. Churchill Livingstone, 2002. 2nd ed.
Slide 30: Source Undetermined
Slide 31: Source Undetermined
Slide 32: Source Undetermined
Slide 33: Source Undetermined
Slide 34: Gray's Anatomy
Slide 36: Source Undetermined
Slide 37: Hanes. Fundamental Neuroscience. Churchill Livingstone, 2002. 2nd ed.
Slide 38: Source Undetermined
Slide 39: Source Undetermined
Slide 40: Source Undetermined