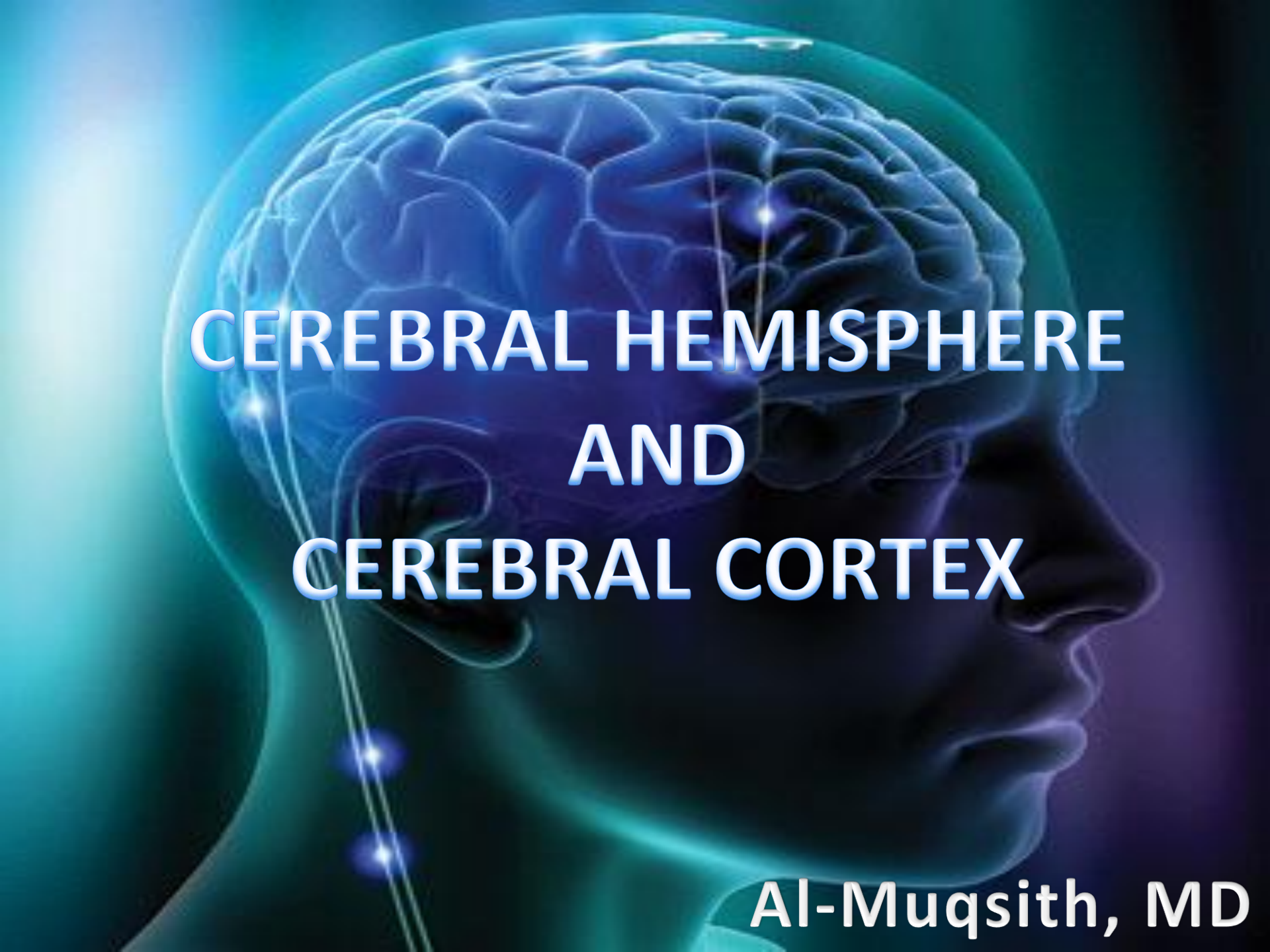

CEREBRAL HEMISPHERE
AND
CEREBRAL CORTEX
Al-Muqsith, MD

Cerebral Hemisphere

- Derived from the embryological telencephalon
- Consists of :

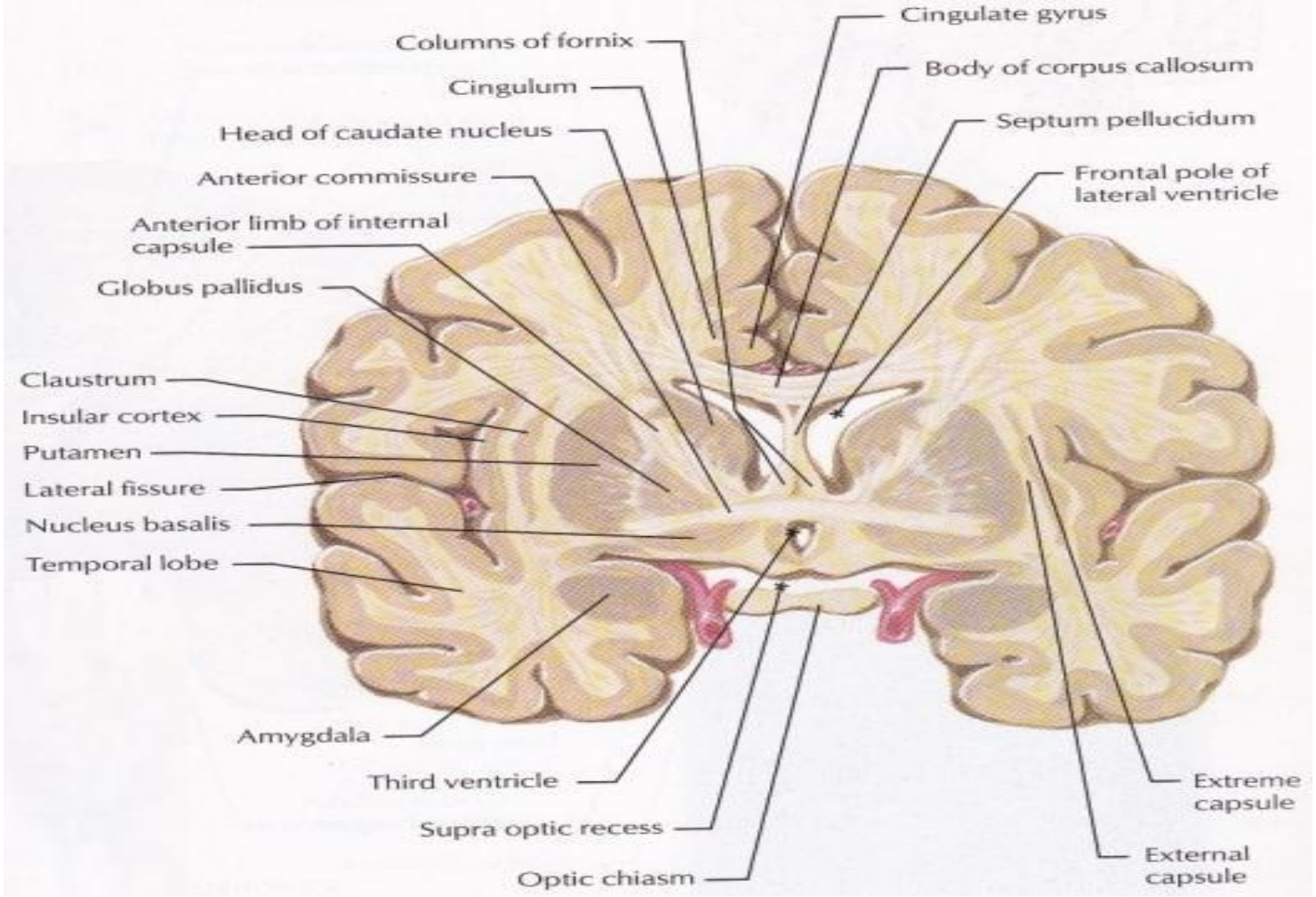
- **Cerebral cortex** (Layer of grey mater)

  highly convulated to form a complex pattern of ridges (gyri) and furrows (sulci)

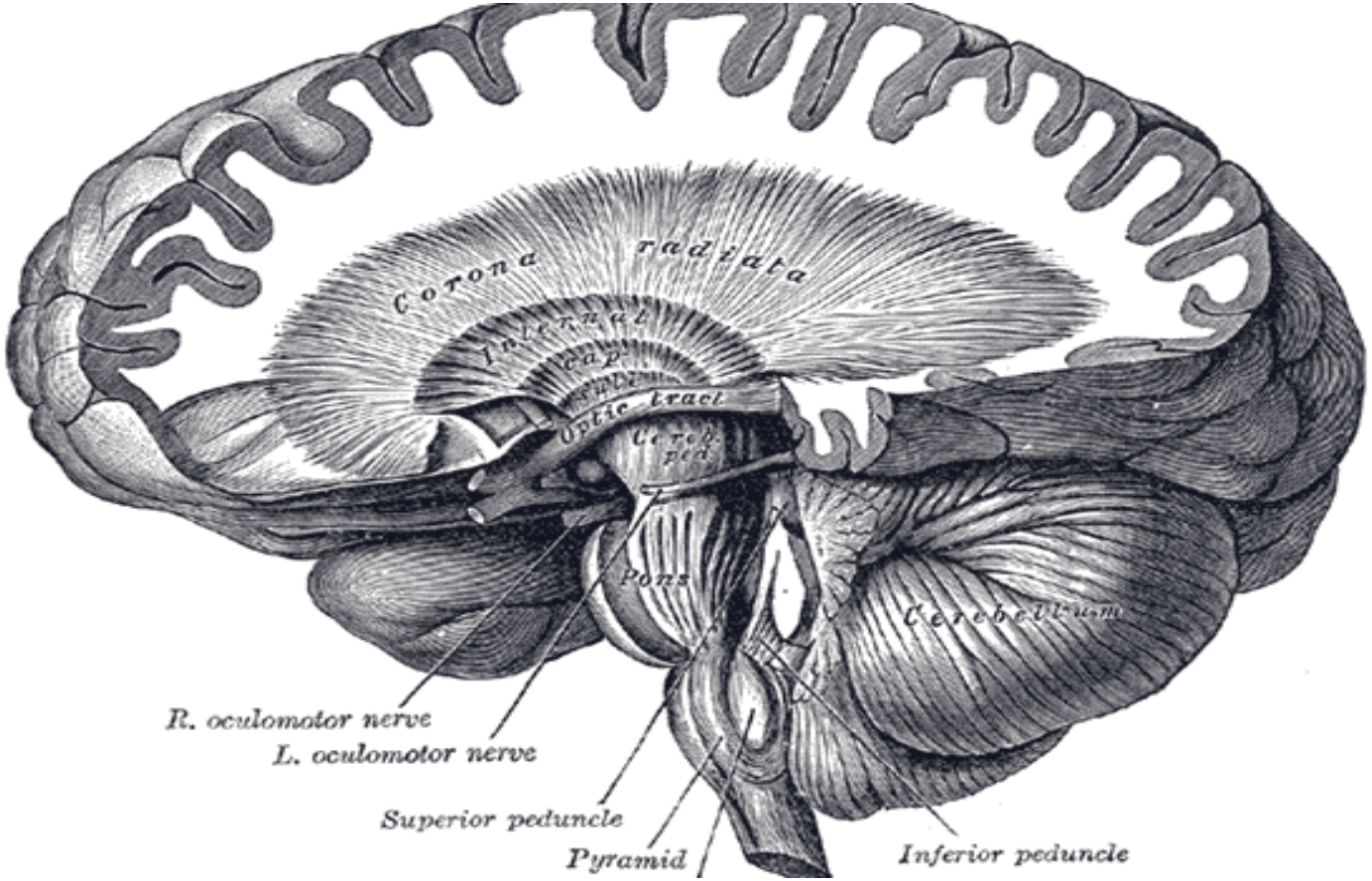
- C**entrum semi ovale** (Layer of white mater)

- **Basal ganglia** (Nuclear masses which buried within the white matter)

- **Rhinencephalon**



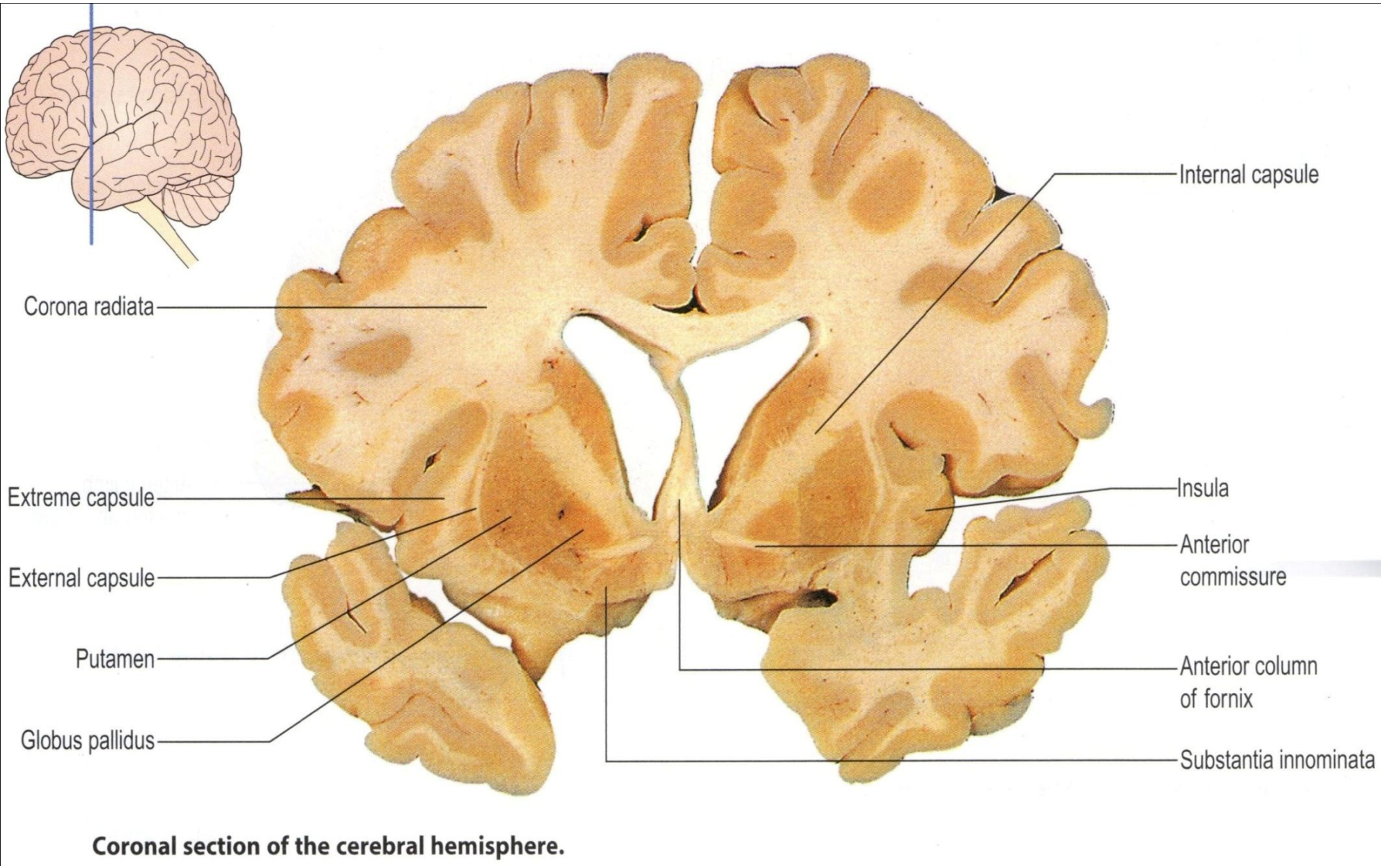
- **Internal capsule**
  - Contains both ascending and descending axons
- **Lateral ventricle**
- **Corpus striatum** or **basal ganglia** → caudate nucleus, putamen, and globus pallidus
- **Corpus callosum**
- **Great Longitudinal fissure**



Corona Radiata

- Fibres radiate in and out to produce a fan-like arrangement between internal capsule and cortical surface
- Contains both descending and ascending axons that carry nearly all of the neural traffic from and to the cerebral cortex

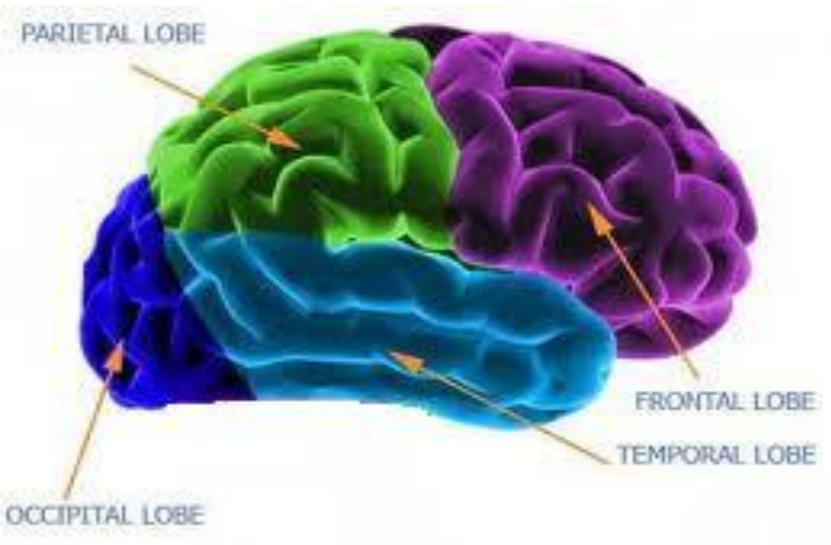
Corona Radiata

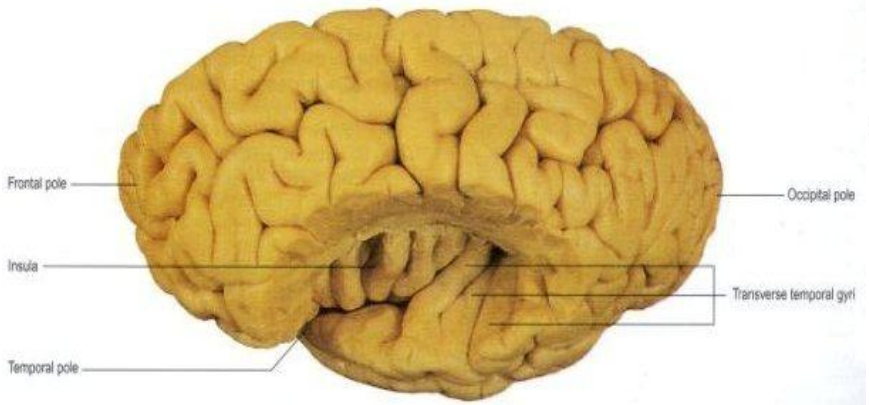


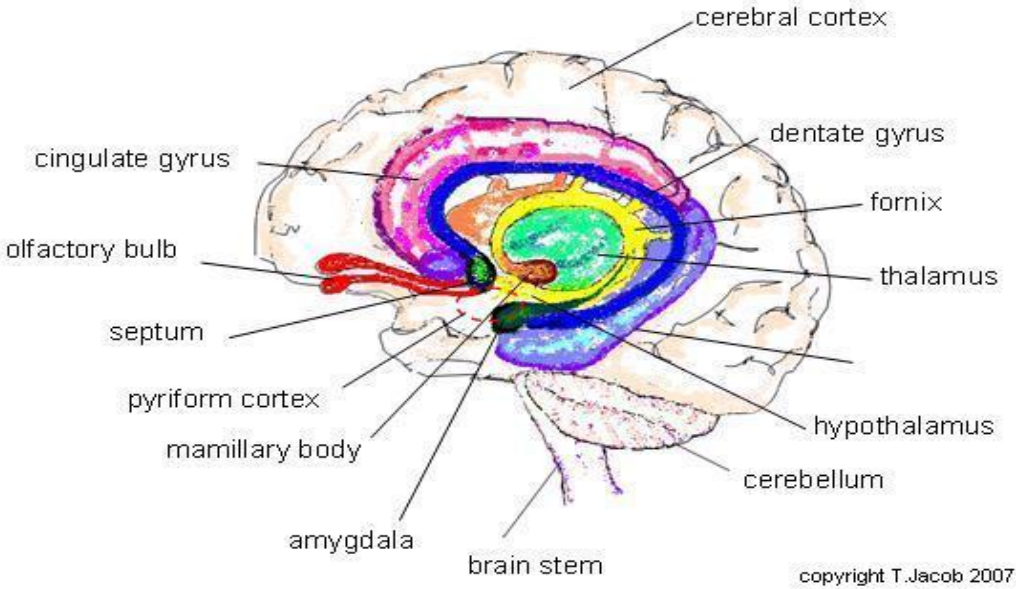
Coronal section of the cerebral hemisphere.

Lobes of The Cerebral Hemisphere

- Frontale lobe
- Parietal lobe
- Temporal lobe
- Occipital lobe
- Insular lobe
- Limbic

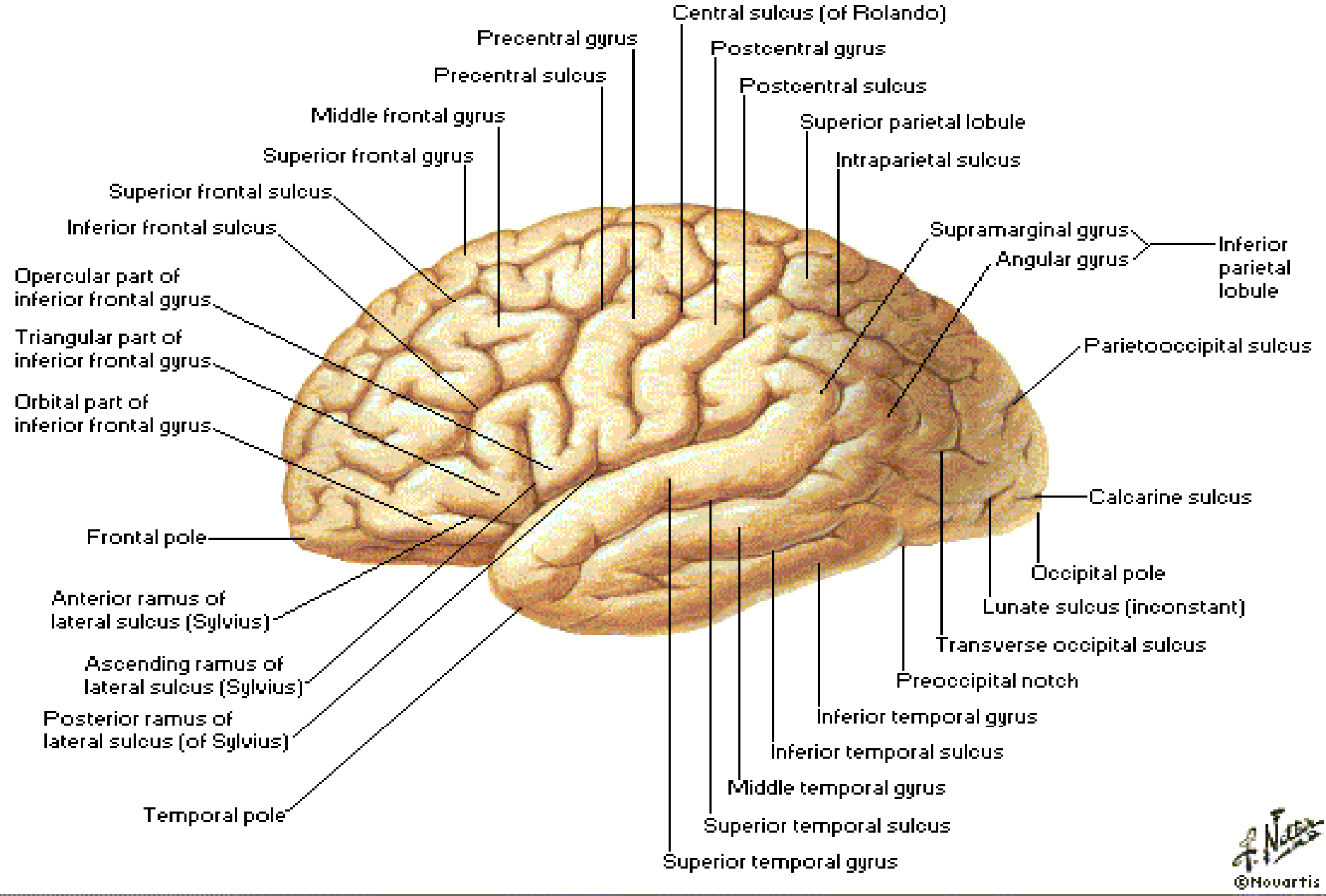






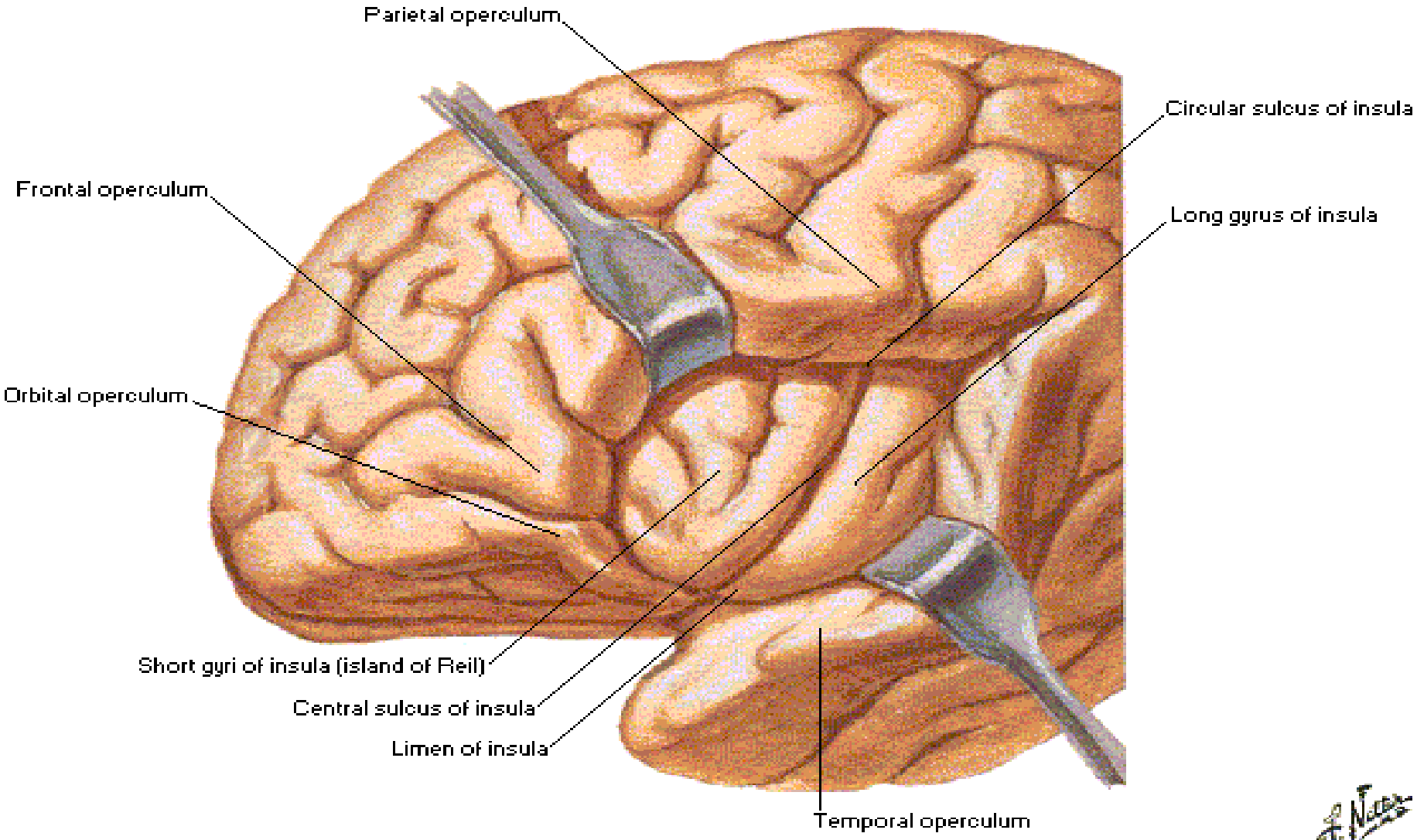
Cerebrum

Lateral View



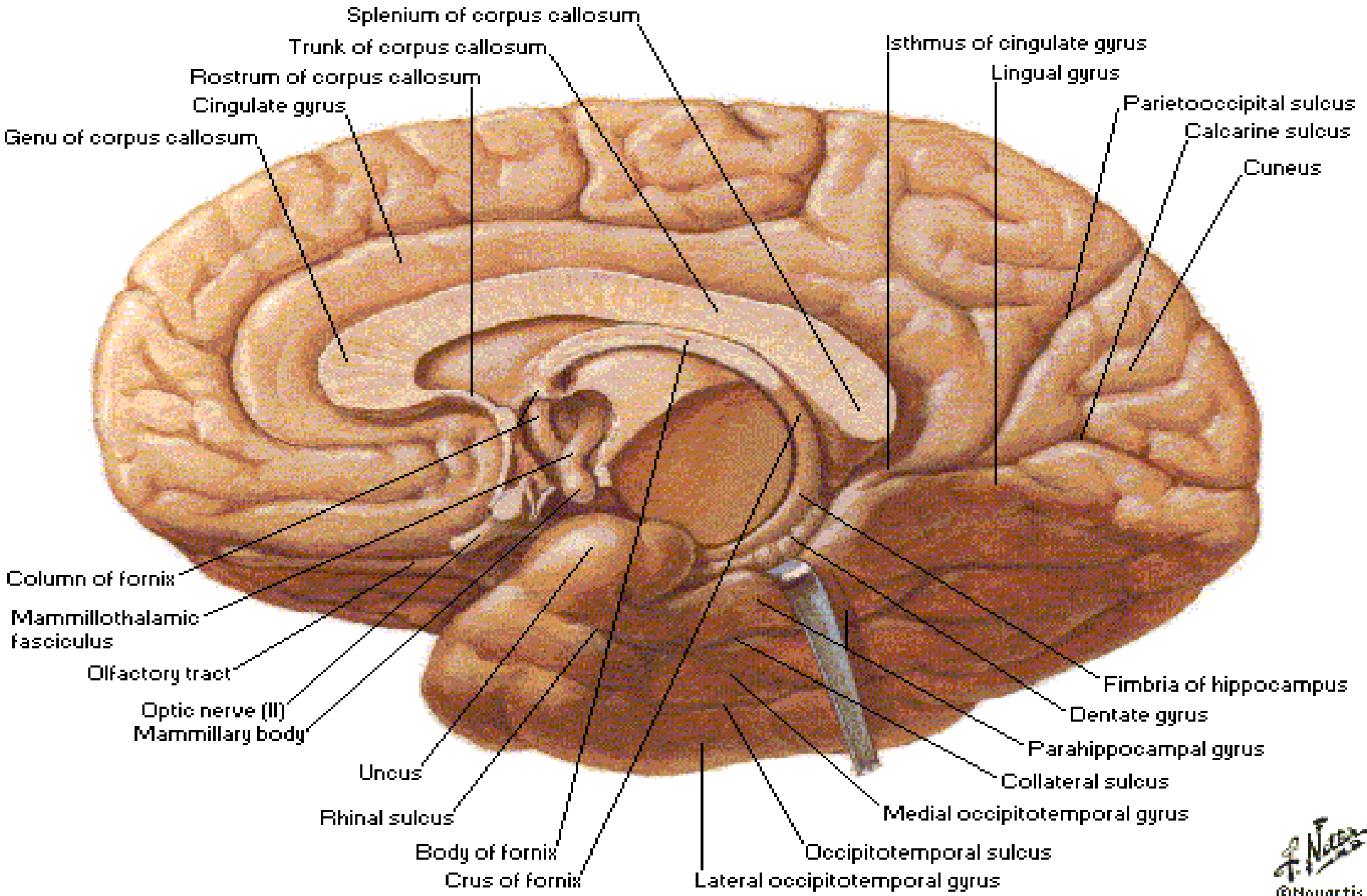
Cerebrum – Insula [Island of Reil]

Lateral View



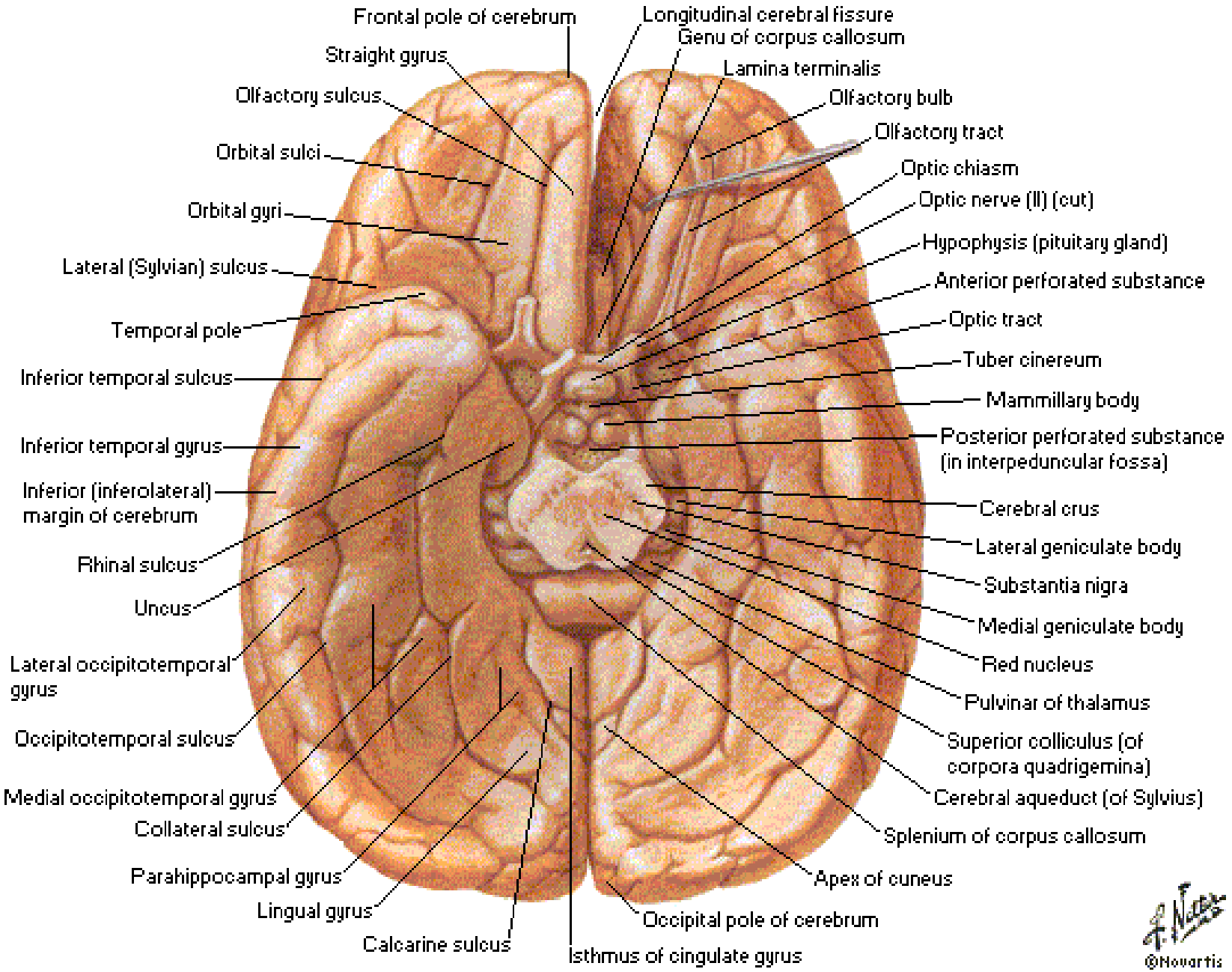
Cerebrum - Hemisphere with Brainstem Excised

Medial View



Cerebrum

Inferior View



Cerebral Cortex

Histological Structure

Consist of :

- Archicortex and Paleocortex → phylogenetically old parts of the cortex

 - hippocampus and other parts of the temporal lobe

 - Three-layered cytoarchitecture

- Neocortex

 - Six-layered cytoarchitecture

Histological Structure of Cerebral Cortex

- **Molecular (plexiform) layer**

  Few nerve cell bodies but many dendritic and axonal processes in synaptic interaction
- **OUTER granular layer**

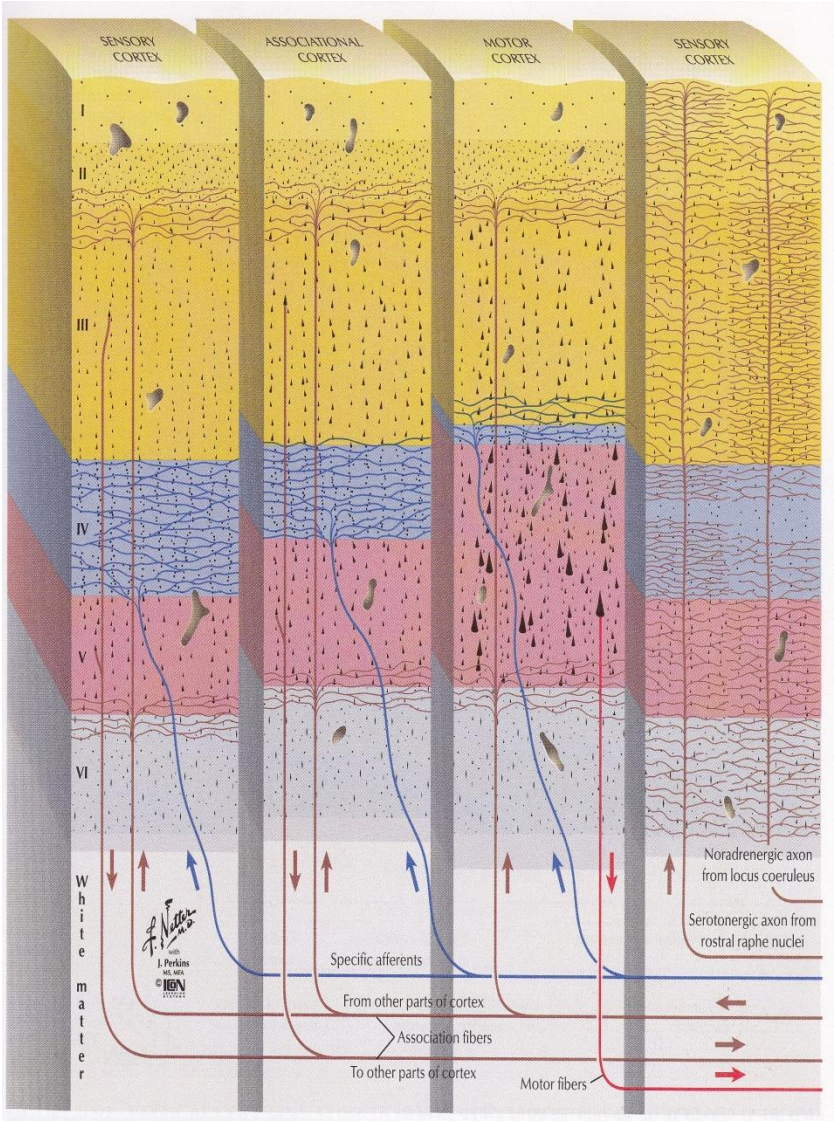
  Many small neurones, which establish intracortical connections
- **OUTER pyramidal cell layer**

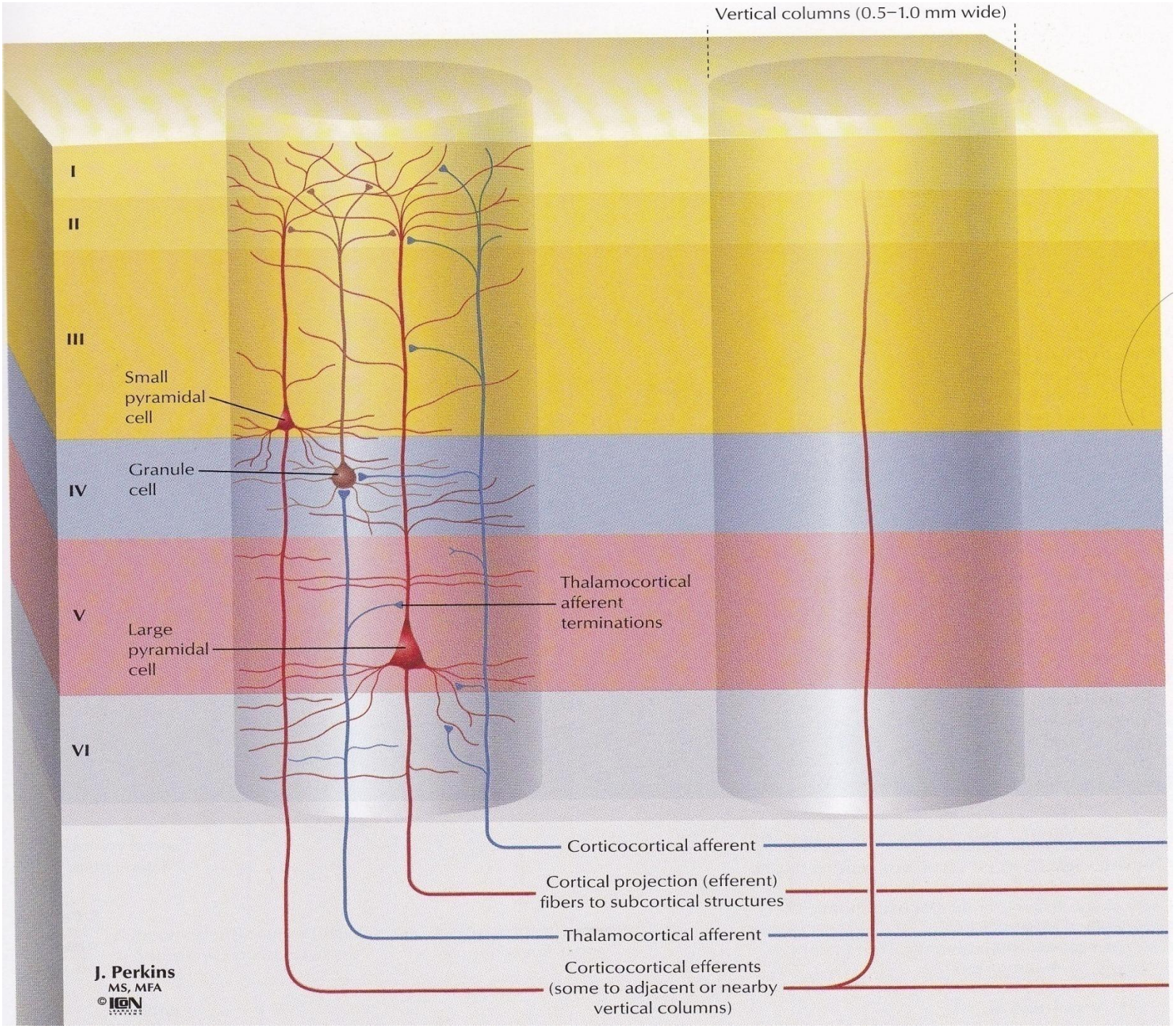
  Medium-sized neurones giving rise to association and commissural fibres
- **INNER granular layer**

  The side of termination of afferent fibres from the spesific thalamic nuclei
- **INNER pyramidal cell later (ganglionic layer)**

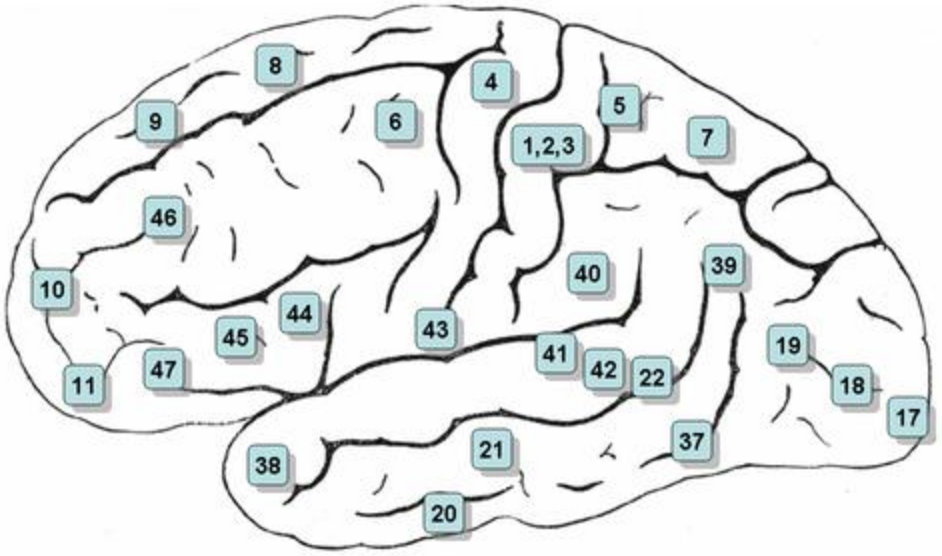
  Origin of projection fibres to extracortical targets. In primary motor cortex, this layer contains giant Betz's cells
- **Multiform cell layer**

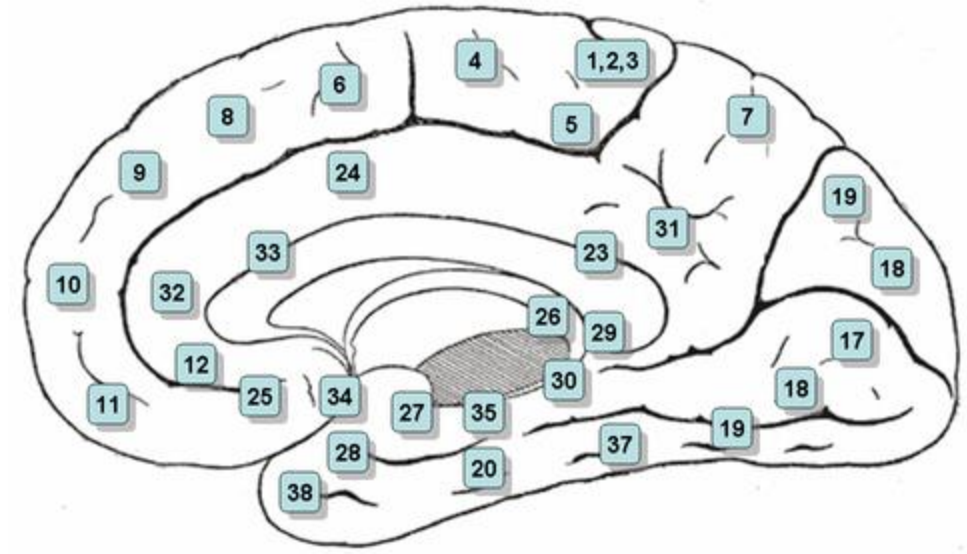
  Contains association and projection neurones



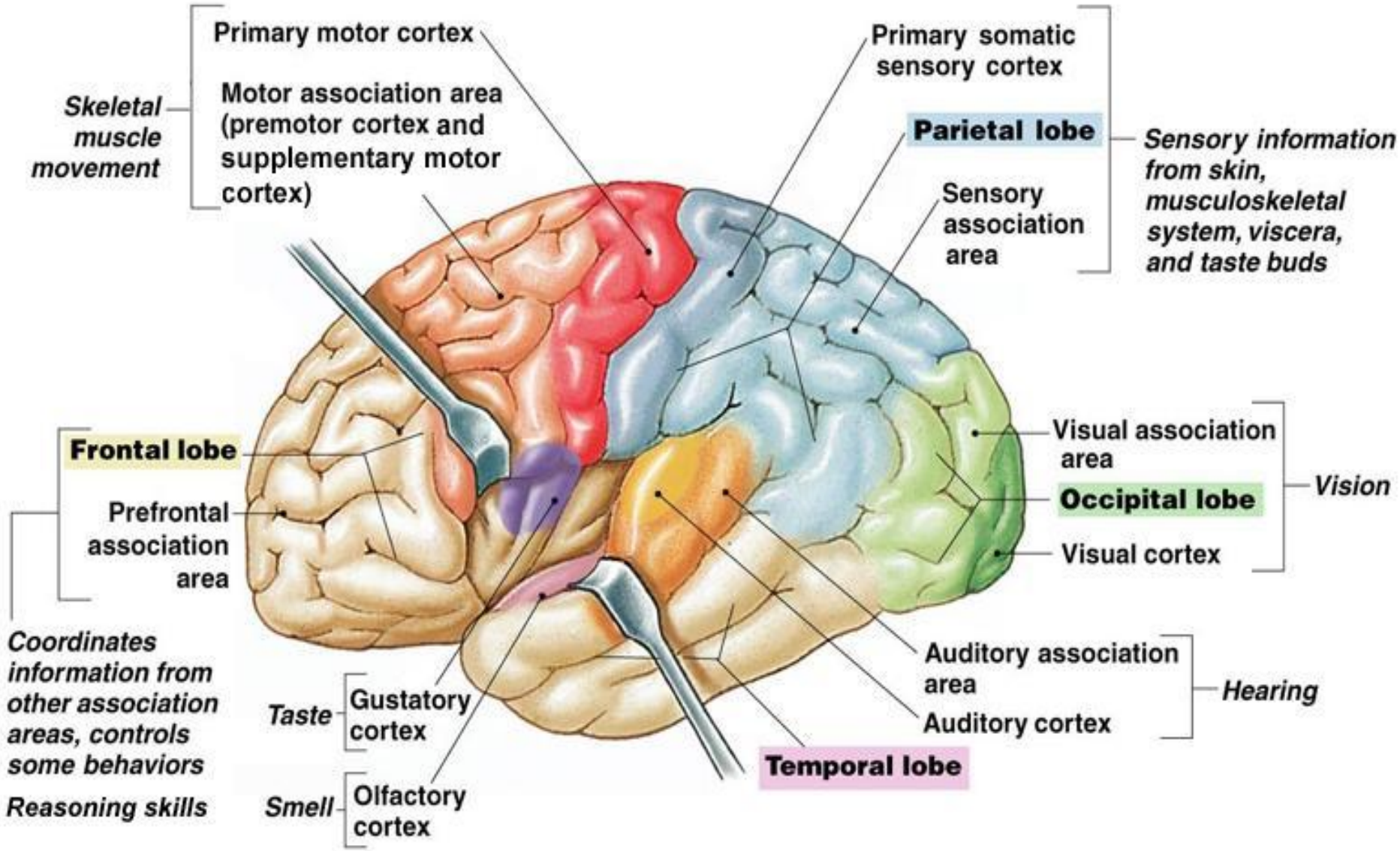

Vertical columns (0.5–1.0 mm wide)
I
II
III
IV
V
VI
Small pyramidal cell
Granule cell
Large pyramidal cell
Thalamocortical afferent terminations
Corticocortical afferent
Cortical projection (efferent) fibers to subcortical structures
Thalamocortical afferent
Corticocortical efferents (some to adjacent or nearby vertical columns)
J. Perkins
MS, MFA
©

Function	Brodmann Area
Vision	
primary	17
secondary	18, 19, 20, 21, 37
Audition	
primary	41, 42
secondary	22
Body Sensation	
primary	1, 2, 3
secondary	5, 7
Sensation, tertiary	7, 22, 37, 39, 40
Motor	
primary	4
secondary	6
eye mov't	8
speech	44
Motor, tertiary	9, 10, 11, 45, 46, 47





Functional Organisation



Functional Organisation of Cerebrum

- **Cerebral cortex** :

- Necessary for conscious awareness, memory, and intellect

- Region to which all sensory modalities ultimately ascend and consciously perceived interpreted in the light of previous experience

- The highest level at which the motor system is represented

Functional Organisation of Cerebrum

- Sensory information → primary sensory area (parietal lobe/somatosensory, occipital lobe/visual, temporal lobe/hearing → Association cortex → touch, sight, and hearing.

- **Frontal lobe**

- Primary motor area, premotor, supplementary motor areas → organisation of movement
- Prefrontal area → strategic guidance of complex motor behaviour over time

- Association cortex in frontal, parietal, and temporal lobes of left hemisphere → comprehension and expression of language

* Left hemisphere is dominant for language

Functional Organisation of Cerebrum

- **Limbic system**

- Anterior thalamic tubercle
- Cingulate gyrus
- Parahippocampal gyrus
- Subcallosal gyri
- Supracallosal gyrus (indusium griseum)
- Hipocampal formation (hippocampus & dentate gyrus)
- Amigdala
- Fornix
- Septal area
- Mamillary bodies

❖ storage and retrieval of information processed in posterior hemispheric regions

❖ Functions:

- flight and fight responses
- feeding behaviour
- behavioural & endocrine of sexual response
- feeding behaviour
- autonomic
- Agression, emosion aspects of behaviour

Focal Cerebral Lesion

Focal cerebral lesion (e.g. stroke or tumour) produce 3 kinds of symptom:

1. Focal epileptic seizure

- Simple focal seizures

  sudden attacks of abnormal movements or sensations, may trigger generalised (tonic-clonic) seizures.

- Complex partial seizures

  brief alterations in perception, mood, and behaviour.

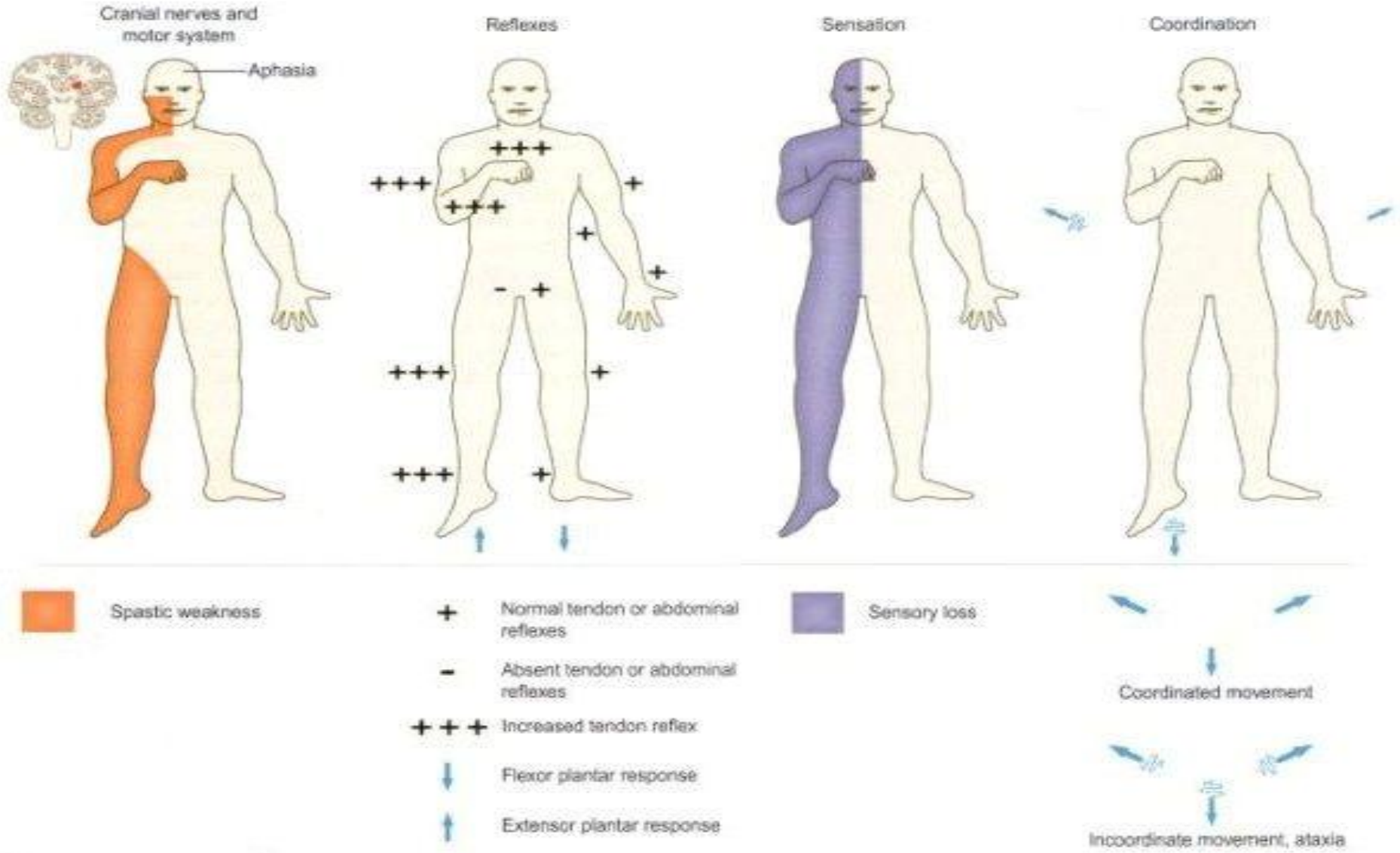
Focal Cerebral Lesion

2. Sensory/motor deficits
   Loss sensation or movement.
3. Psychological deficits
   breakdowns in psychological processes : language, perception, and memory.

- Syndrome of raised intracranial pressure → focal lesion is space-occupying
- Unilateral cerebral hemisphere lesion causes:
  - Mental impairment (e.g. aphasia)
  - Contralateral spastic
  - Hyperreflexia
  - Extensor plantar response

UMN lesion

Unilateral Cerebral Hemisphere Lesion



Crossman A.R, Neuroanatomy

Frontal Lobe

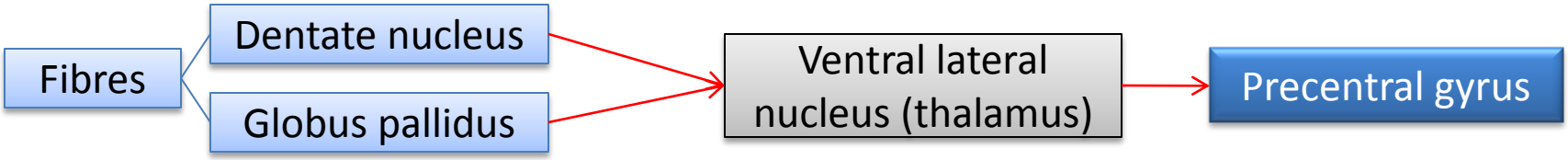
- **Primary motor cortex**

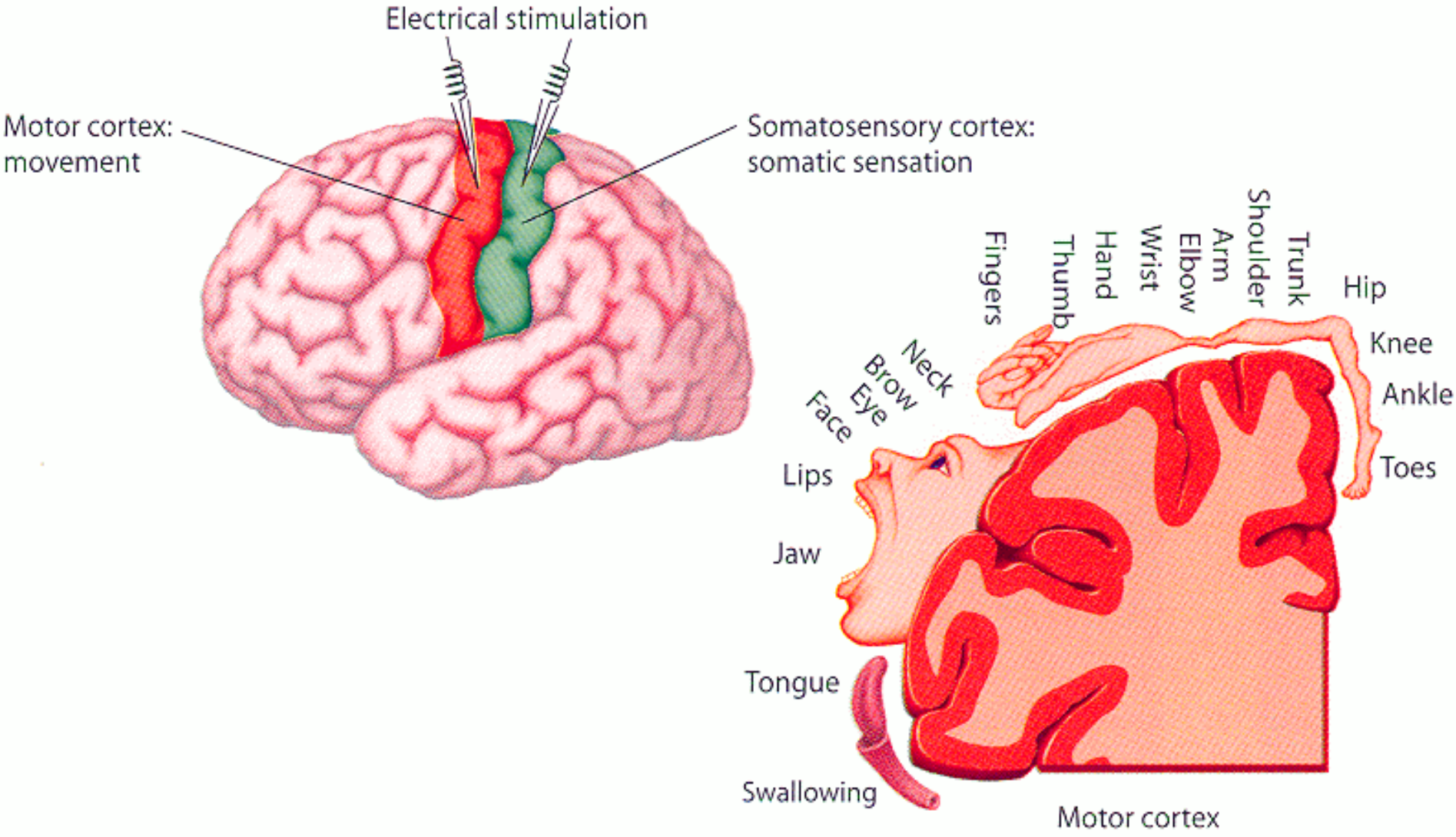
- Precentral gyrus (Brodmann's area 4)
- Contralateral half of the body is represented in a precise somatotopic fashion
- Function:

  control of voluntary, skilled movements, referred to as fractionated movements (sometimes)
- corticospinal (pyramidal tract) & corticobulbar fibres:

  30% from primary motor cortex

  3% giant pyramidal (Betz) cells




Electrical stimulation
Motor cortex: movement
Somatosensory cortex: somatic sensation
Fingers
Thumb
Hand
Wrist
Elbow
Arm
Shoulder
Trunk
Hip
Knee
Ankle
Toes
Neck
Brow
Eye
Face
Lips
Jaw
Tongue
Swallowing
Motor cortex

Frontal Lobe

- **Premotor cortex (Brodmann's area 6)**

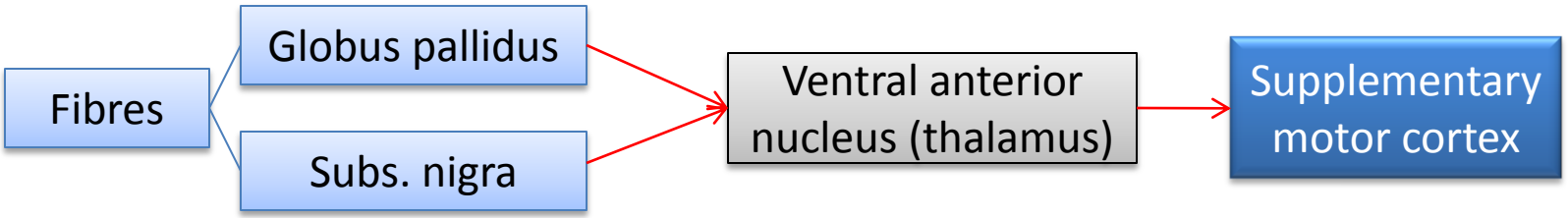
- surface of hemisphere:

  Lateral : includes the posterior portion of the sup., mid., and inf. Frontal gyri.

  Medial : includes to supplementary motor cortex (somatotopic representation appears to be bilateral in both hemispheres)

- Fc : programming and preparation of movement and in the control of posture

- Actions partly via PMC (short association fibres) and corticospinal and corticobulbar fibres (30% in premotor cortex, giant Betz cells [-])



Frontal Lobe

- **Frontal eye field**

- Middle frontal gyrus (Brodmann's area 8)
- fc : controls voluntary conjugate deviation of the eyes
- Unilateral damage causes:

  conjugate deviation of the eye towards the side of the lesion

- **Broca's area**

- Pars triangularis of inferior frontal gyrus (Brodmann's area 44 and 45)
- motor speech area
- interconnections with parts of ipsilateral temporal, parietal, and occipital lobes → language function.

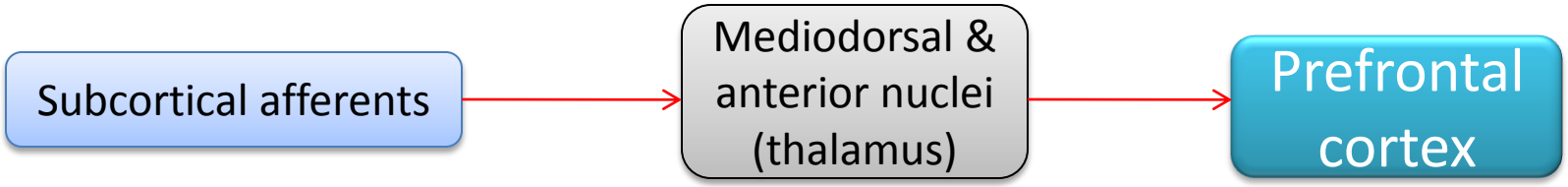
Frontal Lobe

- **Prefrontal cortex**

- Rich connections with parietal, temporal, and occipital cortex through long association fibres

- Fc :

  Cognitive functions (intellectual, judgemental and predictive faculties and planning of behavour)



Left Frontal Lobe Lesions

- Focal Seizure

  paroxysmal jerking movements of the contralateral limbs are termed “simple motor” or Jacksonian seizures
- Sensory/motor deficit

  weakness of the face and hemiplegia contralateral (UMN lesion sign)
- Psychological deficit

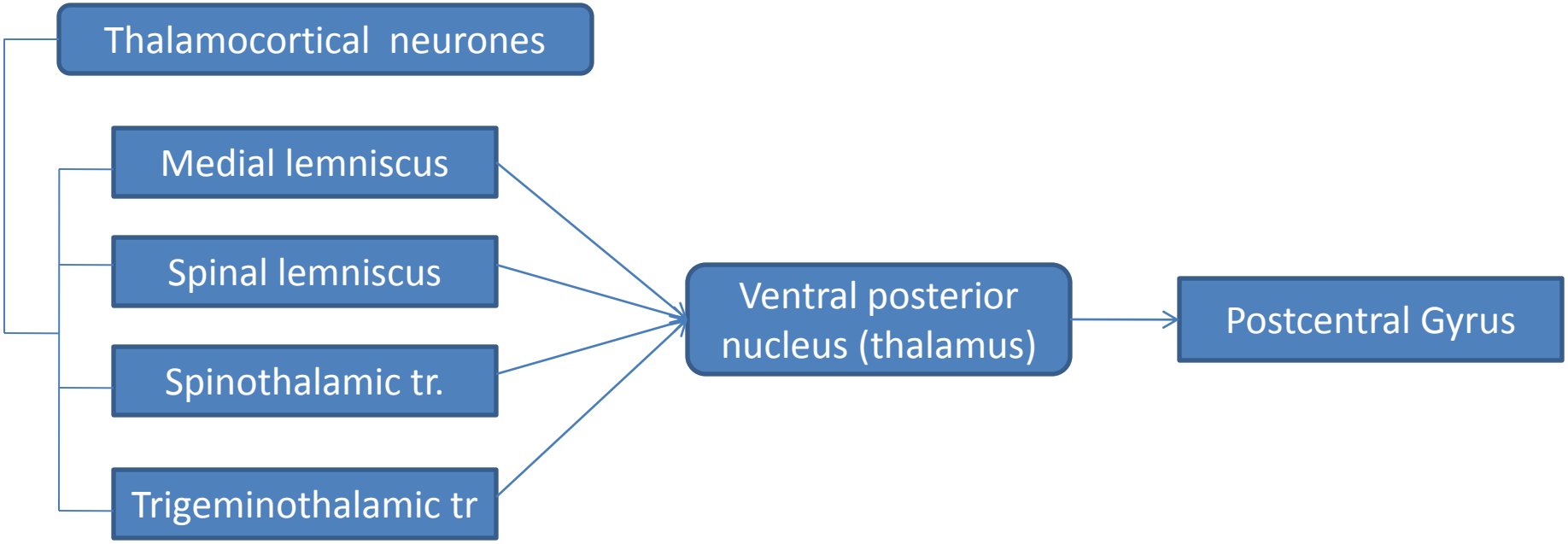
  - Broca’s aphasia
  - Paraphasia
  - Alexia
  - Agraphia

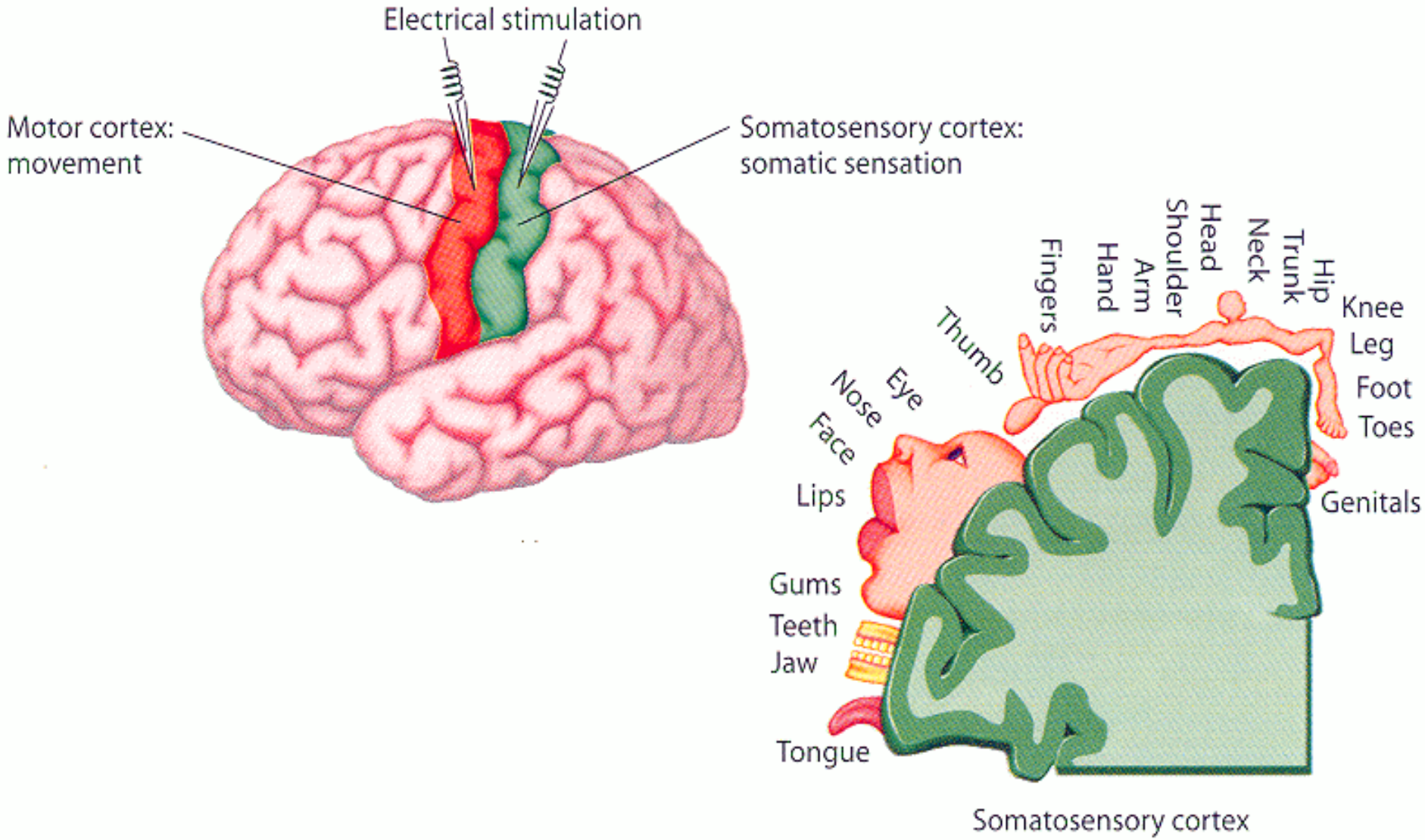
Parietal Lobe

- **Primary somatosensory cortex**

- Postcentral gyrus (Brodmann's area 1, 2, and 3)

- within somatosensory cortex, contralateral half of body is represented in an inverted

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Motor cortex: movement
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Neck
Trunk
Hip
Knee
Leg
Foot
Toes
Genitals
Eye
Nose
Face
Lips
Gums
Teeth
Jaw
Tongue
Somatosensory cortex

Parietal Lobe

- **Parietal association cortex**

- superior parietal lobule → interpretation of general sensory information and conscious awareness of contralateral half of body.

  lesions : impair interpretation and understanding of sensory input and neglect of opposite side of the body

- Inferior parietal lobule → language functions

  (between somatosensory cortex, visual & auditory association cortices)

Parietal Lobe Lesions

- Left parietal lobe

1. Focal seizure

   Paroxysmal attacks of abnormal sensations, spreading down the contralateral side of the body (sensory seizure)

2. Sensory/motoric deficit

   Contralateral hemisensory loss and inferior visual field loss

3. Psychological deficit

   - Anomia
   - Loss of literacy
   - Alexia
   - Agraphia
   - Acalculia

Parietal Lobe Lesions

- Right parietal lobe

1. Focal seizure

   Paroxysmal attacks of sensory disturbance affecting to contralateral side of the body (simple sensory seizures)

2. Sensory/motoric deficit

   Contralateral hemisensory loss and inferior visual field loss

3. Psychological deficit

   Constructional apraxia

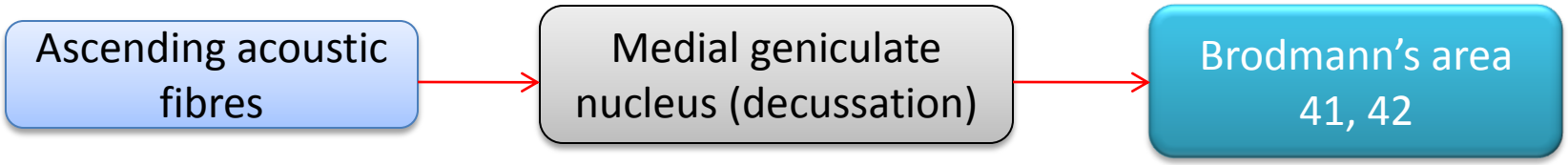
Temporal lobe

- **Primary auditory cortex**

- Superior temporal gyrus (Brodmann's area 41, 42)
- Precise location → marked by small transverse temporal gyri (Heschl's convolutions)
- fc :

  Conscious perception of sound or "tonotopical" representation of cochlear duct

- Unilateral lesion → partial deafness in both ears (at cortical level, the organ of hearing are bilaterally represented)



Temporal lobe

- **Auditory association cortex**

- Wernicke's area

  (surrounding and immediately posterior of primary auditory cortex)

- fc :

  understanding of spoken word and important connections with other language area

- **Cortical representation of vestibular system**

- the location → uncertain

- evidence that it lies in superior temporal gyrus anterior to primary auditory cortex, or inferior parietal lobule

Temporal lobe

- **Hippocampus**

- A part of limbic system

- Relation to memory and emosional aspects of behaviour

- **Amygdala**

- A part of limbic system

- amygdala + adjacent parts of inferomedial temporal cortex → conscious appreciation of sense of smell

Left Temporal Lobe Lesions

1. Focal seizure

- Paroxysmal attacks of unresponsiveness (absences)
- Purposeless behaviour (automatism)
- Olfactory, complex visual, and auditory hallucinations
- Disturbances of mood and memory (déjà vu)
- referred to as complex partial seizures

2. Sensory/motoric deficit

Contralateral superior visual field loss

3. Psychological deficit

Wernicke's aphasia

- Paraphasia and incomprehensible
- Profound word-finding difficulty, impaired repetition of words, profound loss of comprehension.

Bilateral Cortical Disorder

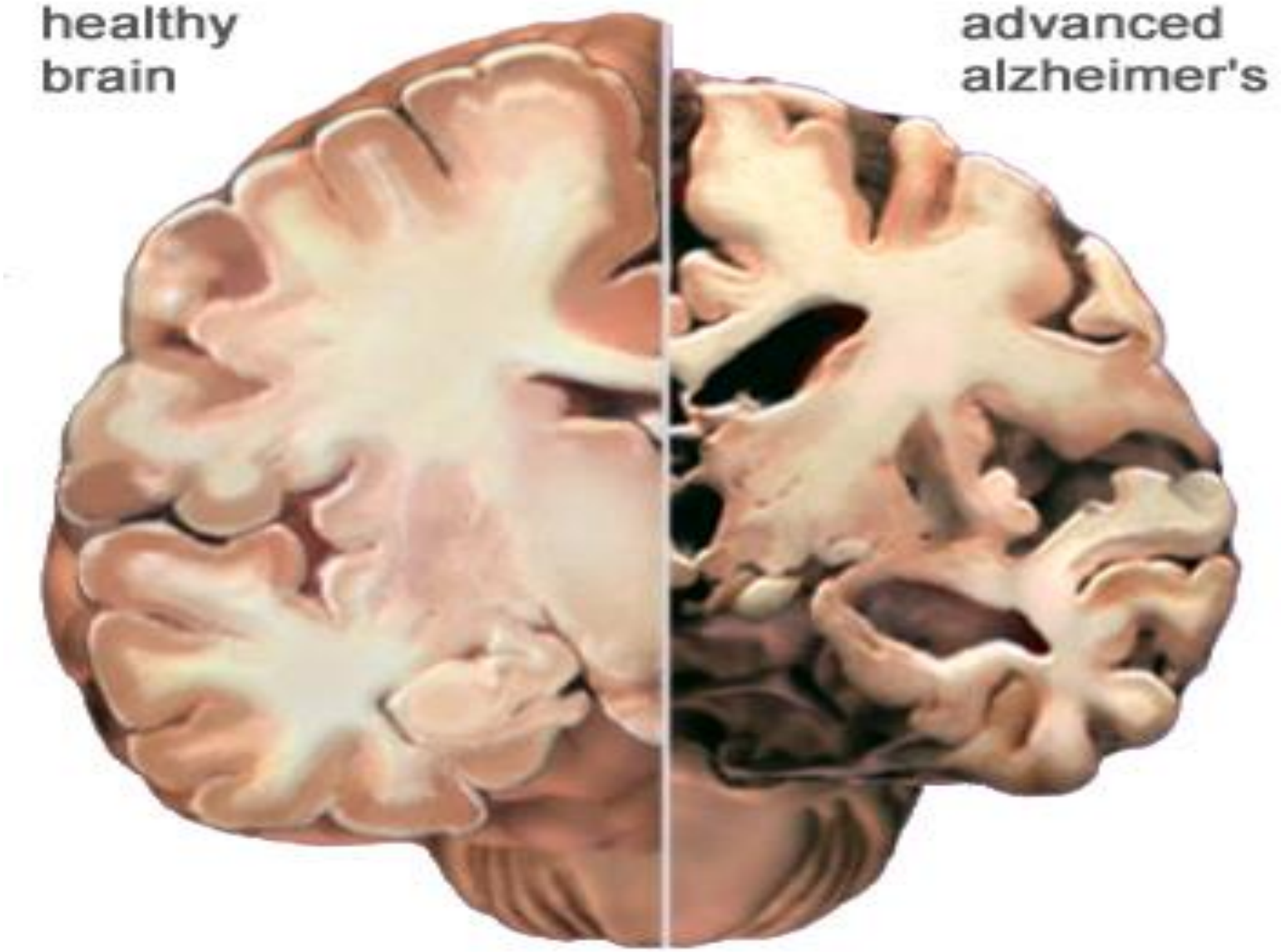
1. Alzheimer's disease

- Common degenerative disorder of the elderly
- Atrophy of temporal and parietal lobes and limbic system
- It causes:
  - Disorientation in space
  - Aphasia
  - Amnesia

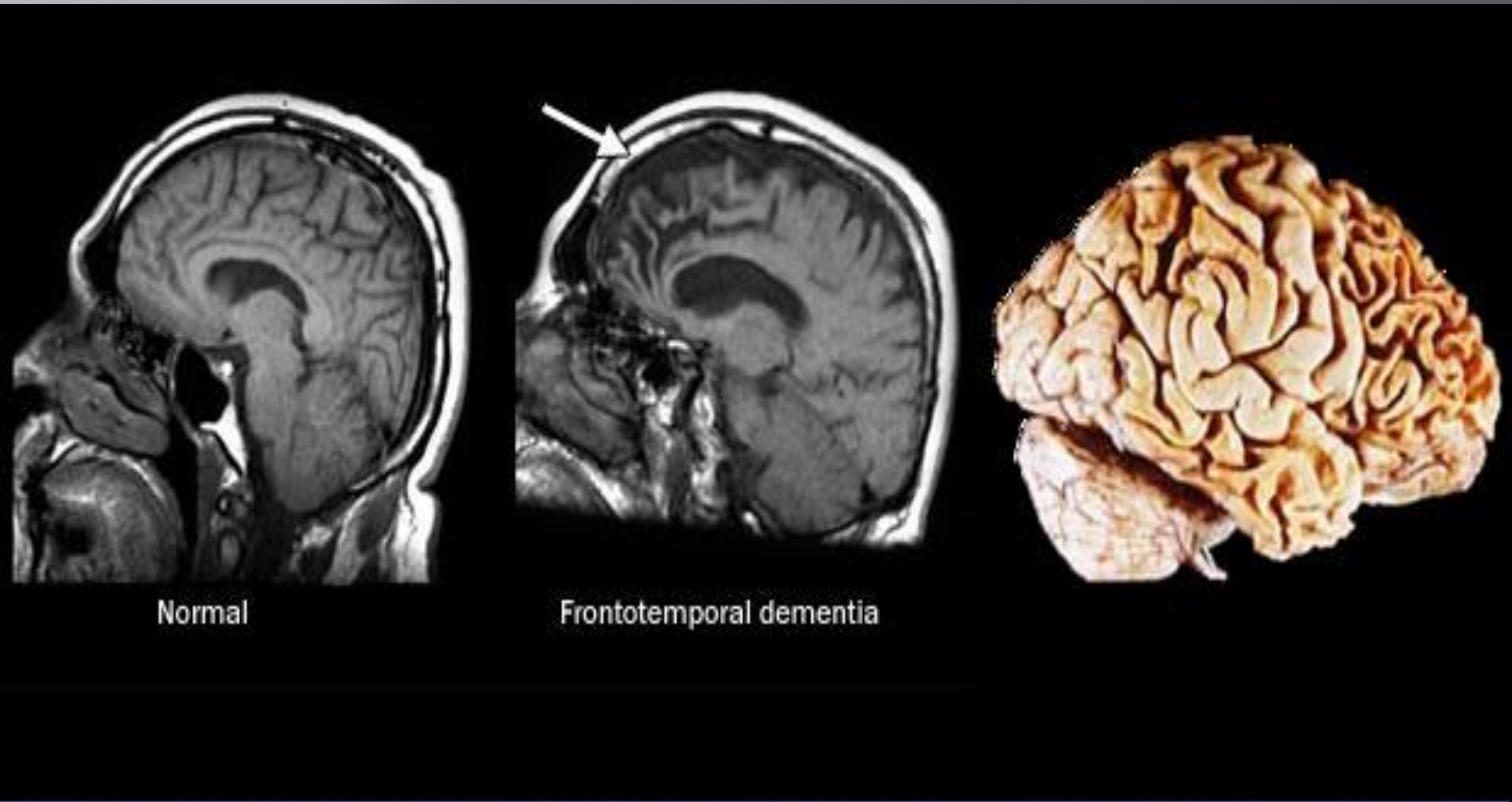
2. Frontotemporal dementia

- Total alteration of personality with loss of judgement, planning, and insight
- Appearance of bizarre and uncharacteristic behaviour
- Young people are affected

Alzheimer’s Disease



Frontotemporal dementia



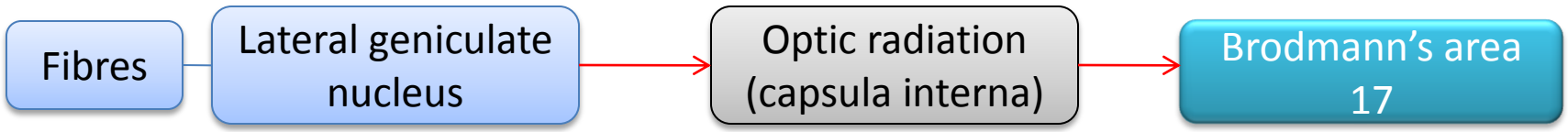
Occipital Lobe

- **primary visual cortex**

- Calcarina sulcus (Brodmann's area 17)
- fc : responsible for visual perception
- Each lateral half of visual fiels represented in primary visual cortex of contralateral hemisphere

  Upper half of visual field → below calcarina sulcus

  Lower half of visual field → upper calcarina sulcus
- Lesions : blindness in corresponding part of visual cortex



Occipital Lobe

- **Visual association cortex**

- Concerned with interpretation of visual images

- Lesions :

  deficits in visual interpretation and recognition

Occipital Lobe Lesion

1. Focal seizure

   Paroxysmal visual hallucinations of a simple, unformed nature, such as light and colours (simple partial seizures)

2. Sensory/motoric deficit

   Contralateral visual field loss (contralateral homonymous hemianopia)

- Bilateral occipital lobe lesions lead to cortical blindness → unaware (Anton's syndrome)
- Bilateral occipitoparietal lesions → apperceptive visual agnosia

Language Area

- Left hemisphere → dominant for language and mathematical ability
- Right hemisphere → spatial perception and musical proficiency

- Language area :

- Broca's area

  Expressive aspects of language (articulation)

- Wernicke's area

  Comprehension of the spoken word

- Angular & supramarginal gyrus

  Provide a functional interface between auditory and visual association (naming, reading, writing, calculation)

White Matter of Cerebral Hemisphere

1. Association fibres

   Interconnect cortical sites lying within one cerebral hemisphere
2. Commisural fibres

   Cerebral hemisphere – cerebral hemisphere, connecting functionally related structure
3. Projection fibres

   Cerebral cortex – Subcortical structure

Association Fibres

- U fibres

  short and nearby area of cortex
- Superior longitudinal fasciculus

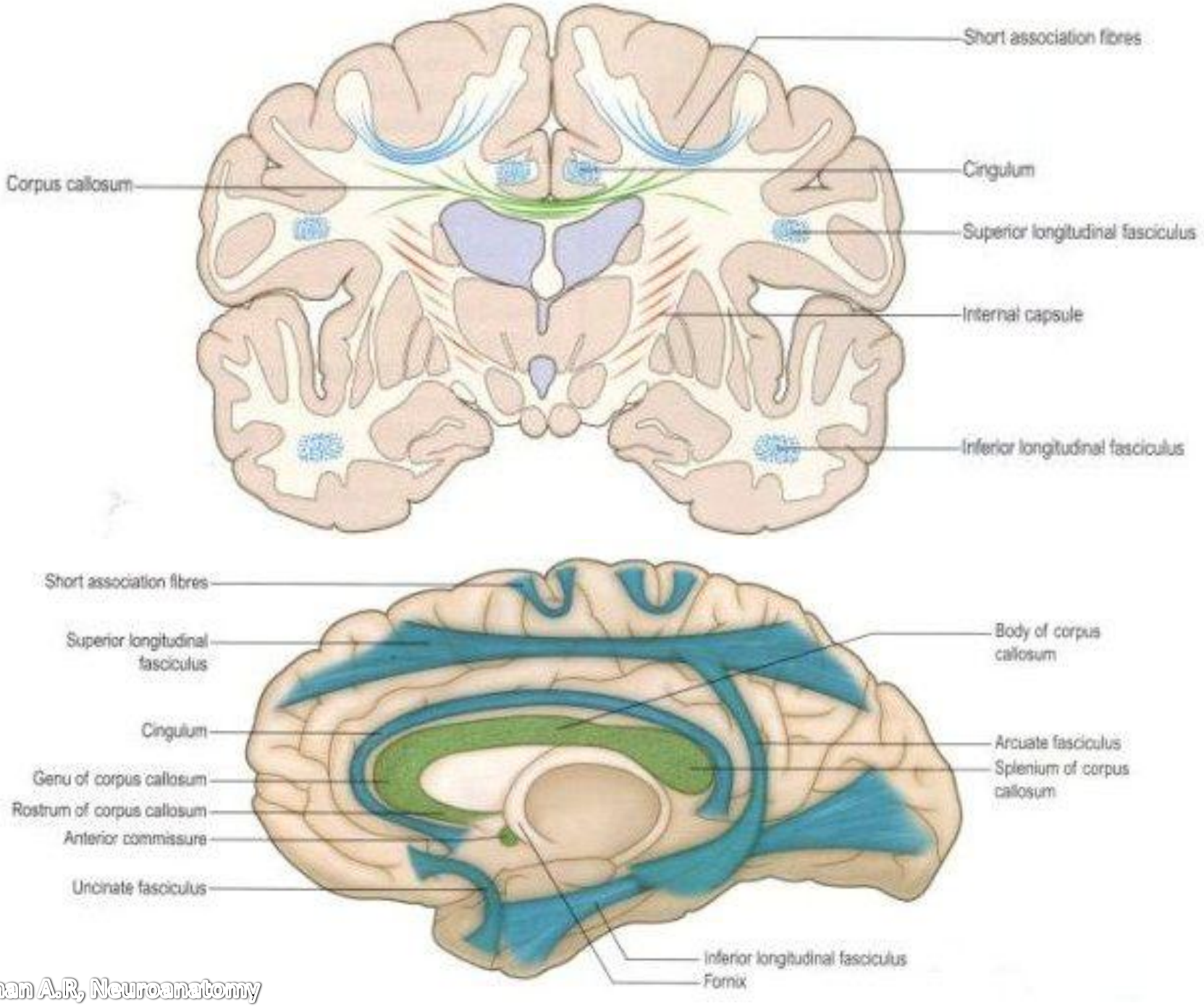
  frontal lobe – occipital lobe
- Arcuata fasciculus

  Gyri in frontal lobe – temporal lobe (language function)
- Inferior longitudinal fasciculus

  Occipital lobe – temporal lobe (visual recognition)
- Uncinate Fasciculus

  ant. & inf. frontal lobe – temporal gyri (regulation of behaviour)
- Cingulum

  Frontal & parietal lobe – parahippocampal & adjacent temporal gyri



Associative Agnosia

- CO poisoning → destroy Inferior longitudinal fasciculus bilaterally → cerebral damage

- Causes :

  - Object agnosia

  - Prosopagnosia

Commissural Fibres

- Corpus callosum

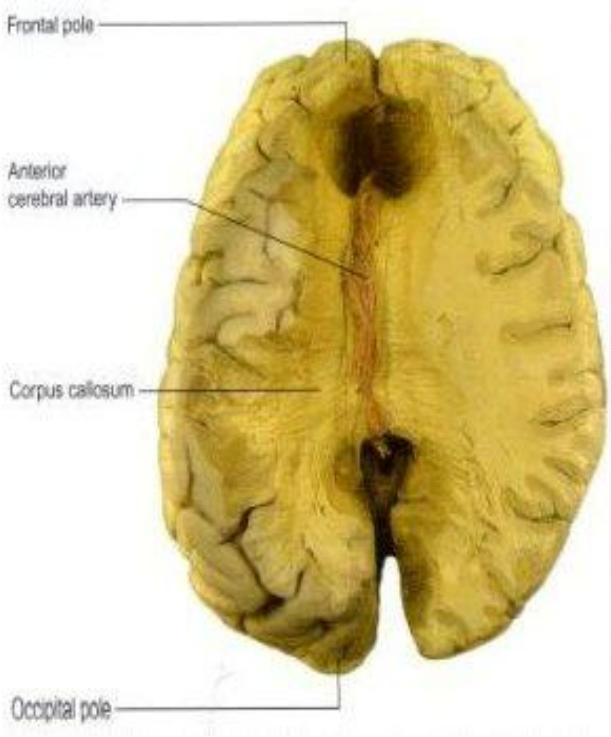
  - Spans two cerebral hemisphere and connects corresponding regions of neocortex
  - Anterior forceps : frontal pole – rostrum
  - Posterior forceps : occipital pole – splenium
  - Splenium interconnects occipital cortices (visual function)

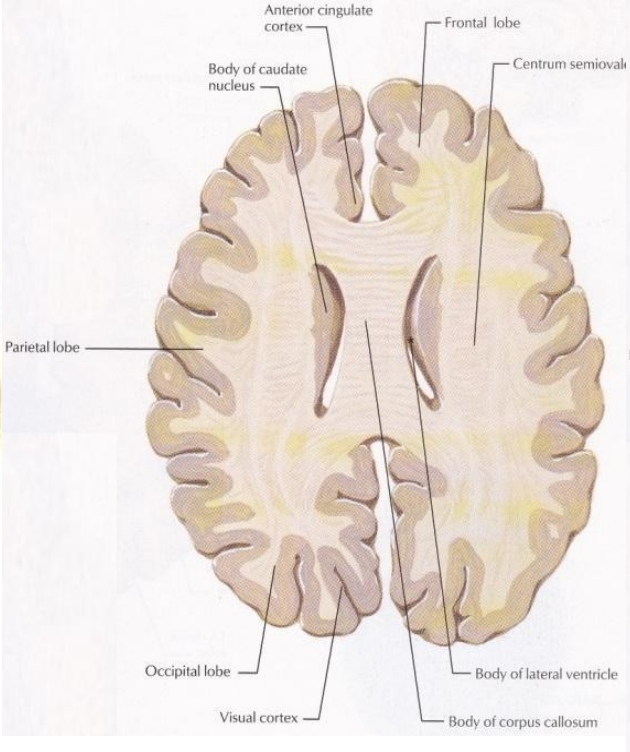
- Anterior commissure

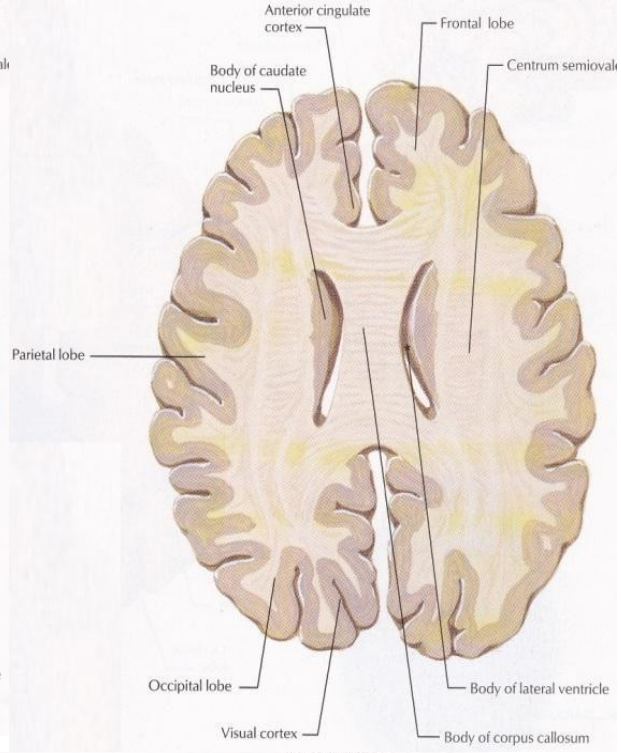
  - Transversely in front of anterior column of fornix
  - Interconnects inferior – middle temporal gyri – olfactory regions on the two sides

- Hippocampal commissure

  Posterior columns of fornix on each side


Frontal pole
Anterior cerebral artery
Corpus callosum
Occipital pole


Anterior cingulate cortex
Frontal lobe
Body of caudate nucleus
Centrum semiovale
Parietal lobe
Occipital lobe
Body of lateral ventricle
Visual cortex
Body of corpus callosum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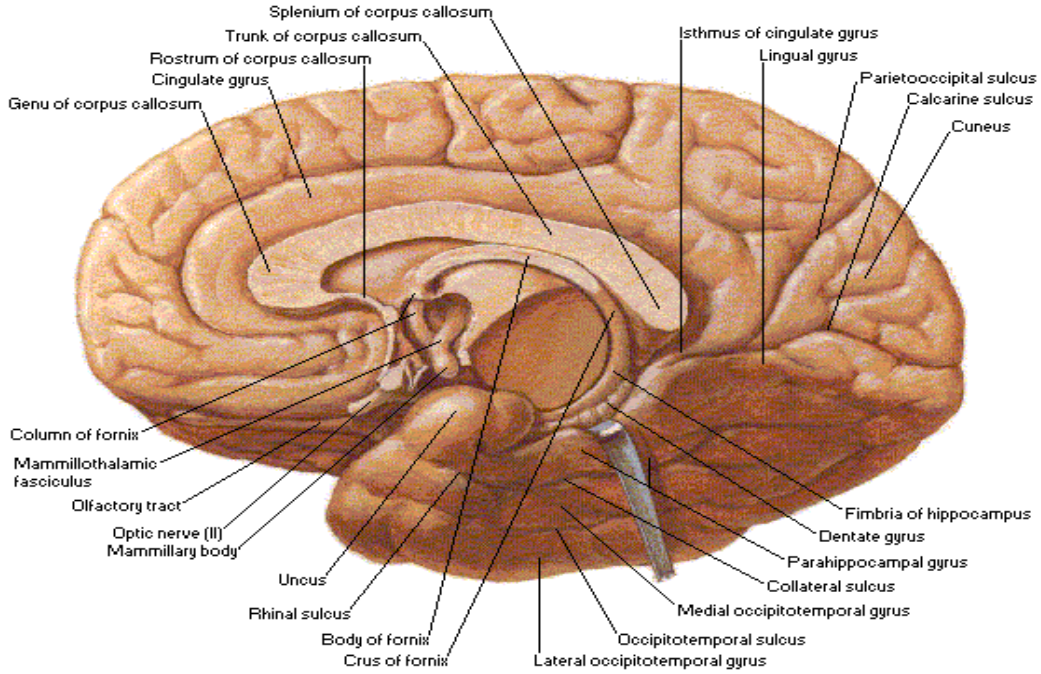
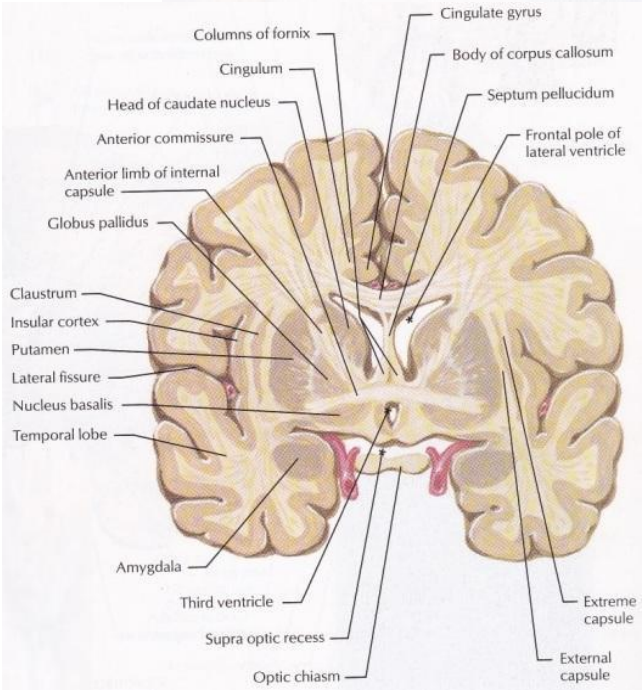
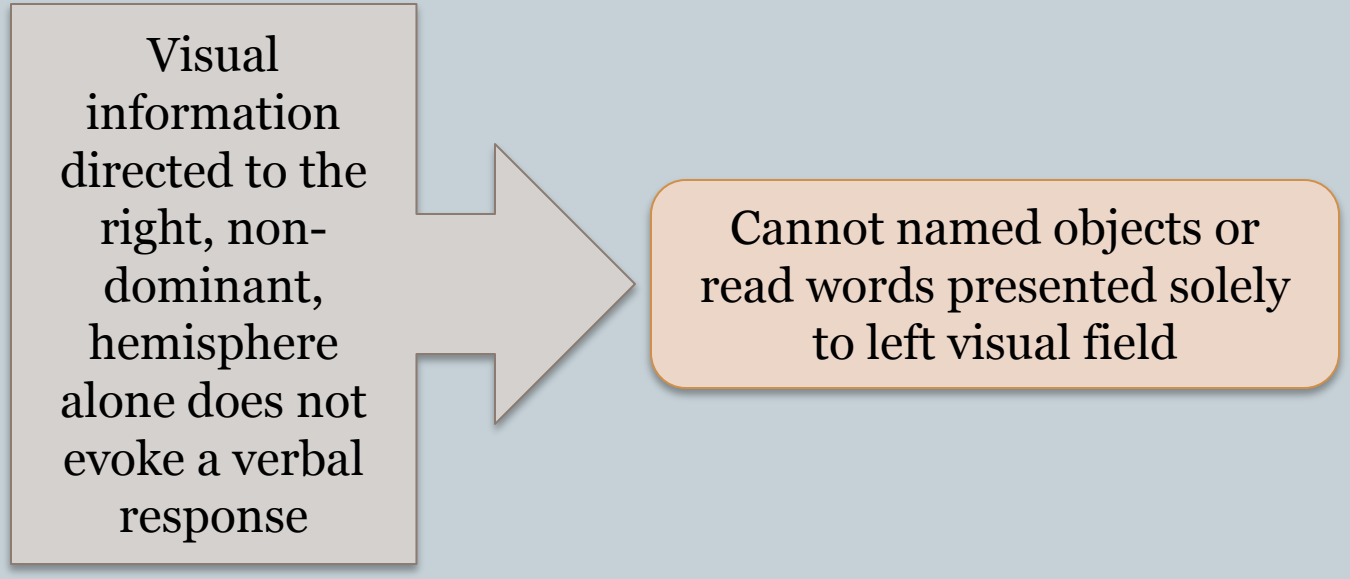

Splenium of corpus callosum
Trunk of corpus callosum
Rostrum of corpus callosum
Cingulate gyrus
Genu of corpus callosum
Isthmus of cingulate gyrus
Lingual gyrus
Parietooccipital sulcus
Calcarine sulcus
Cuneus
Column of fornix
Mammillothalamic fasciculus
Olfactory tract
Optic nerve (II)
Mammillary body
Uncus
Rhinal sulcus
Body of fornix
Crus of fornix
Lateral occipitotemporal gyrus
Occipitotemporal sulcus
Medial occipitotemporal gyrus
Collateral sulcus
Parahippocampal gyrus
Dentate gyrus
Fimbria of hippocampus


Columns of fornix
Cingulate gyrus
Cingulum
Body of corpus callosum
Head of caudate nucleus
Septum pellucidum
Anterior commissure
Frontal pole of lateral ventricle
Anterior limb of internal capsule
Globus pallidus
Claustrum
Insular cortex
Putamen
Lateral fissure
Nucleus basalis
Temporal lobe
Amygdala
Third ventricle
Supra optic recess
Optic chiasm
Extreme capsule
External capsule

Damage to Corpus Callosum

- Chronic epylepsy → undergone section of CC → two halves of brain appear to behave relatively autonomously



- Destruction of splenium → posterior disconnection syndrome (alexia without agraphia)

Projection Fibres

- Consist of afferent fibres to cortex & efferent fibres away from cortex

- **Corona radiata**

- **Internal Capsule**

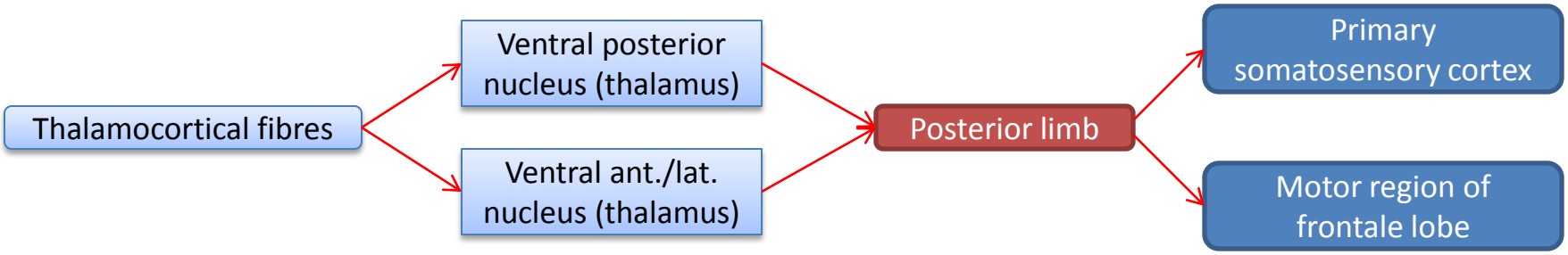
❖ Anterior limb

- Mediodorsal nucleus (thalamus) – prefrontal cortex
- Frontopontine fibres – pontine nuclei (basal pons)

Projection Fibres

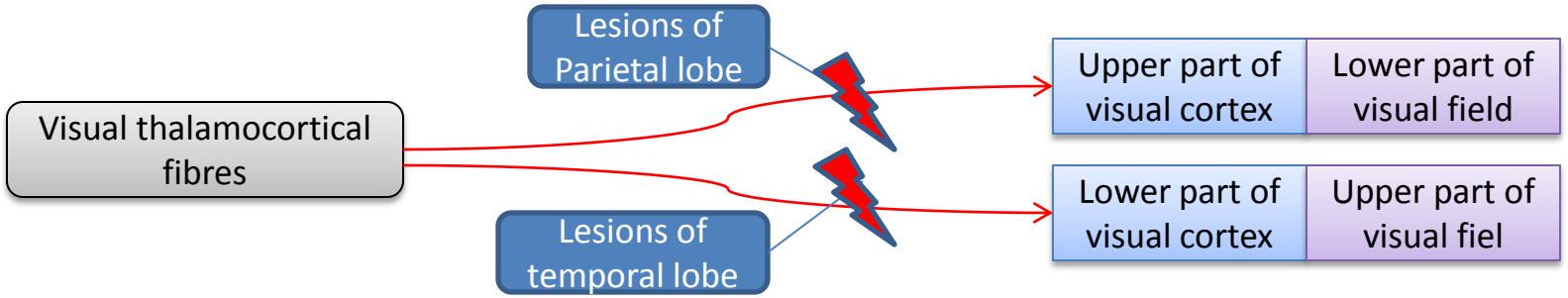
❖ Posterior limb

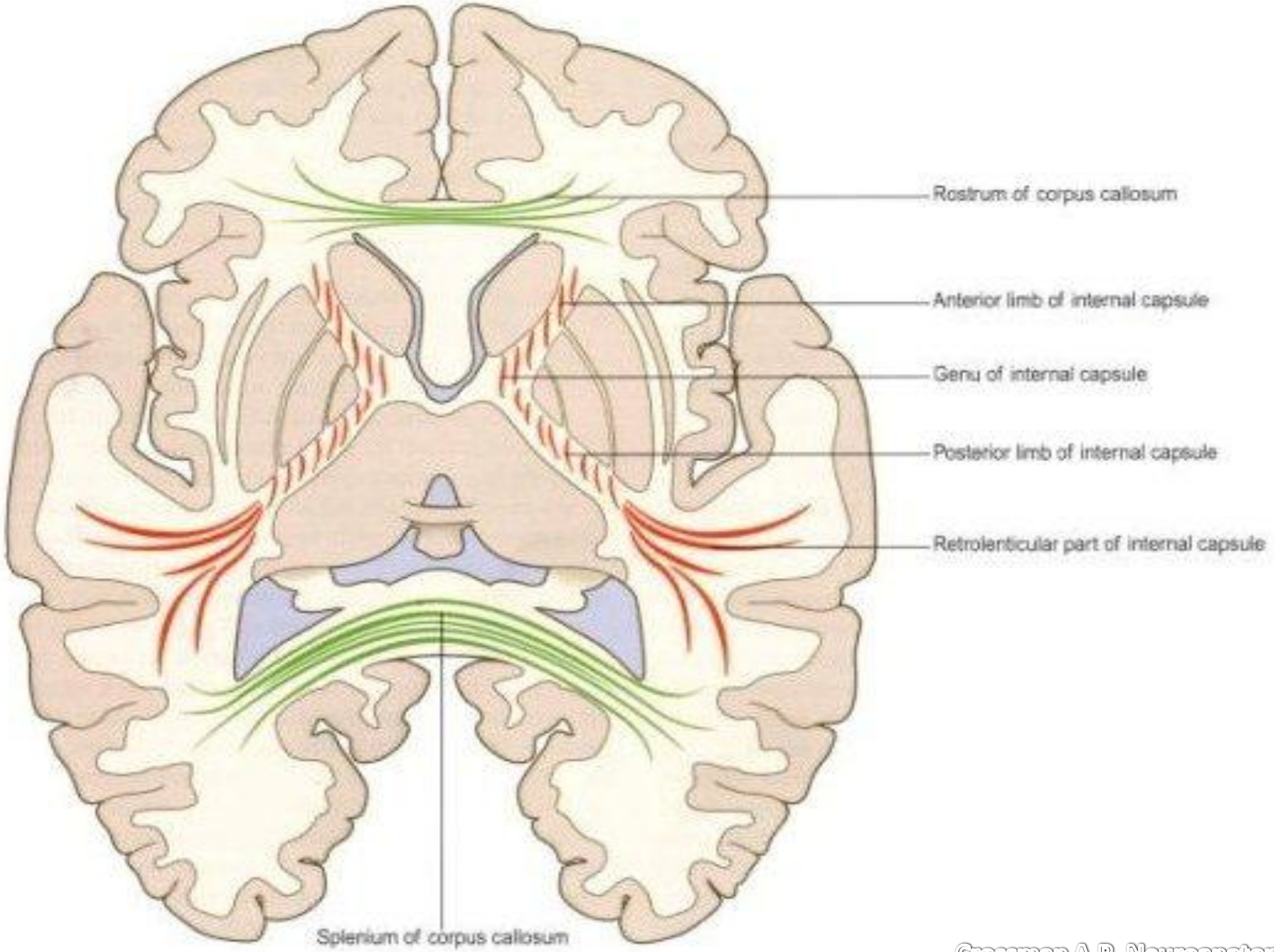
- contains corticobulbar & corticospinal motor fibres



❖ Retrolenticular

- Consists of fibres arising from med./lat. geniculate nuclei as auditory/visual radiations → auditory/visual cortices





THANK YOU