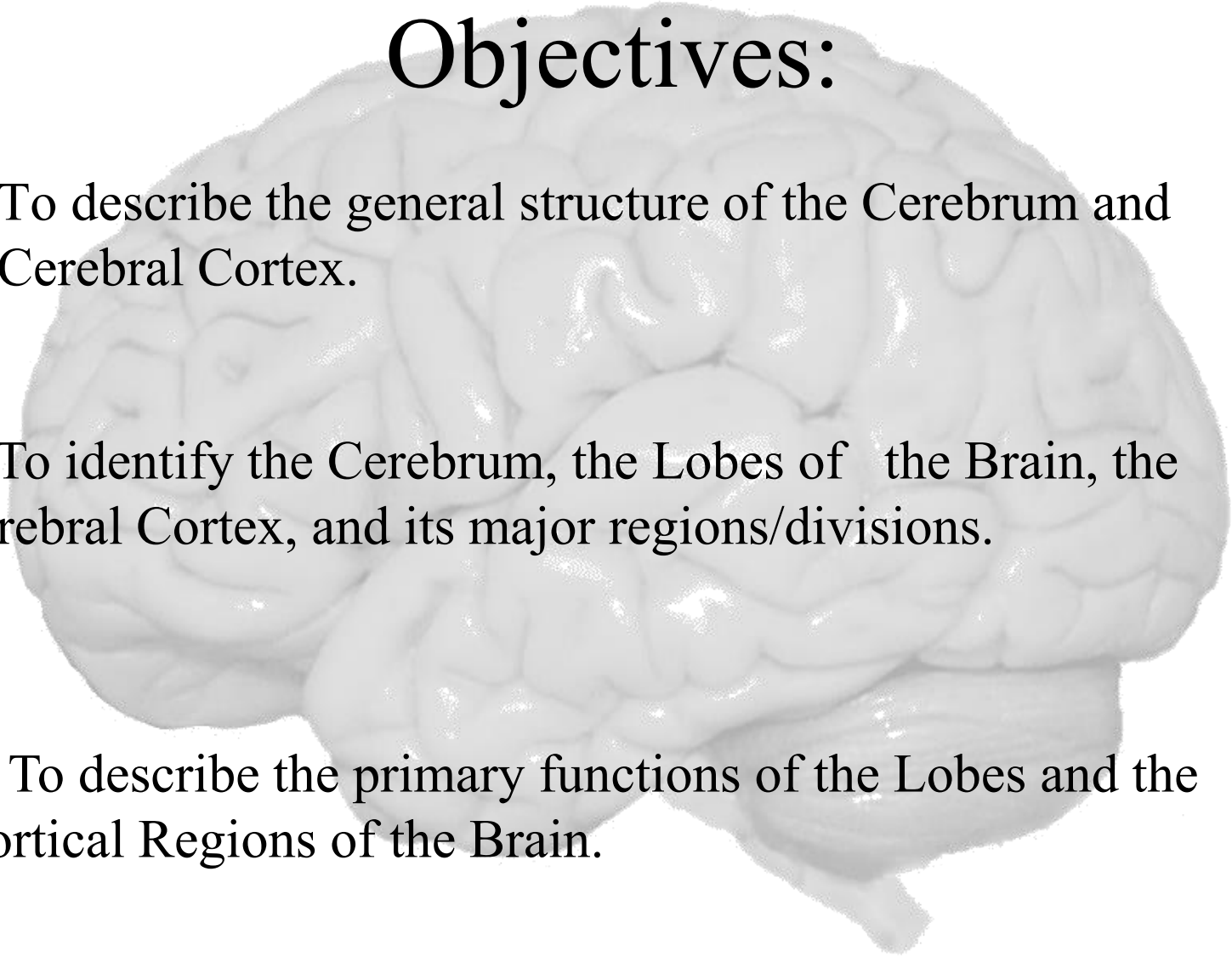


Human Brain

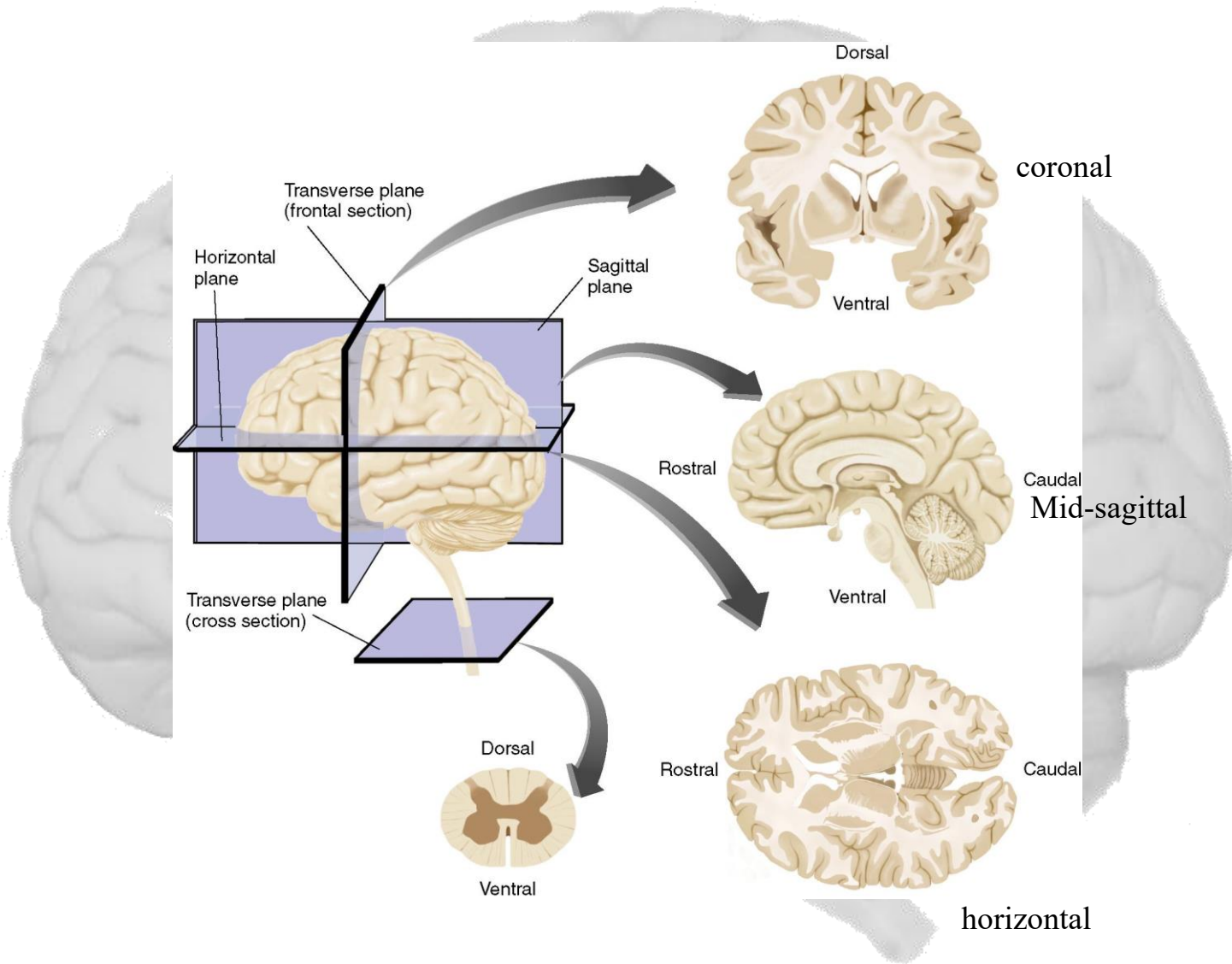
Objectives:

- To describe the general structure of the Cerebrum and Cerebral Cortex.
- To identify the Cerebrum, the Lobes of the Brain, the Cerebral Cortex, and its major regions/divisions.
- To describe the primary functions of the Lobes and the Cortical Regions of the Brain.



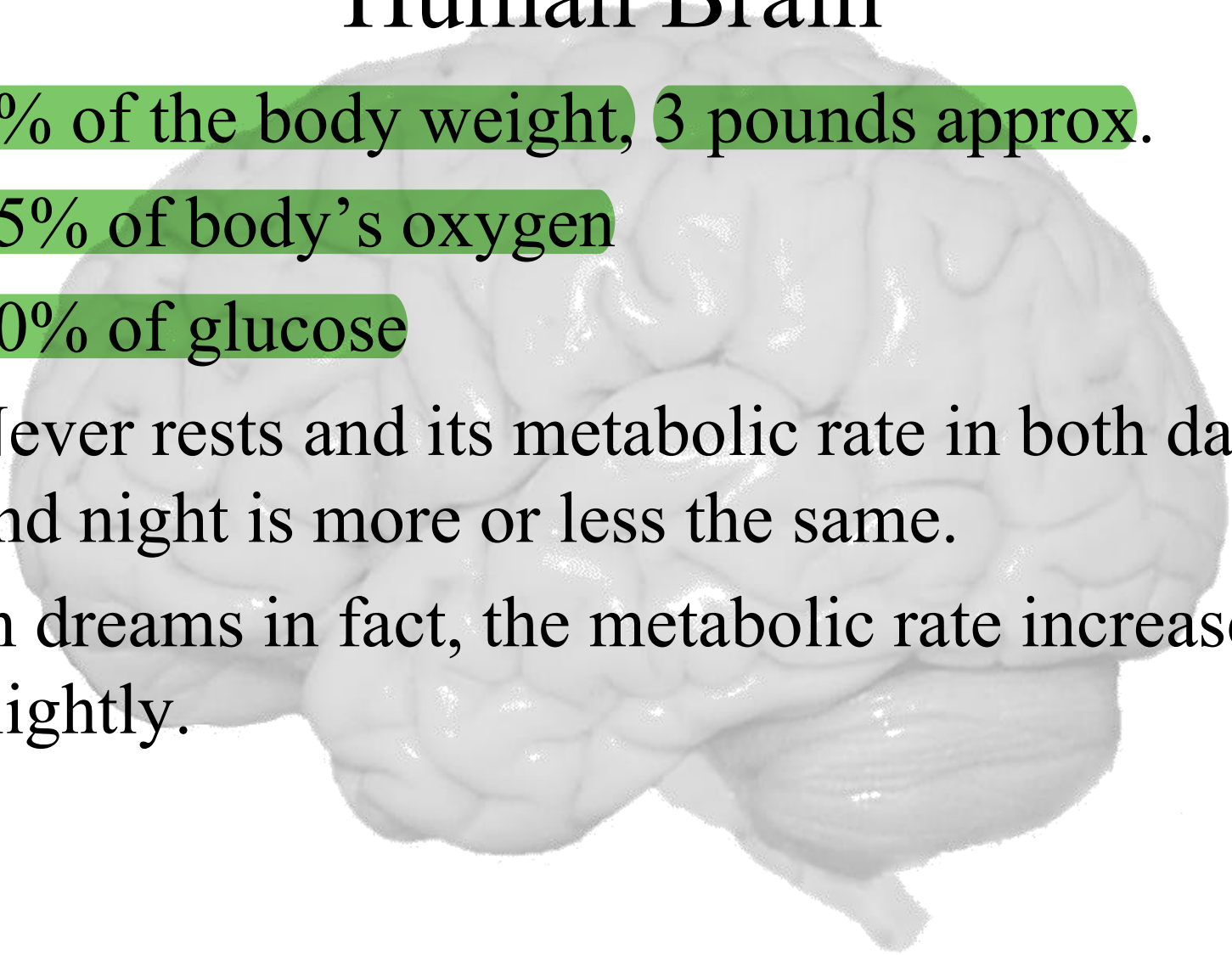


Terminology in Brain Structure and Functions



Human Brain

- 2% of the body weight, 3 pounds approx.
- 25% of body's oxygen
- 70% of glucose
- Never rests and its metabolic rate in both day and night is more or less the same.
- In dreams in fact, the metabolic rate increases slightly.



Hierarchical Brain: Structure & Functions

- Represents approx. 500 million yrs of evolutionary development and fine tuning.
- Core structures of brain are the same in all vertebrates
- They govern the physiological functions
- Built upon these are newer systems that involve complex functions – sensing, emoting, thinking, reasoning etc.
- Cerebral cortex is the one which makes us Human



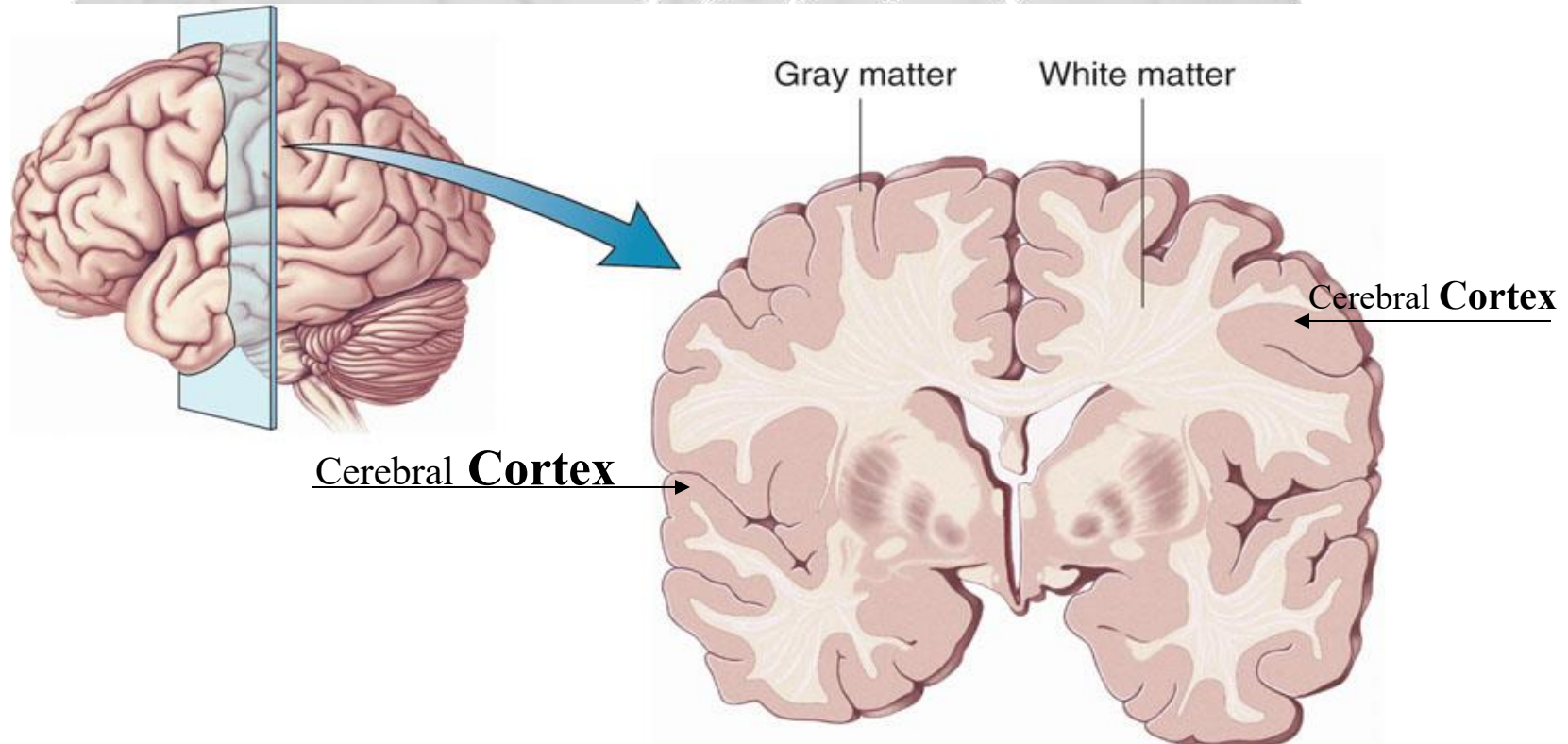
The Cerebrum

Lobes, the Cerebral Cortex, and Cortical Regions of the Brain

Cerebrum - The largest division of the brain. It is divided into two hemispheres, each of which is divided into four lobes.



Cerebral Cortex - The outermost layer of gray matter making up the superficial aspect of the cerebrum.



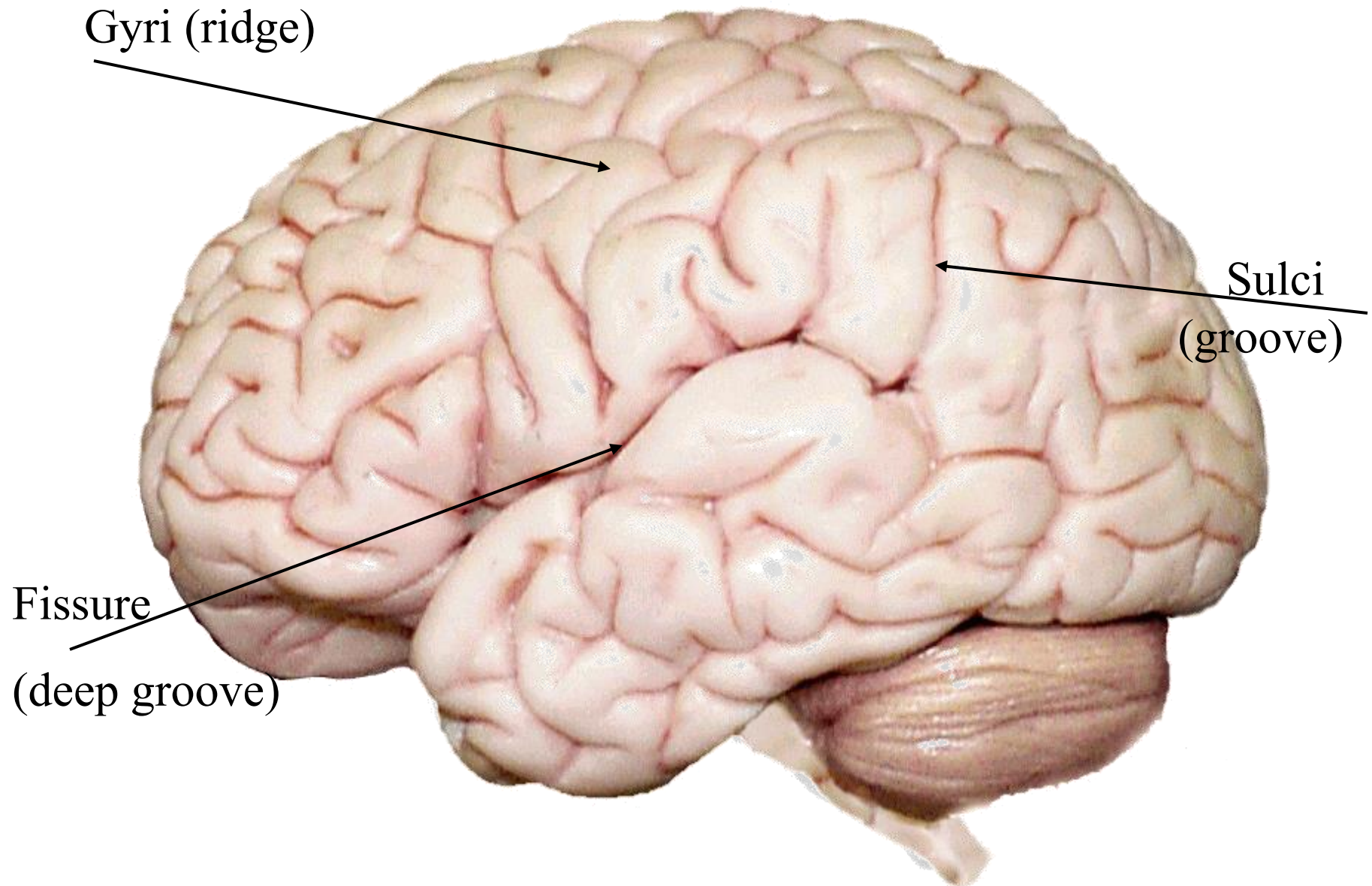
CEREBRAL FEATURES:

- **Gyri** – Elevated ridges “winding” around the brain.
- **Sulci** – Small grooves dividing the gyri
 - **Central Sulcus** – Divides the Frontal Lobe from the Parietal Lobe
- **Fissures** – Deep grooves, generally dividing large regions/lobes of the brain
 - **Longitudinal Fissure** – Divides the two Cerebral Hemispheres
 - **Transverse Fissure** – Separates the Cerebrum from the Cerebellum
 - **Sylvian/Lateral Fissure** – Divides the Temporal Lobe from the Frontal and Parietal Lobes

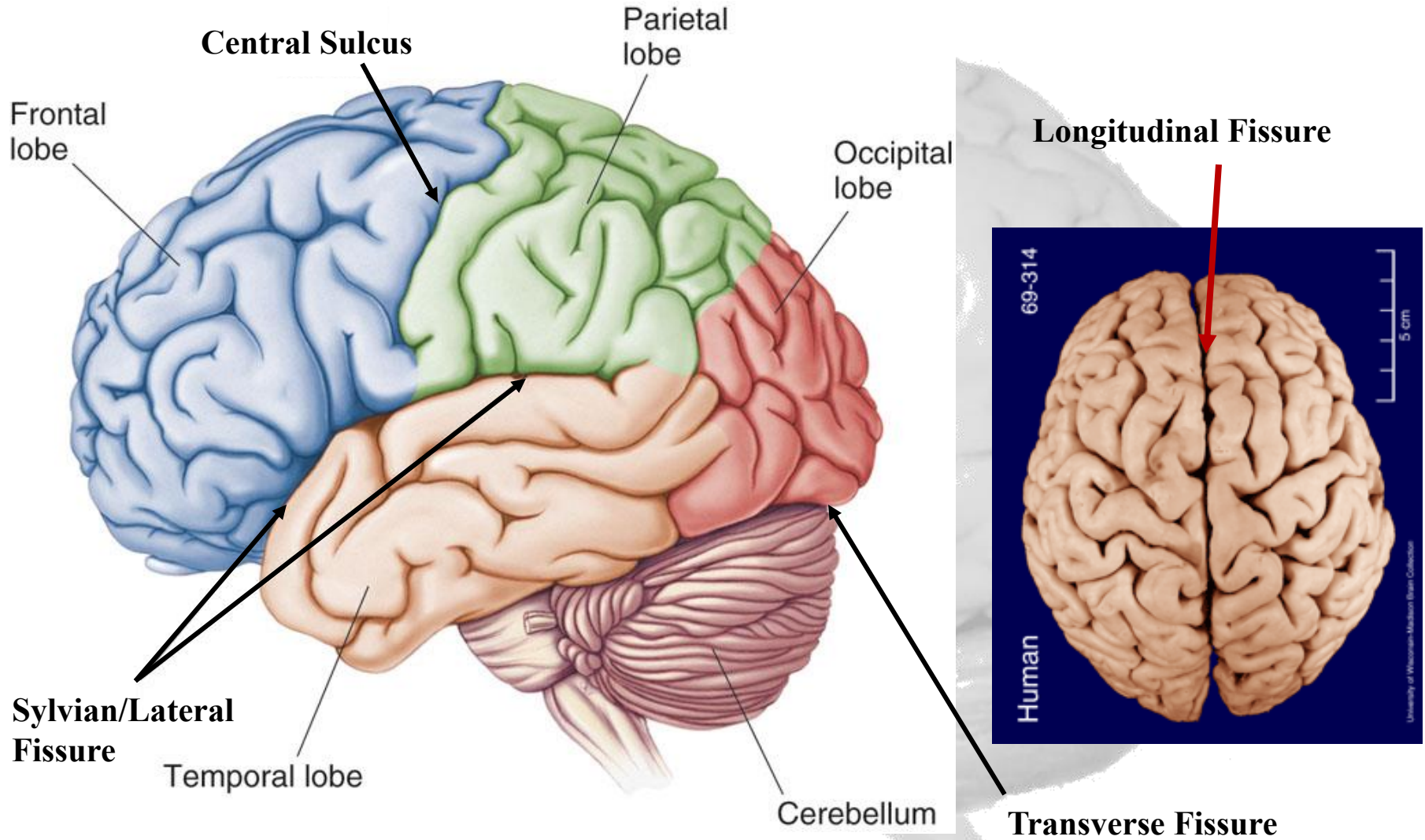
Cerebral Cortex



- $\frac{1}{4}$ inch in thickness, gray cells
- 80% of the brain tissue in humans
- Not essential for physical survival but involved in ‘human functioning’
- 75% of the total cortex area is in its fissures – deep groves that divide brain into different lobes and two hemispheres
 - Longitudinal, sylvian and transverse

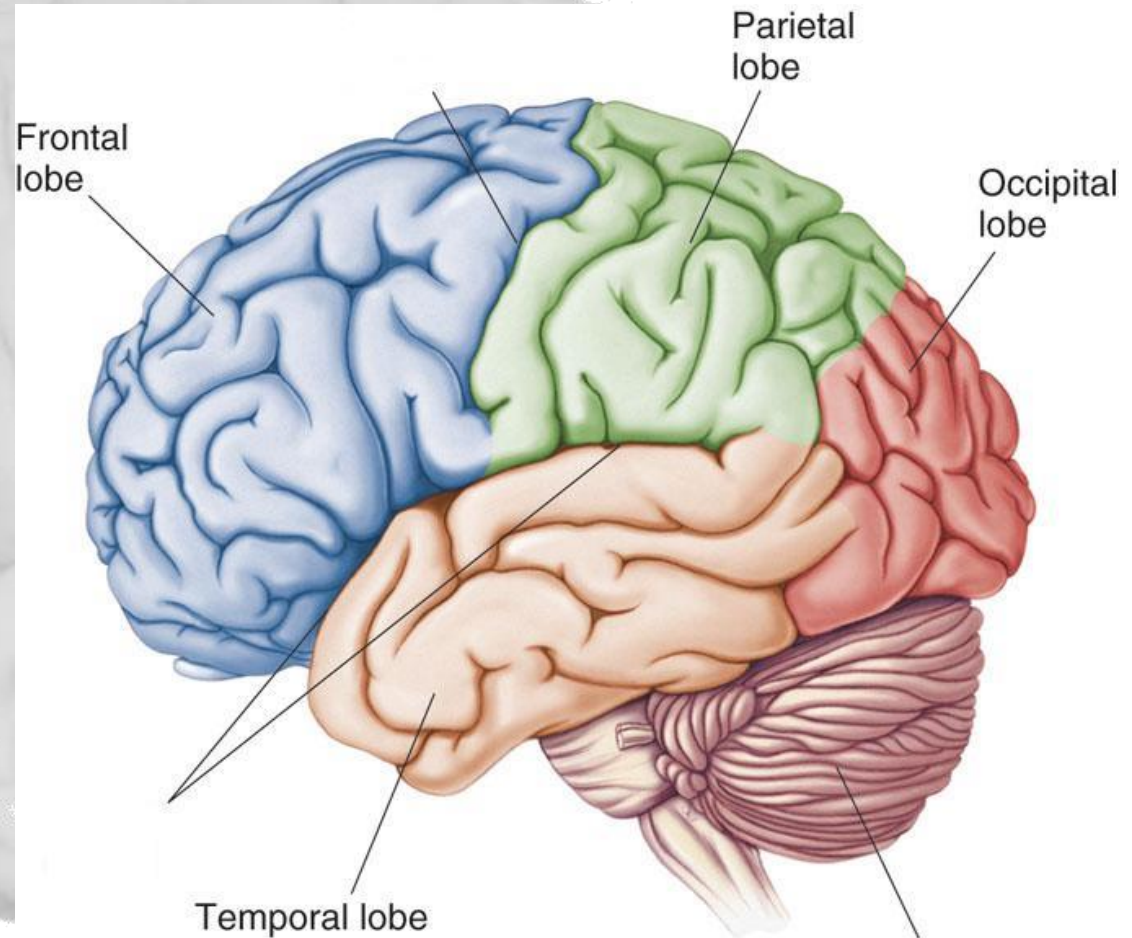


Specific Sulci/Fissures:



Lobes of the Brain (4)

- Frontal
- Parietal
- Occipital
- Temporal

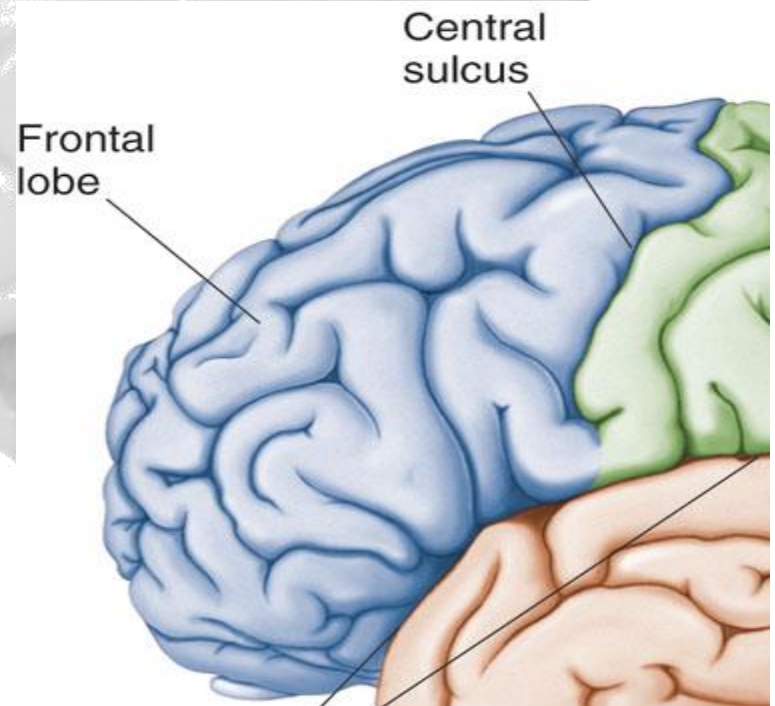


<http://www.bioon.com/book/biology/whole/image/1/1-8.tif.jpg>

* Note: Occasionally, the Insula is considered the fifth lobe. It is located deep to the Temporal Lobe.

Lobes of the Brain - Frontal

- The Frontal Lobe of the brain is located deep to the Frontal Bone of the skull.
- It plays an integral role in the following functions/actions:
 - Memory Formation
 - Emotions
 - Decision Making/Reasoning
 - Personality

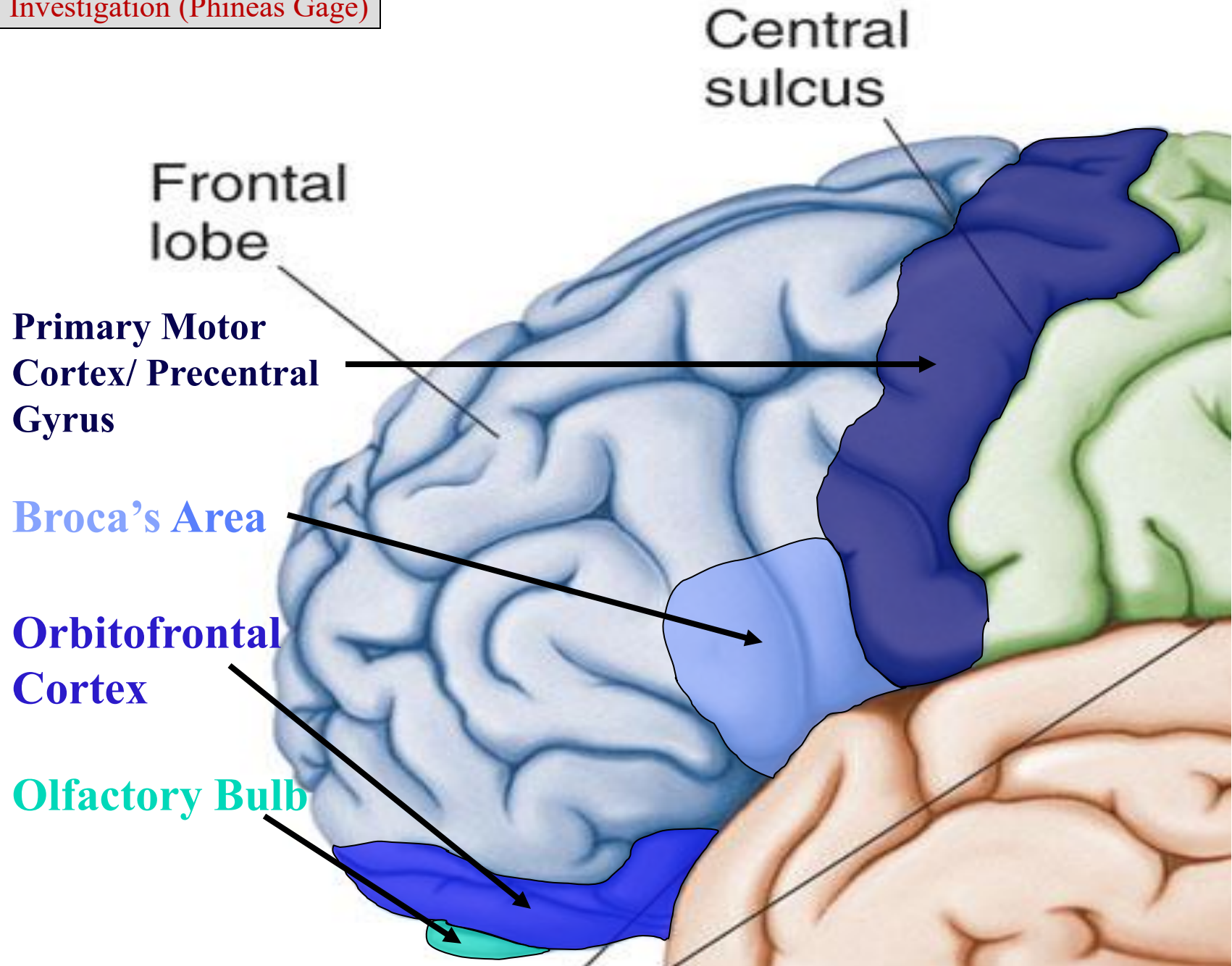


Investigation (Phineas Gage)

Frontal Lobe - Cortical Regions

- **Primary Motor Cortex (Precentral Gyrus)** – Cortical site involved with controlling movements of the body.
- **Broca's Area** – Controls facial neurons, speech, and language comprehension. Located on Left Frontal Lobe.
 - **Broca's Aphasia** – Results in the ability to comprehend speech, but the decreased motor ability (or inability) to speak and form words.
- **Orbitofrontal Cortex** – Site of Frontal Lobotomies
 - * Desired Effects:
 - Diminished Rage
 - Decreased Aggression
 - Poor Emotional Responses
 - * Possible Side Effects:
 - Epilepsy
 - Poor Emotional Responses
 - Perseveration (Uncontrolled, repetitive actions, gestures, or words)
- **Olfactory Bulb** - Cranial Nerve I, Responsible for sensation of Smell

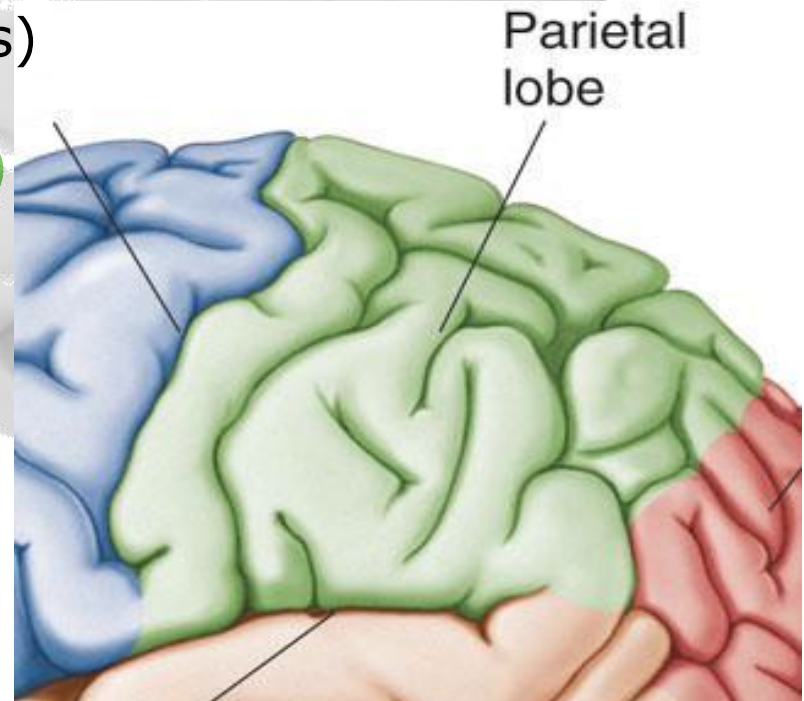
Investigation (Phineas Gage)



Regions

Lobes of the Brain - Parietal Lobe

- The Parietal Lobe of the brain is located deep to the Parietal Bone of the skull.
- It plays a major role in the following functions/actions:
 - Senses and integrates sensation(s)
 - Spatial awareness and perception (Proprioception - Awareness of body/ body parts in space and in relation to each other)



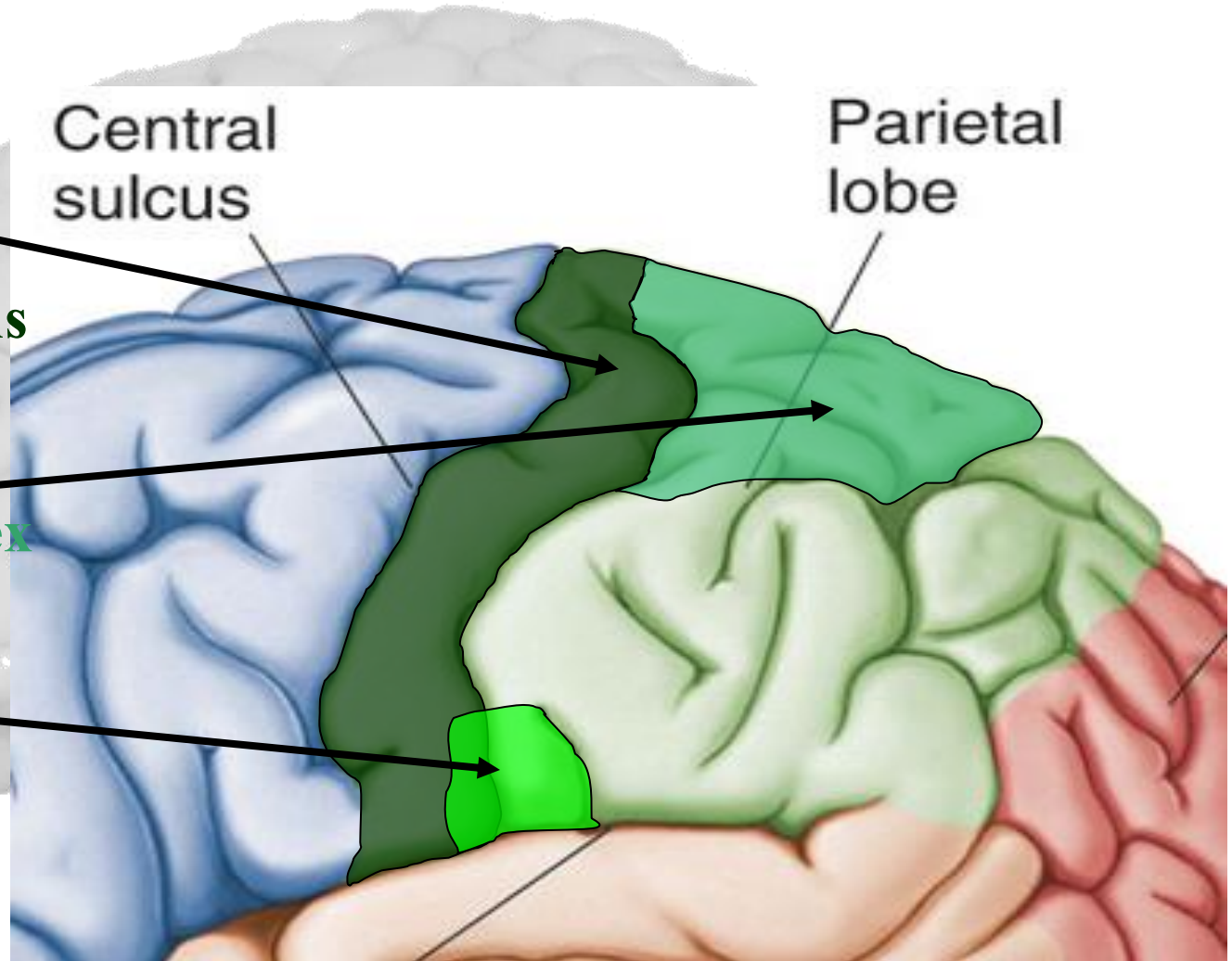
Parietal Lobe - Cortical Regions

- **Primary Somatosensory Cortex (Postcentral Gyrus)** – Site involved with processing of tactile and proprioceptive information.
- **Somatosensory Association Cortex** - Assists with the integration and interpretation of sensations relative to body position and orientation in space. May assist with visuo-motor coordination.
- **Primary Gustatory Cortex** – Primary site involved with the interpretation of the sensation of Taste.

**Primary
Somatosensory
Cortex/
Postcentral Gyrus**

**Somatosensory
Association Cortex**

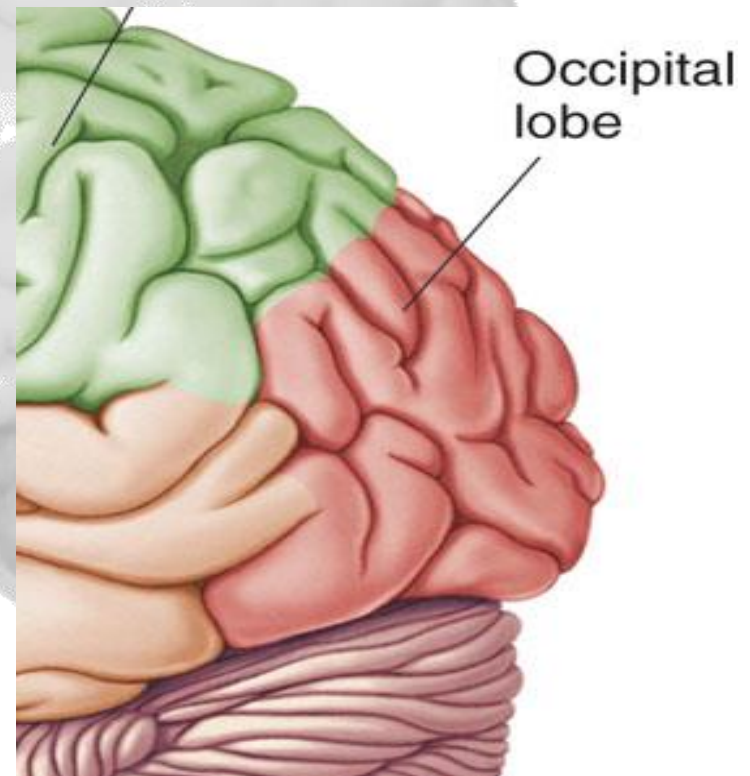
**Primary
Gustatory Cortex**



Modified from: <http://www.bioon.com/book/biology/whole/image/1/1-8.tif.jpg>

Lobes of the Brain – Occipital Lobe

- The Occipital Lobe of the Brain is located deep to the Occipital Bone of the Skull.
- Its primary function is the processing, integration, interpretation, etc. of VISION and visual stimuli.



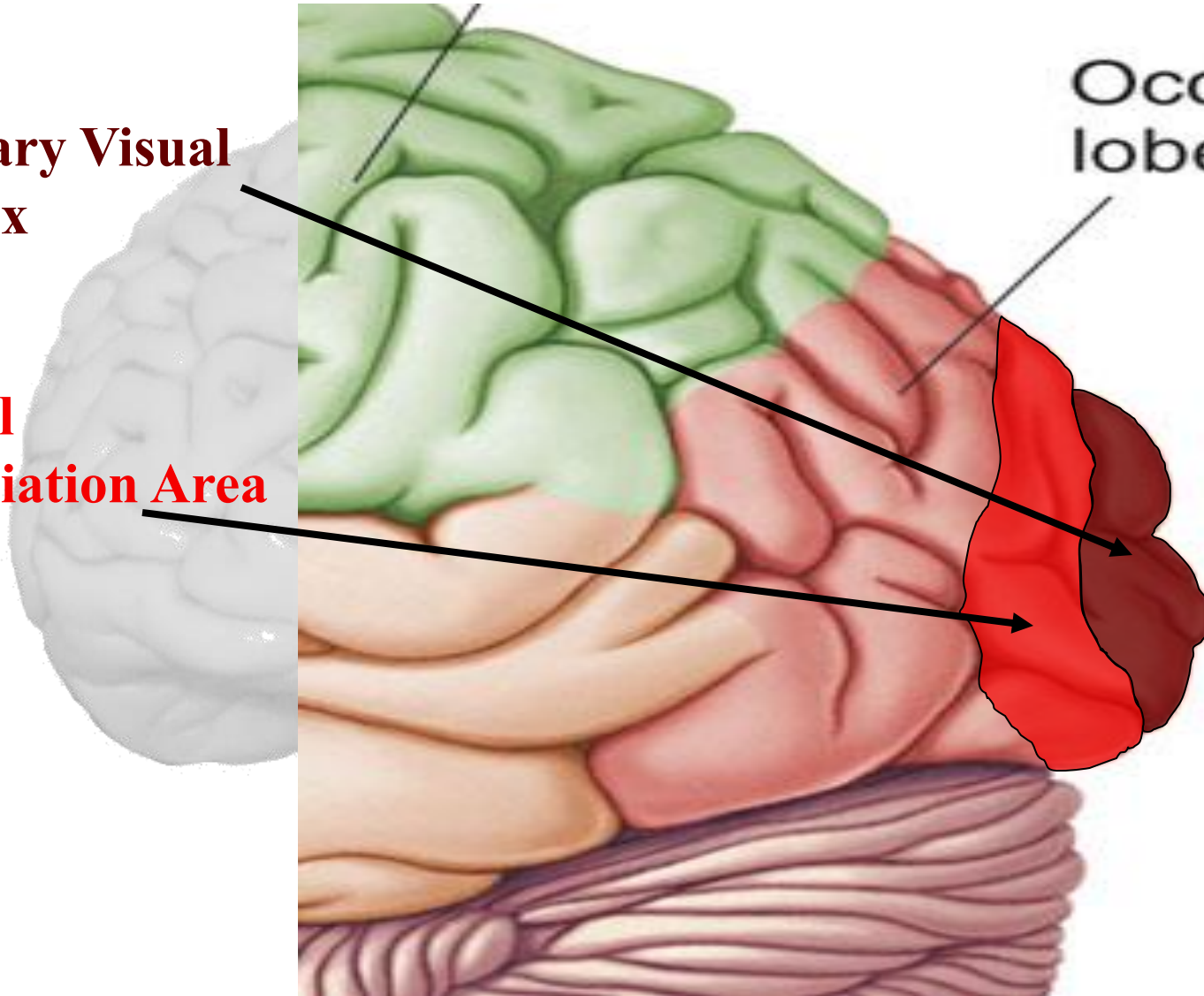
Occipital Lobe – Cortical Regions

- **Primary Visual Cortex** – This is the primary area of the brain responsible for sight - recognition of size, color, light, motion, dimensions, etc.
- **Visual Association Area** – Interprets information acquired through the primary visual cortex.

**Primary Visual
Cortex**

**Visual
Association Area**

Occipital
lobe

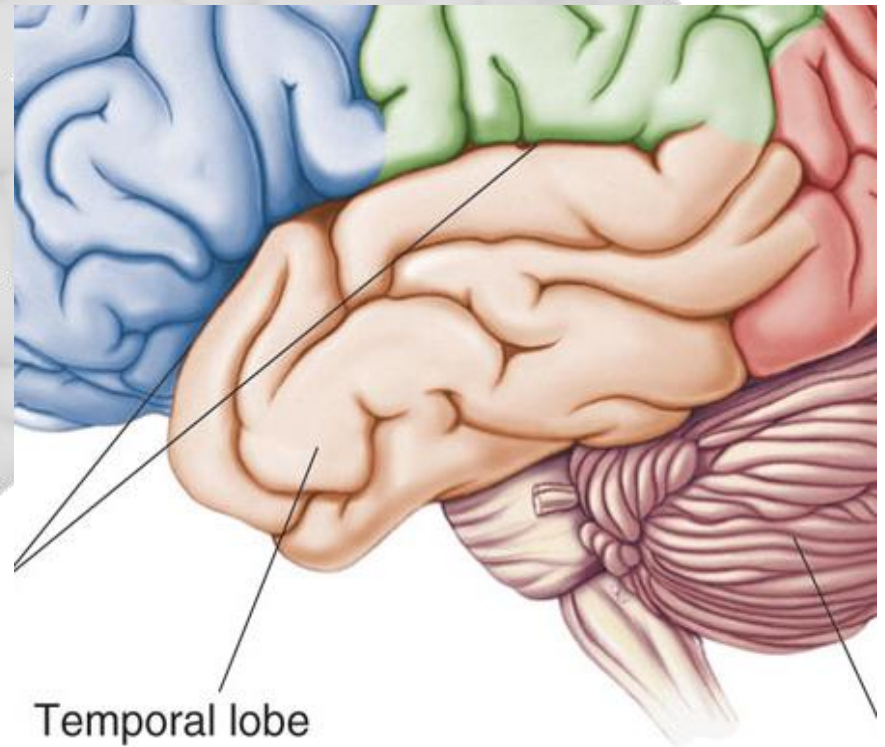


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Regions

Lobes of the Brain – Temporal Lobe

- The Temporal Lobes are located on the sides of the brain, deep to the Temporal Bones of the skull.
- They play an integral role in the following functions:
 - Hearing
 - Organization/Comprehension of language
 - Information Retrieval
(Memory and Memory Formation)



Temporal Lobe – Cortical Regions

- **Primary Auditory Cortex** – Responsible for hearing
- **Primary Olfactory Cortex** – Interprets the sense of smell once it reaches the cortex via the olfactory bulbs. (Not visible on the superficial cortex)
- **Wernicke's Area** – Language comprehension. Located on the **Left** Temporal Lobe.
 - **Wernicke's Aphasia** – Language comprehension is inhibited. Words and sentences are not clearly understood, and sentence formation may be inhibited or non-sensical.

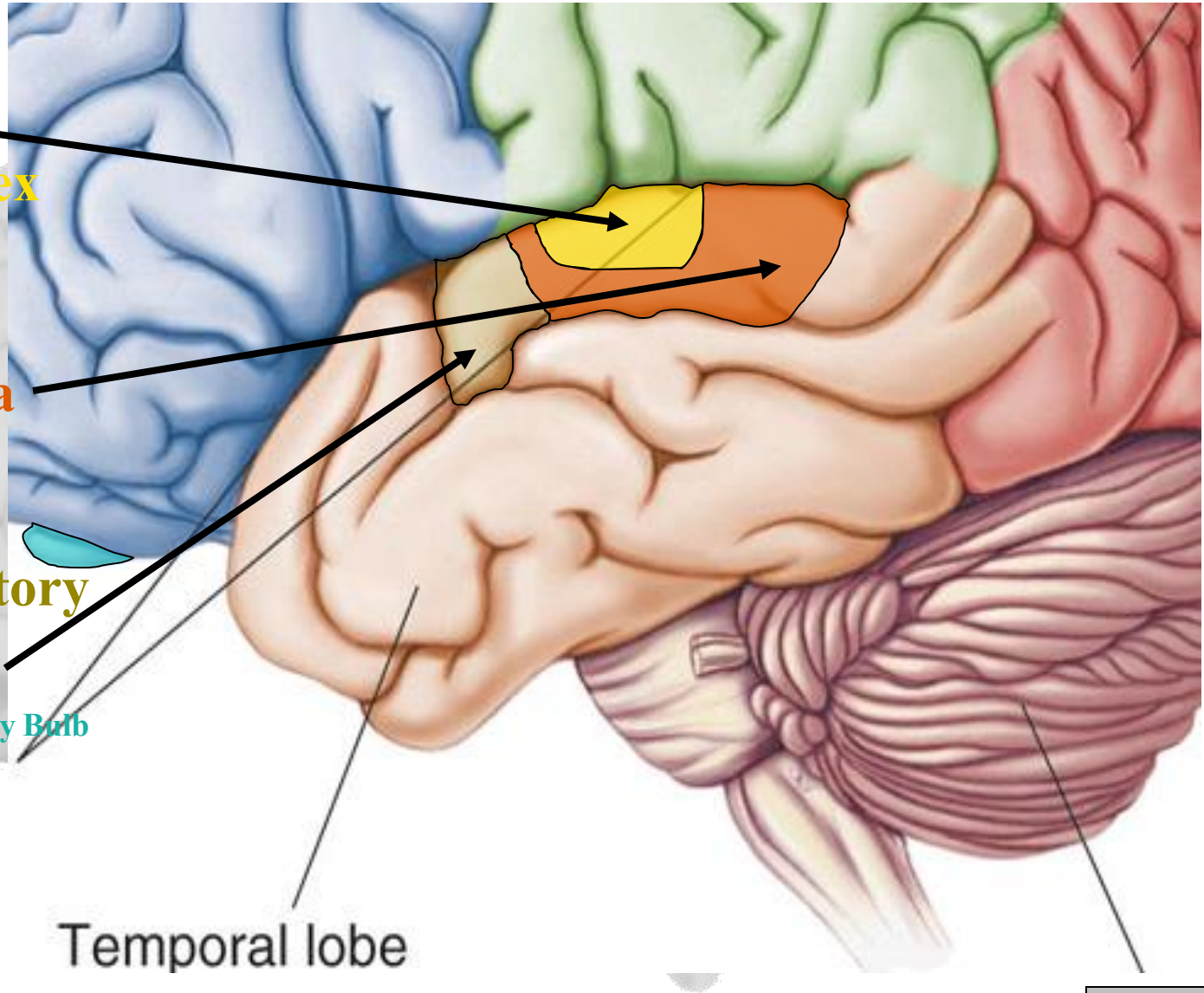
**Primary
Auditory Cortex**

Wernike's Area

**Primary Olfactory
Cortex (Deep)**

Conducted from Olfactory Bulb

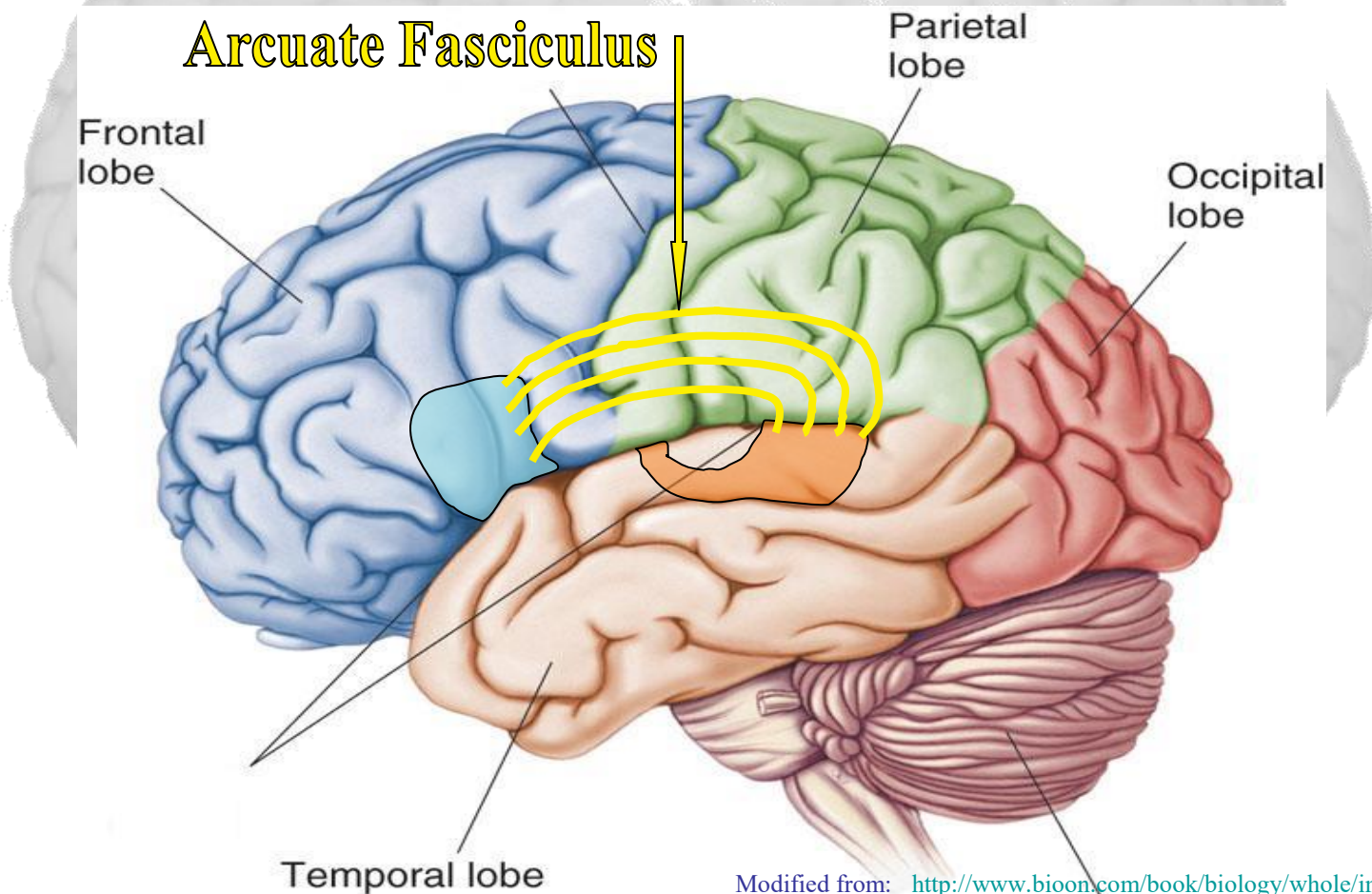
Temporal lobe



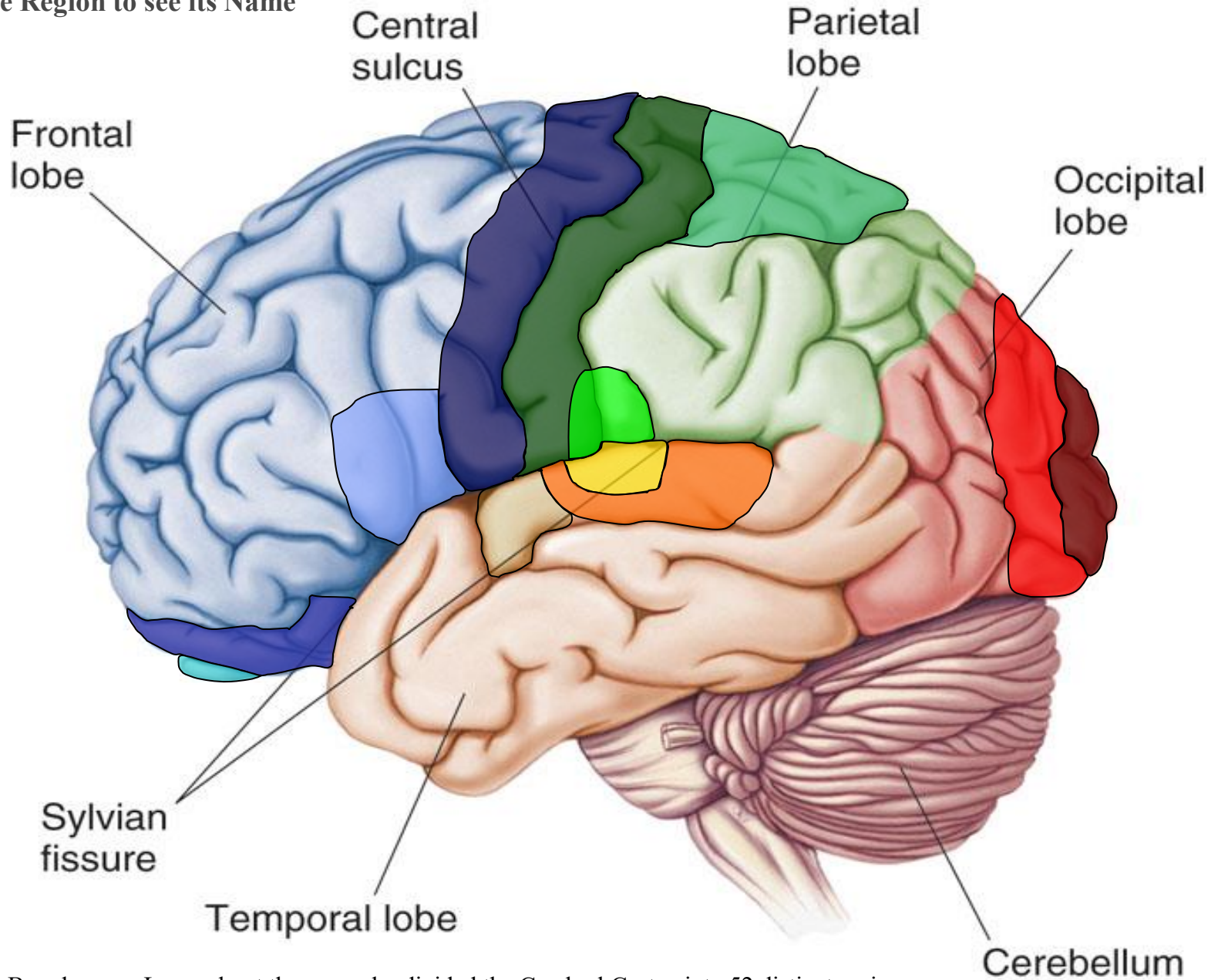
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Regions

- **Arcuate Fasciculus** - A white matter tract that connects Broca's Area and Wernicke's Area through the Temporal, Parietal and Frontal Lobes. Allows for coordinated, comprehensible speech. Damage may result in:
 - **Conduction Aphasia** - Where auditory comprehension and speech articulation are preserved, but people find it difficult to repeat heard speech.



Click the Region to see its Name

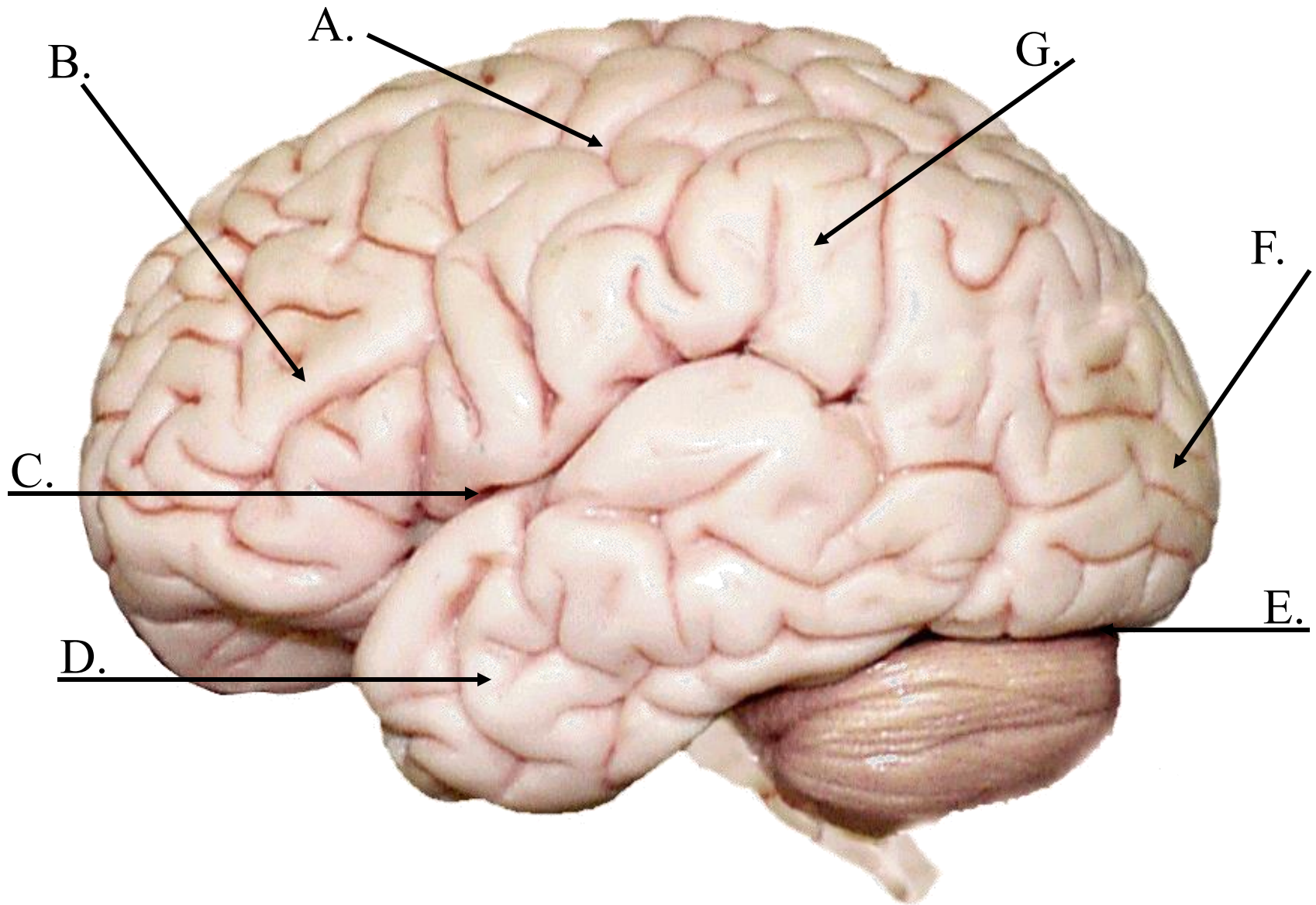


Korbinian Brodmann - Learn about the man who divided the Cerebral Cortex into 52 distinct regions:

http://en.wikipedia.org/wiki/Korbinian_Brodmann

Modified from: <http://www.bioon.com/book/biology/whole/image/1/1-8.tif.jpg>

Lobes and Structures of the Brain



Lobes and Structures of the Brain

A. Central Sulcus

B. Frontal Lobe

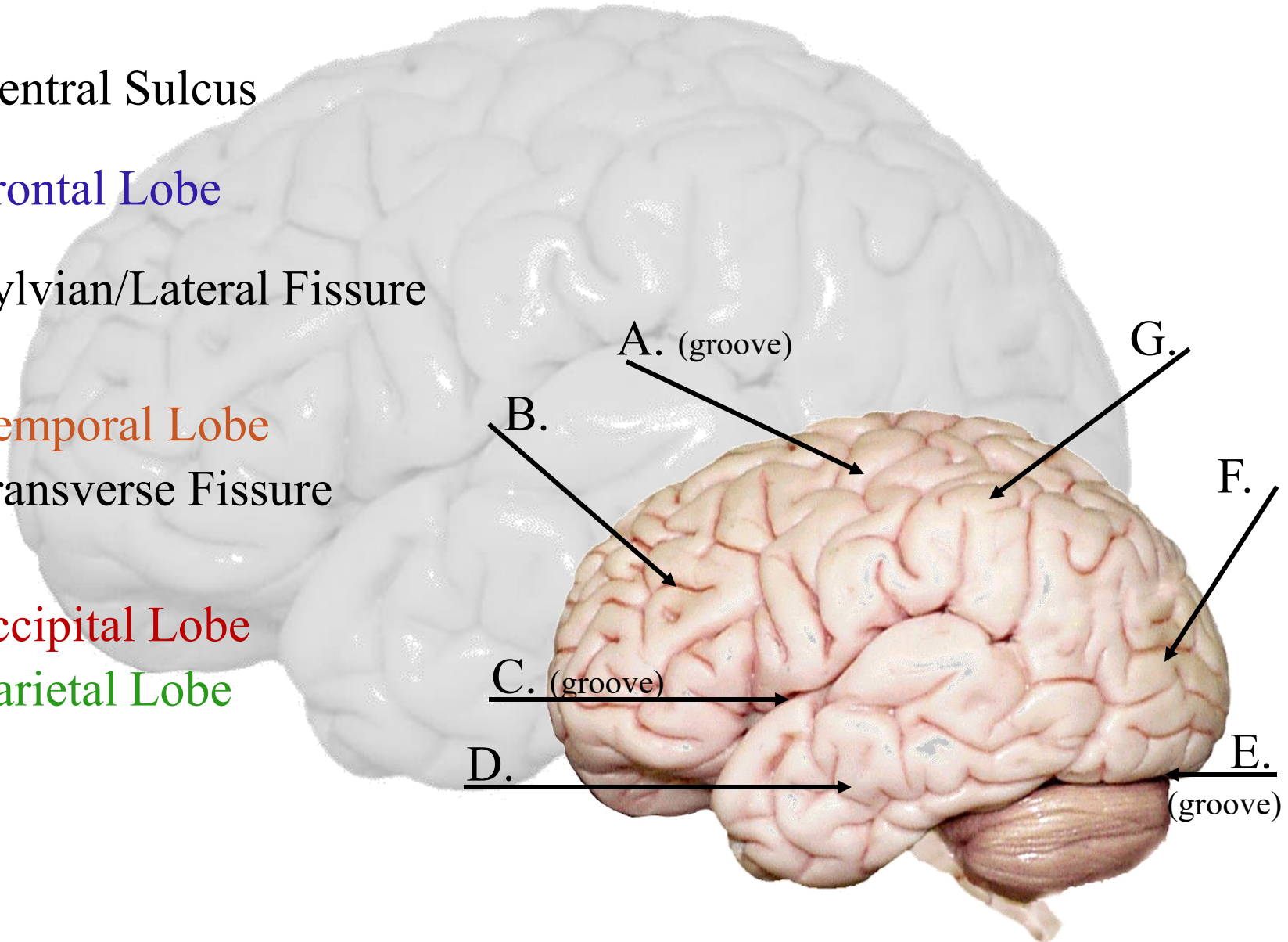
C. Sylvian/Lateral Fissure

D. Temporal Lobe

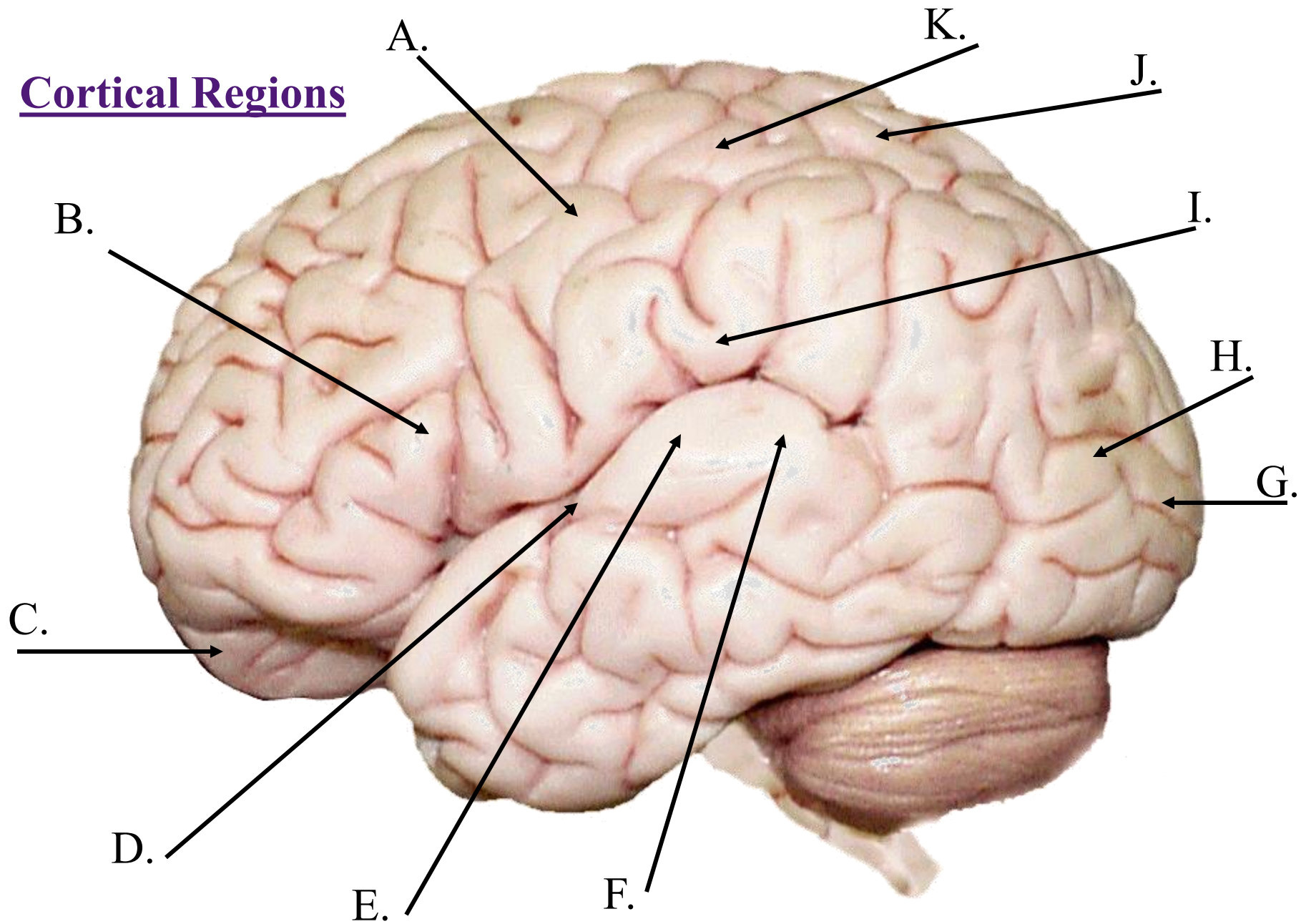
E. Transverse Fissure

F. Occipital Lobe

G. Parietal Lobe



Cortical Regions



A. Primary Motor Cortex/ Precentral Gyrus

B. Broca's Area

C. Orbitofrontal Cortex

D. Primary Olfactory Cortex (Deep)

E. Primary Auditory Cortex

F. Wernike's Area

G. Primary Visual Cortex

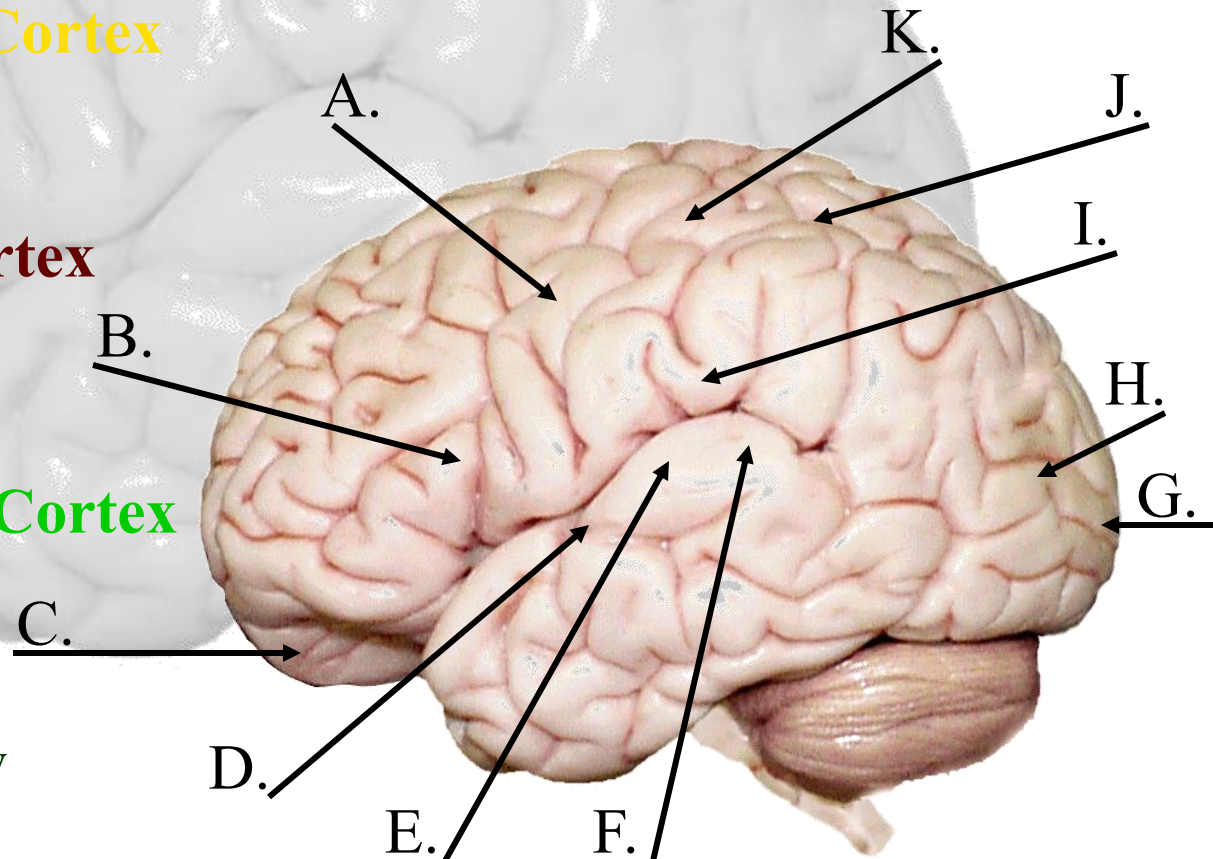
**H. Visual
Association Area**

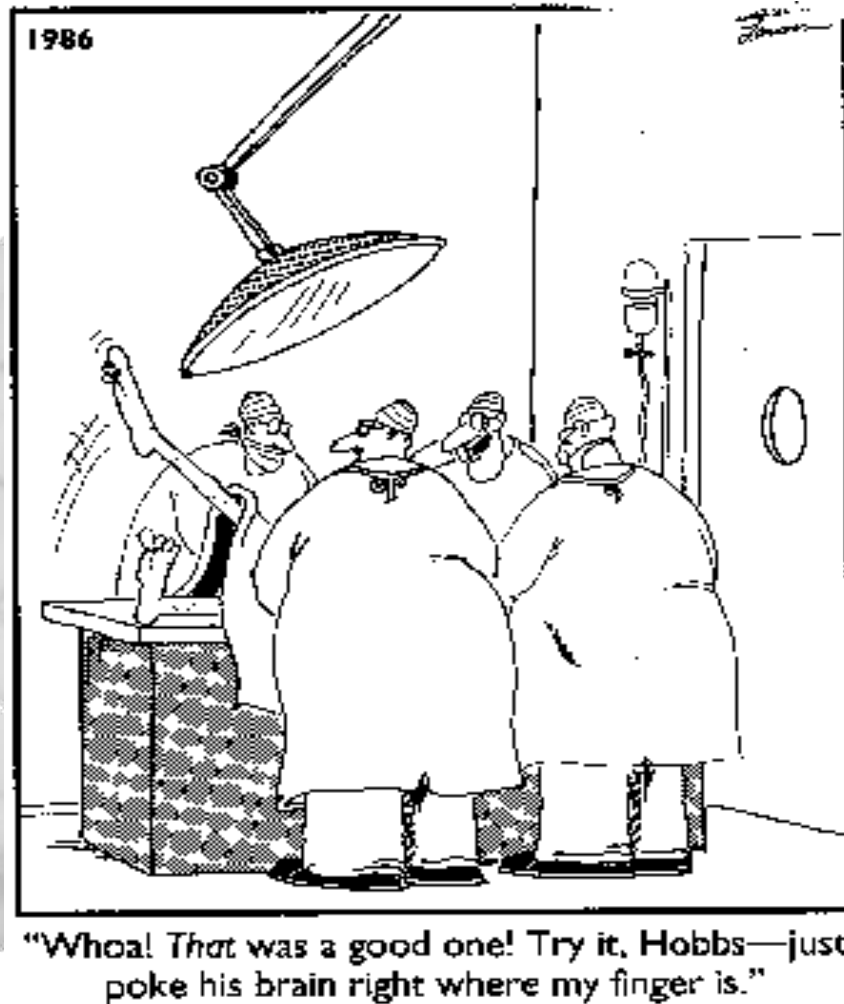
I. Primary Gustatory Cortex

**J. Somatosensory
Association Cortex**

**K. Primary Somatosensory
Cortex/ Postcentral Gyrus**

Cortical Regions

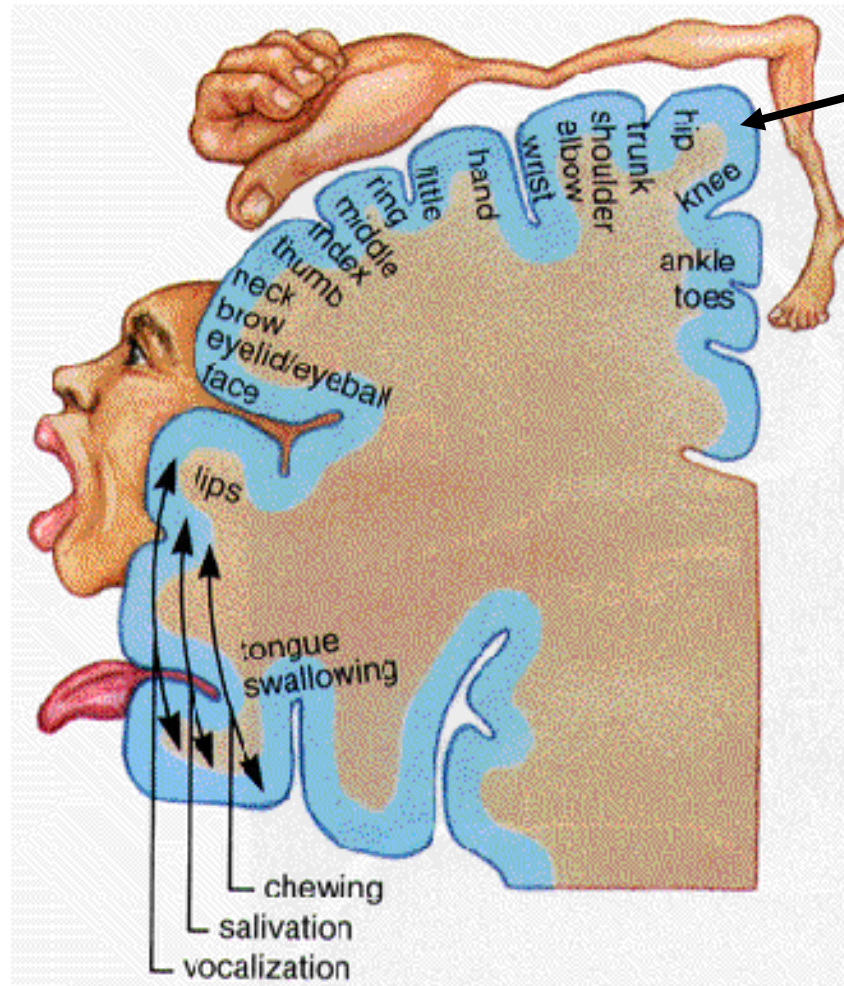




Copyright: Gary Larson

Q: Assuming this comical situation was factually accurate, what Cortical Region of the brain would these doctors be stimulating?

A: Primary Motor Cortex



* This graphic representation of the regions of the Primary Motor Cortex and Primary Sensory Cortex is one example of a HOMUNCULUS:

Homunculus

* Note: Homunculus literally means “little person,” and may refer to one whose body shape is governed by the cortical area devoted to that body region.

Q: What do you notice about the proportions depicted in the aforementioned homunculus?

A: They are not depicted in the same scale representative of the human body.

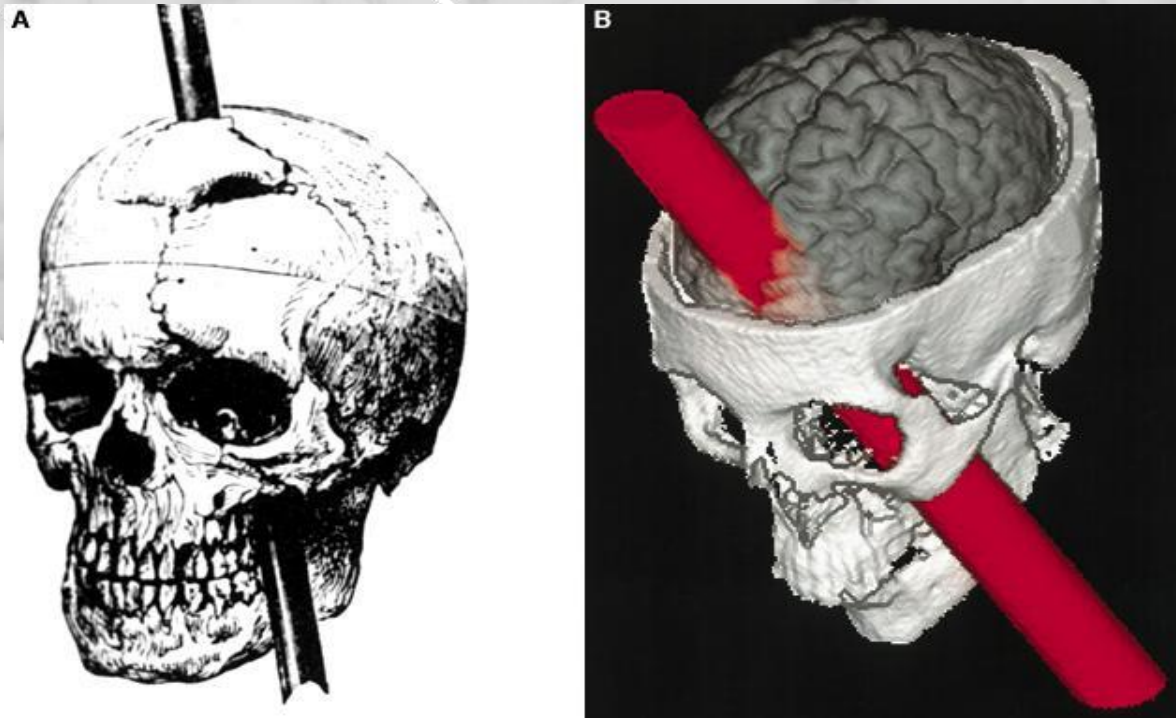
Q: What is meant by depicting these body parts in such outrageous proportions?

A: These outrageous proportions depict the cortical area devoted to each structure.

- Ex: Your hands require many intricate movements and sensations to function properly. This requires a great deal of cortical surface area to control these detailed actions. Your back is quite the opposite, requiring limited cortical area to carry out its actions and functions, or detect sensation.

Further Investigation

Phineas Gage: Phineas Gage was a railroad worker in the 19th century living in Cavendish, Vermont. One of his jobs was to set off explosive charges in large rock in order to break them into smaller pieces. On one of these instances, the detonation occurred prior to his expectations, resulting in a 42 inch long, 1.2 inch wide, metal rod to be blown right up through his skull and out the top. The rod entered his skull below his left cheek bone and exited after passing through the anterior frontal lobe of his brain.



Remarkably, Gage never lost consciousness, or quickly regained it (there is still some debate), suffered little to no pain, and was awake and alert when he reached a doctor approximately 45 minutes later. He had a normal pulse and normal vision, and following a short period of rest, returned to work several days later. However, he was not unaffected by this accident.

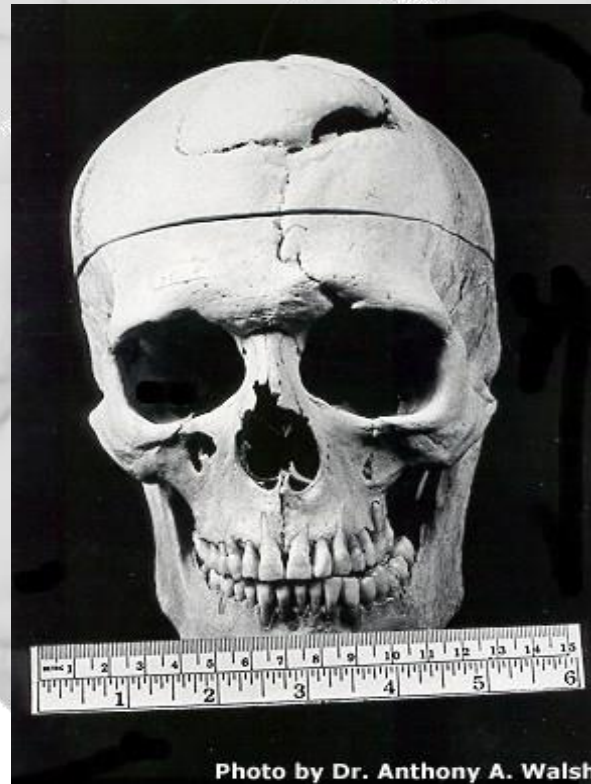


Photo by Dr. Anthony A. Walsh

<http://www.sruweb.com/~walsh/gage5.jpg>

Learn more about Phineas Gage: http://en.wikipedia.org/wiki/Phineas_Gage

Q: Recalling what you have just learned regarding the frontal lobe, what possible problems or abnormalities may Gage have presented with subsequent to this type of injury (remember the precise location of the rod through his brain)?

A: Gage's personality, reasoning, and capacity to understand and follow social norms had been diminished or destroyed. He illustrated little to no interest in hobbies or other involvements that at one time he cared for greatly. 'After the accident, Gage became a nasty, vulgar, irresponsible vagrant. His former employer, who regarded him as "the most efficient and capable foreman in their employ previous to his injury," refused to rehire him because he was so different.'

Q: It is suggested that Gage's injury inspired the development of what at one time was a widely used medical procedure. What might this procedure be, and how does it relate to Gage's injury?

A: The frontal lobotomy. This has been used with the intention to diminish aggression and rage in mental patients, but generally results in drastic personality changes, and an inability to relate socially. This procedure is largely frowned upon today, with the development of neurological drugs as treatments.

Resources



Images:

- http://www.dalbsoutss.eq.edu.au/Sheepbrains_Me/human_brain.gif
- <http://www.bioon.com/book/biology/whole/image/1/1-8.tif.jpg>
- <http://www.bioon.com/book/biology/whole/image/1/1-6.tif.jpg>
- <http://williamcalvin.com/BrainForAllSeasons/img/bonoboLH-humanLH-viaTWD.gif>
- <http://www.math.tu-dresden.de/~belov/brain/motorcor2.gif>
- Larson, Gary. The Far Side.

Phineas Gage:

- <http://www.sruweb.com/~walsh/gage5.jpg>
- <http://soma.npa.uiuc.edu/courses/bio303/Image7.jpg>
- http://en.wikipedia.org/wiki/Phineas_Gage
- http://science-education.nih.gov/nihHTML/ose/snapshots/multimedia/ritn/Gage/Broken_brain1.html