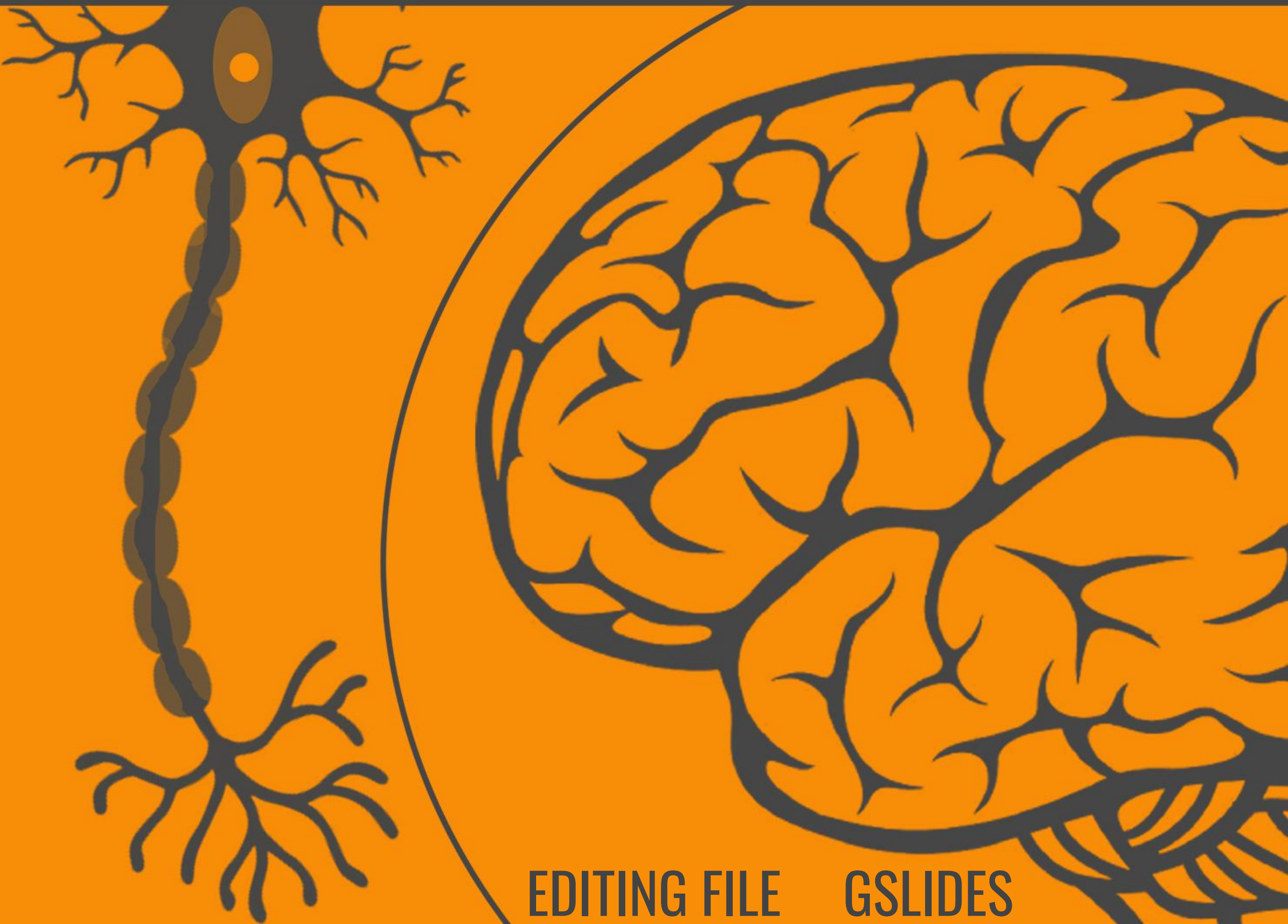


MEDICINE438's CNS PHYSIOLOGY

LECTURE XVI: Cerebral Hemisphere Function



EDITING FILE

GSLIDES

IMPORTANT

MALE SLIDES

EXTRA

FEMALE SLIDES

LECTURER'S NOTES

OBJECTIVES

- Describe the general structure of the Cerebrum and Cerebral Cortex.
- Identify the Cerebrum, the Lobes of the Brain, the Cerebral Cortex, and its major regions and divisions.
- Describe the primary functions of the Lobes and the Cortical Regions of the Brain

Introduction

- The cerebrum is the largest part of the brain with two hemisphere, each of which is divided into four lobes. linked by commissural fibres of corpus callosum.
- Each cerebral hemisphere contains externally highly convoluted cortex of grey matter and internal mass of white matter or medulla .
- The cerebral hemispheres contains motor and sensory areas and the limbic system.

Cerebral Cortex

- The outermost layer of gray matter making up the superficial aspect of the cerebrum.
- Microscopically the cortex consists of six layers or laminae lying parallel to the surface.
- From outside to inside the layers are (Figure 16-1):
 1. Molecular Layer
 2. External Granular Layer¹
 3. Layer of Pyramidal Cells
 4. Internal Granular Layer¹
 5. Large Pyramidal Cell Layer
 6. Layer of Fusiform or Pleomorphic Cells

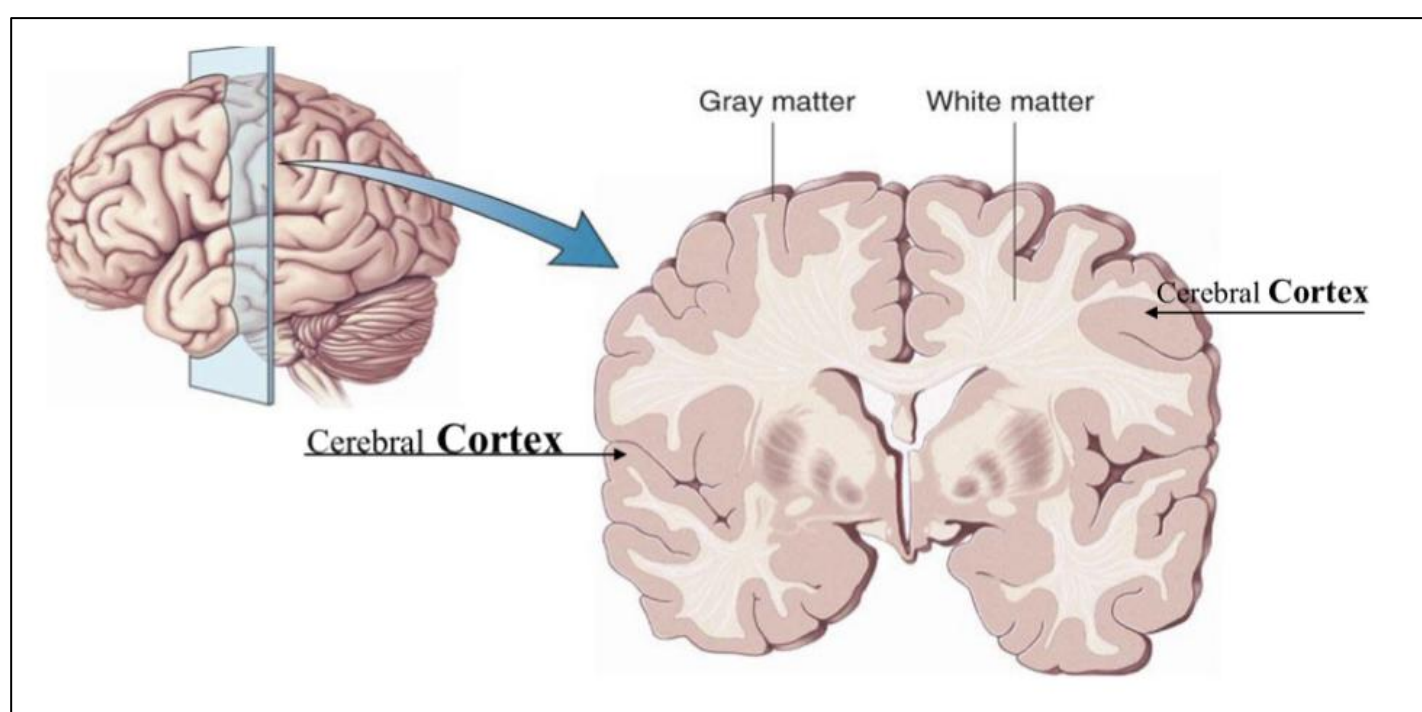


Figure 16-2

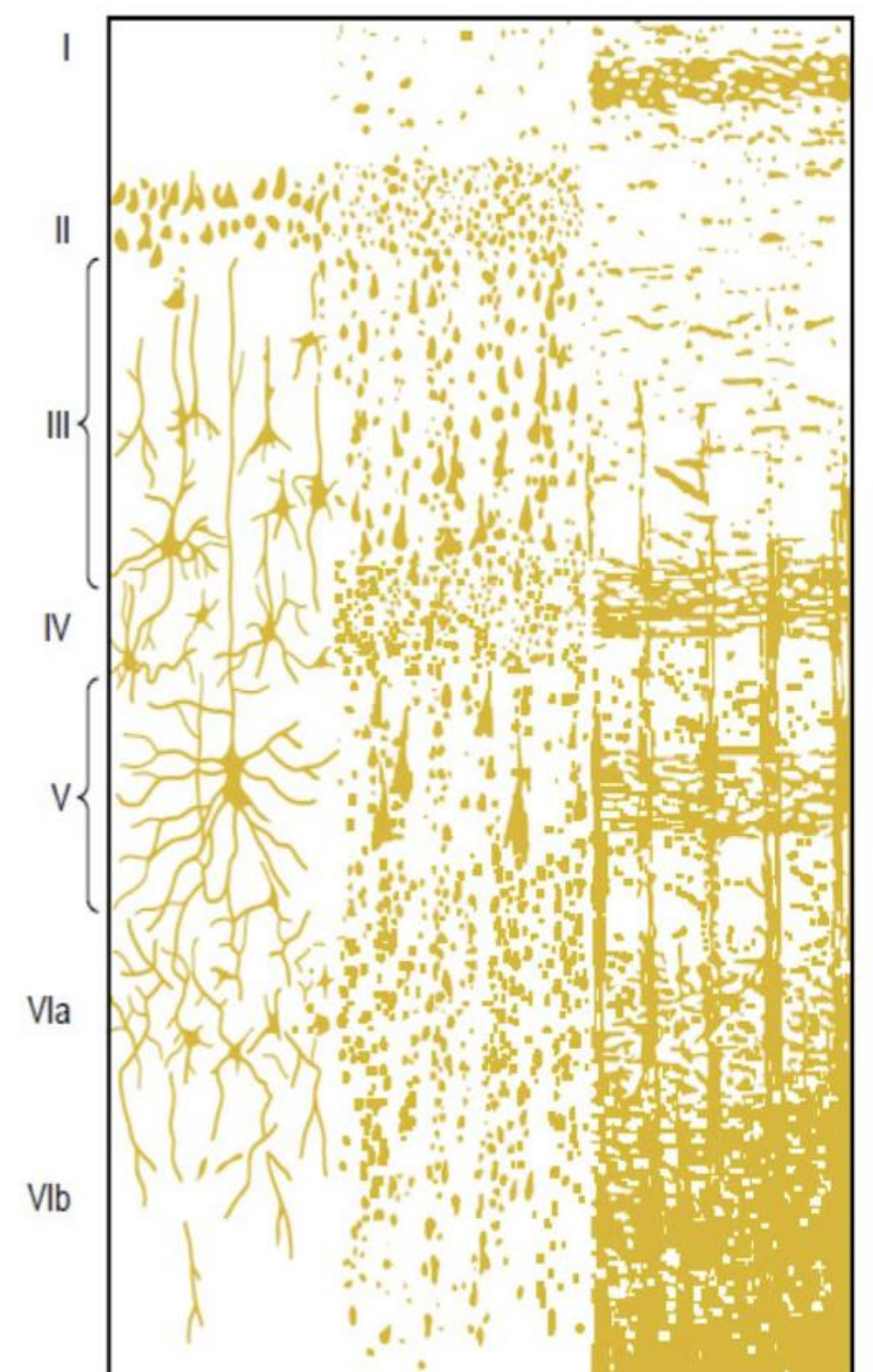


Figure 16-1

FOOTNOTES

1. The granular neurons usually have small axons, therefore they function mainly as interneurons that transmit signals over only short distances within the cortex itself. Remember that an interneuron does not have a motor or sensory function, and functions mainly in connecting other neurons. The pyramidal and fusiform layers have long axons, therefore they may extend as far as to the cortex, like for example the corticospinal tract arising from Layer V.

Cerebral Cortex Layers

- The incoming sensory signal excites neuronal layer IV first; then the signal spreads toward the surface of the cortex and also toward deeper layers.
- Layers I and II & III perform most of intracortical association function.
- The neurons in layers II and III making short horizontal connections with adjacent cortical areas.
- **The neurons in layers V and VI send output signals to brain stem, spinal cord (V) & thalamus (VI).**

There Are Three Main Types Of Functional Areas In The Cerebral Cortex¹

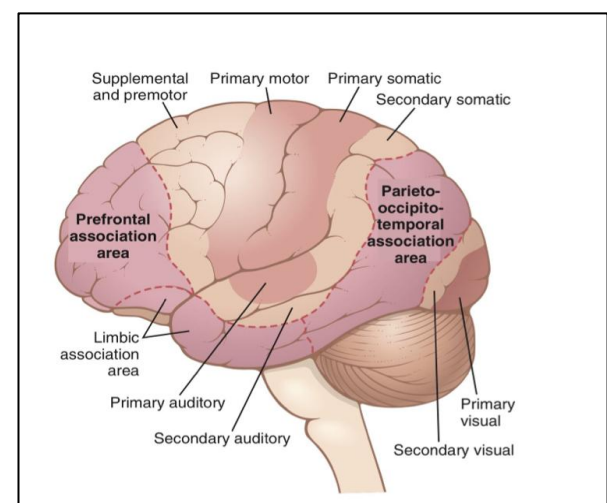
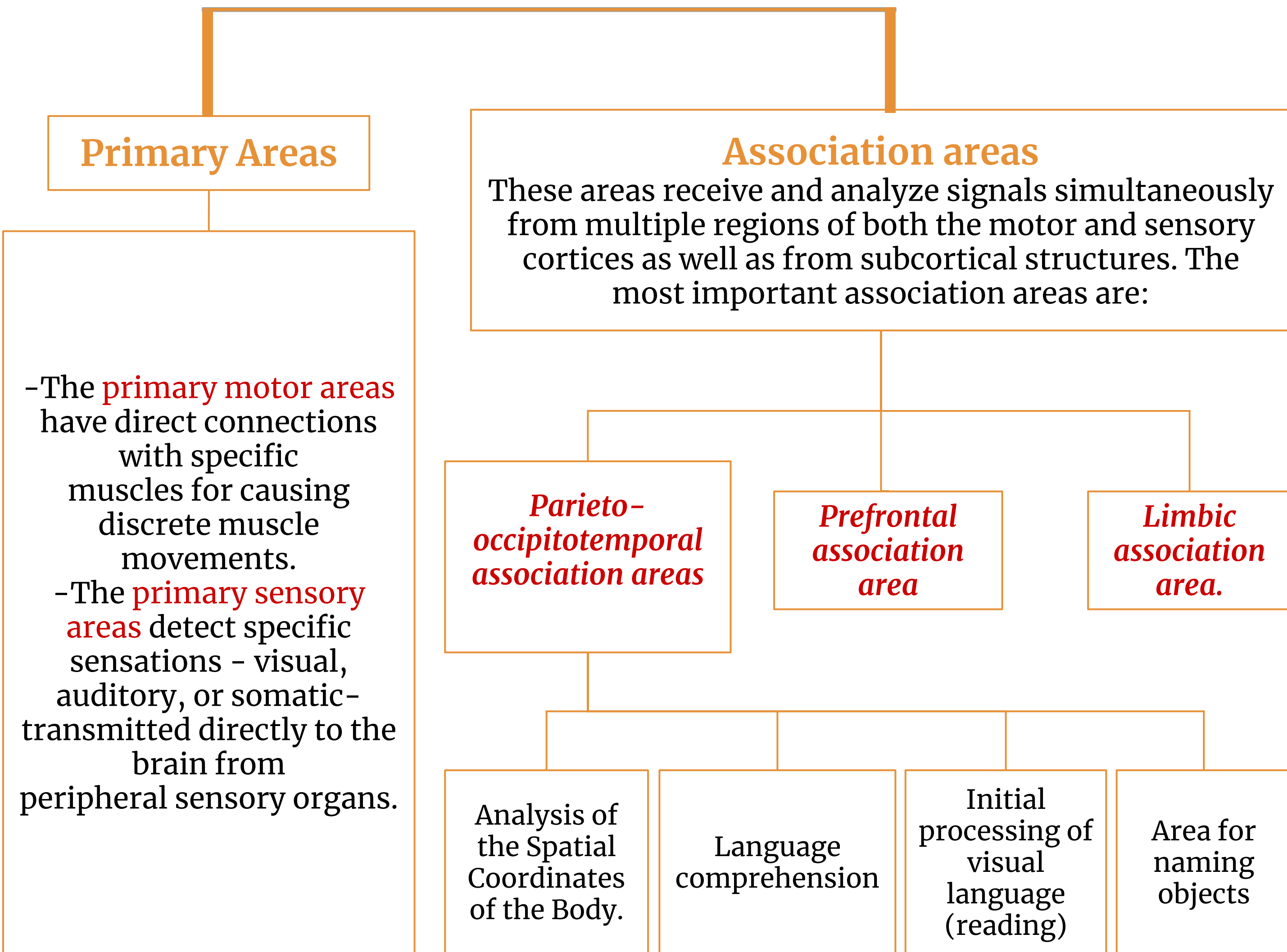


Figure 16-3

FOOTNOTES

1. The third type of functional areas are the secondary areas, either sensory or motor, these areas make sense of the signals in the primary areas, like Wernicke's area, or premotor and supplementary areas of the motor cortex which make motor programs for muscle movements, motor programs are specific patterns of neuronal firing by secondary motor areas into specific regions of primary motor cortex in specific frequencies. This allows the performance of complex movements.

1. Parieto-Occipitotemporal association areas

Area	Site	Function
1) Analysis of the spatial coordinates of the body	Beginning in the posterior parietal cortex and extending into the superior occipital cortex	Computes the coordinates of the visual, auditory, and body surroundings.
2) Area for language comprehension	Wernicke's area , lies behind the primary auditory cortex in the posterior part of the superior gyrus of the temporal lobe	Higher intellectual function
3) Area for Initial processing of visual learning (Reading)	Angular gyrus area ¹	Make meaning out of the visually perceived words (lesion causes Dyslexia or word blindness)
4) Area for naming objects ²	Lateral portion of anterior occipital lobe and posterior temporal lobe	Naming objects

Table 16-1

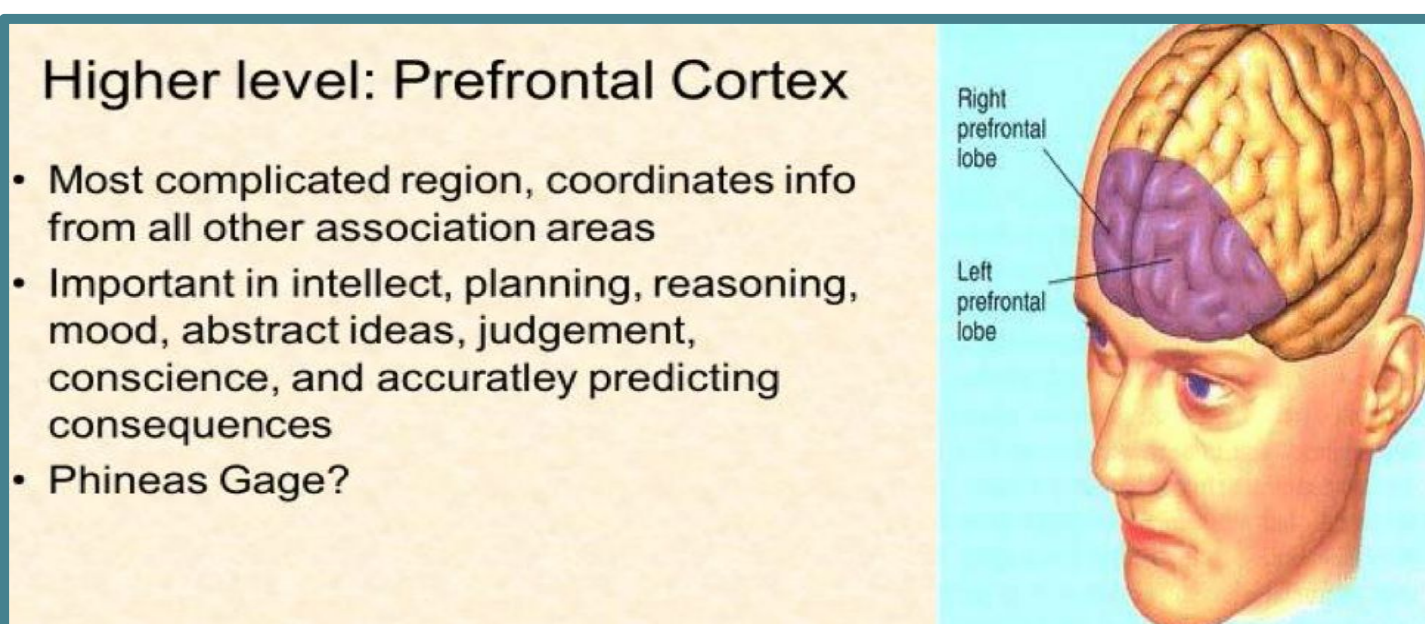


Figure 16-4

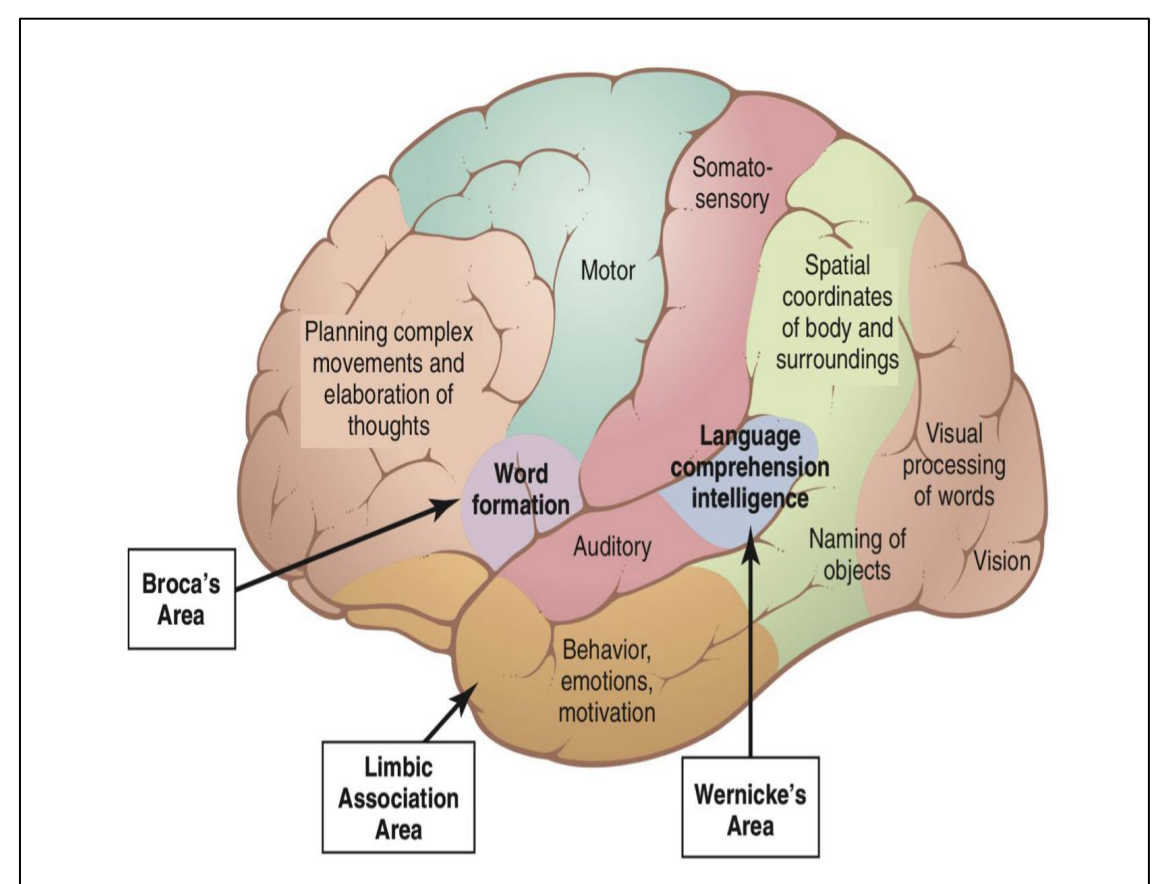


Figure 16-5

FOOTNOTES

1. It is a visual association area that feeds visual information conveyed by words read from a book into Wernicke's area. Angular gyrus area is needed to make meaning out of the visually perceived words. In its absence, a person can still have excellent language comprehension through hearing but not through reading.
2. Naming objects involve auditory and visual recognition, auditory for the name itself, and visually for the physical appearance, the area is located in the occipital and temporal lobes, which means it receives signals from both auditory and visual areas and computes them to associate names to specific objects.

2. Prefrontal Association Area

Definition	Function	Lesion
It is the anterior pole of frontal lobe.	<ol style="list-style-type: none"> 1. Planning of complex pattern of movements. 2. Personality characteristics and social relationship. 3. Production of deep, more abstract and logically sequenced thoughts which enable attainment of goals. 4. Working memory (ability to tie thoughts together in a logical sequence by comparing many bits of information with appropriate stored knowledge and be able to instantly recall this information for future planning). 	Lesions in this area lead to change in personality and behavior)

Table 16-2

3. Limbic Association Area

Definition	Function	Lesion
Anterior and inner portion of temporal lobe.	Is primarily concerned with emotion, behavior and motivational drive for different tasks most importantly learning.	(lesions in this area may lead to decreased aggression, lack of emotion, hyper sexuality and hyperphagia)

Table 16-3

Area of Recognition of Faces

Location	Function	Lesion
The underside of the brain on the medial occipital and temporal lobe	The occipital portion is contiguous with visual cortex, while the temporal one is closely associated with limbic system.	(inability to recognize faces is called prosopagnosia ¹)

Table 16-4

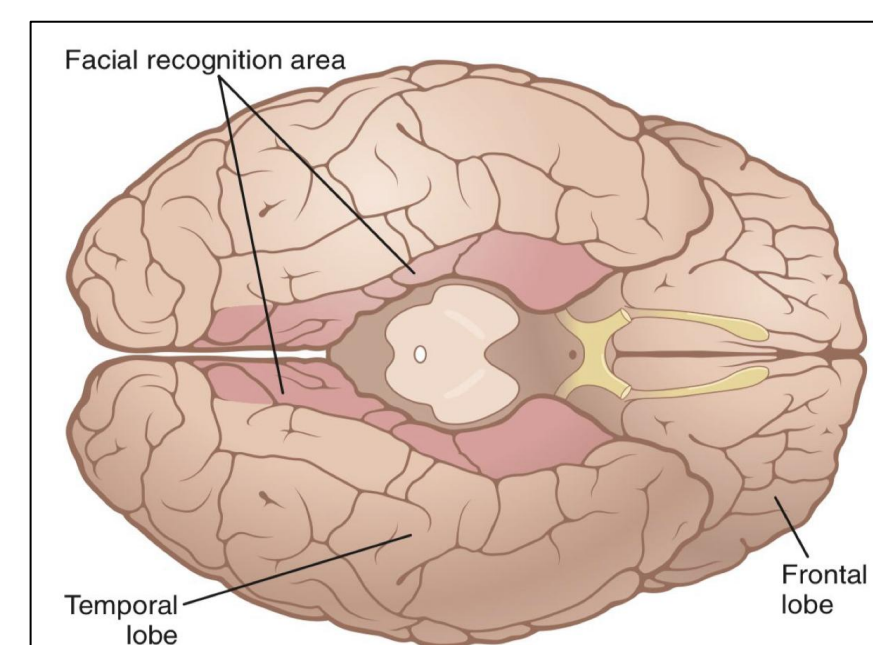


Figure 16-6

FOOTNOTES

1. Prosopagnosia, also called face blindness, is a cognitive disorder of face perception in which the ability to recognize familiar faces, including one's own face (self-recognition), is impaired, while other aspects of visual processing and intellectual functioning remain intact.

Lobes of the brain

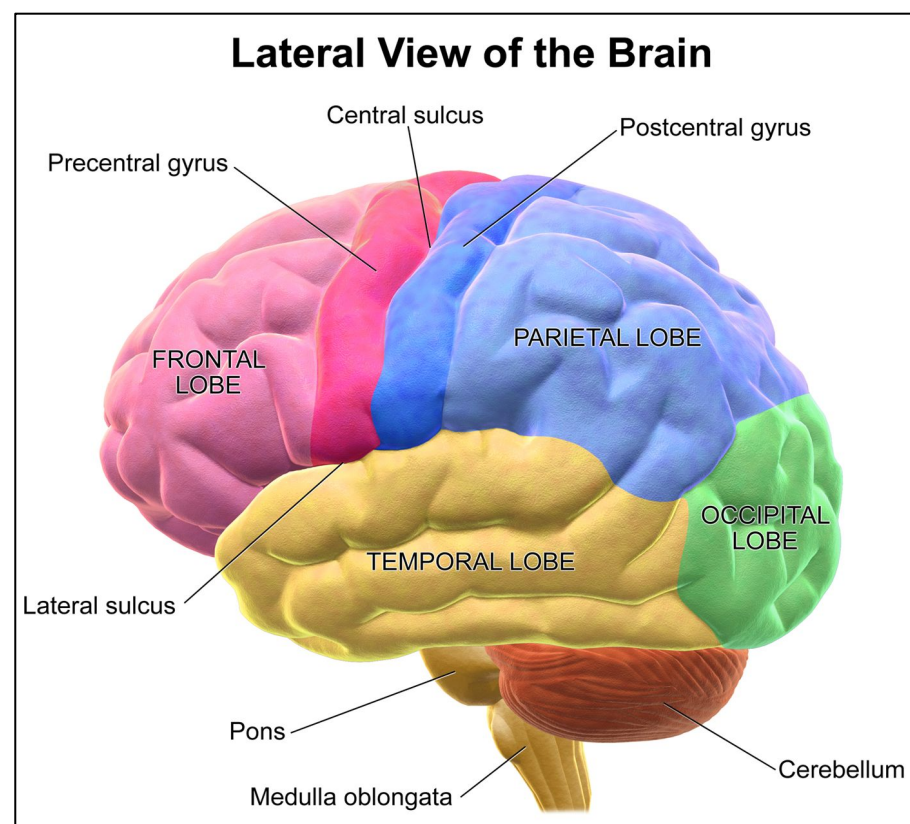
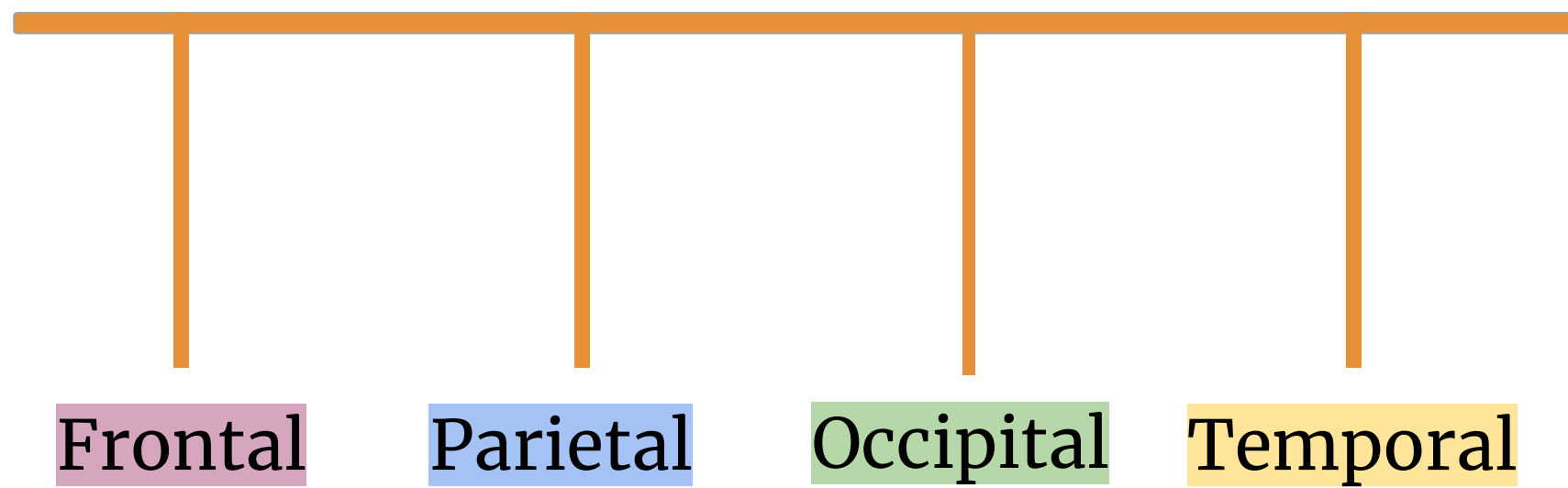


Figure 16-7

Occipital lobe

Definition	located deep to the Occipital Bone of the Skull.
Function	Its primary function is the processing, integration, and interpretation of VISION and visual stimuli
Cortical region	<ol style="list-style-type: none"> Primary Visual Cortex This is the primary area of the brain responsible for detection of visual stimuli Visual Association Area Interprets information acquired through the primary visual cortex.

Table 16-5

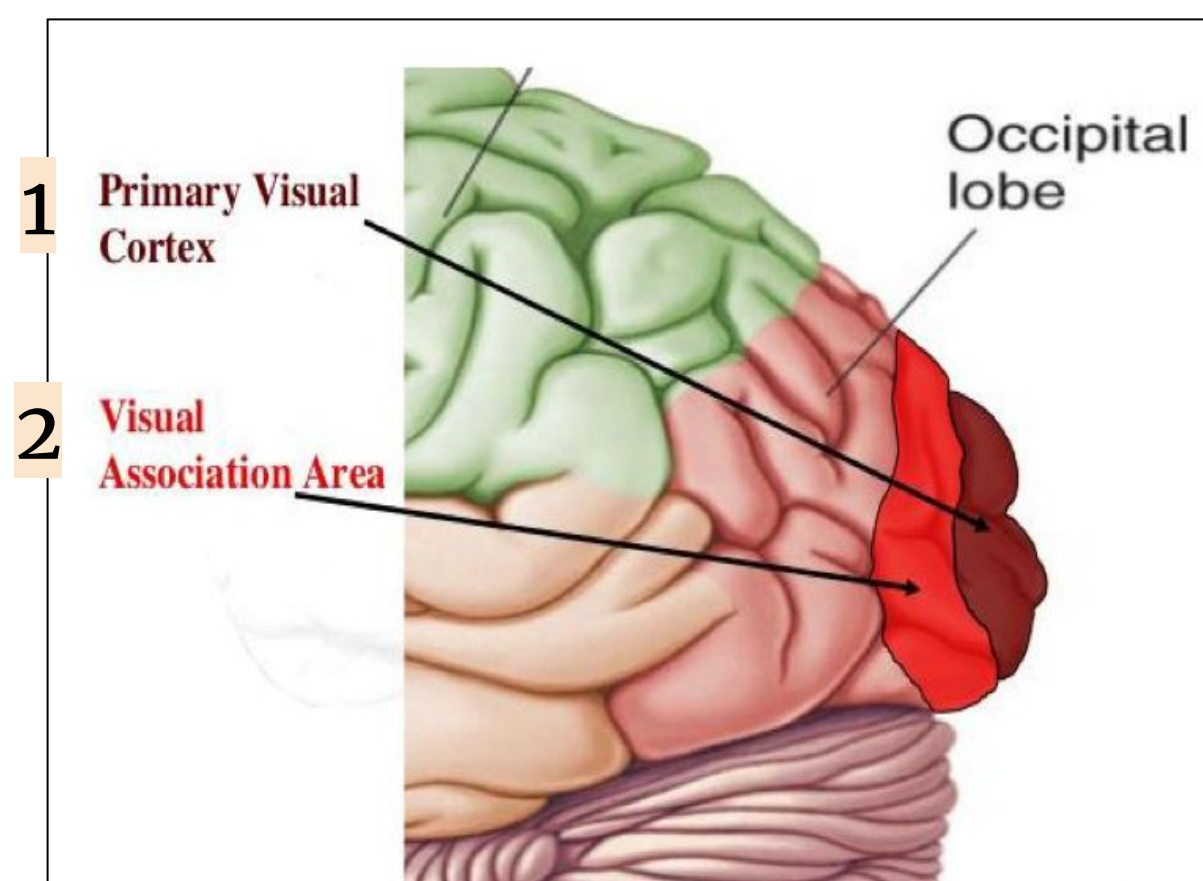


Figure 16-8

Frontal lobe

Definition	located deep to the Frontal Bone of the skull.								
Function	-Memory Formation - Emotions - Personality - Decision Making/Reasoning								
Cortical region	<p>1. Primary Motor Cortex (Precentral Gyrus) Cortical site involved with controlling movements of the body.</p> <p>2. Broca's Area Plan of motor pattern for expressing of individual words. Located on Left Frontal Lobe.</p> <ul style="list-style-type: none"> • Broca's Aphasia Results in the ability to comprehend speech, but the decreased motor ability (or inability) to speak and form words. <p>3. Orbitofrontal Cortex¹ Site of Frontal Lobotomies²</p> <table border="1" data-bbox="478 1347 1948 1816"> <thead> <tr> <th>Desired Effects:</th> <th>Possible Side Effects:</th> </tr> </thead> <tbody> <tr> <td>-Diminished Rage</td> <td>- Epilepsy</td> </tr> <tr> <td>-Decreased Aggression</td> <td>-Poor Emotional Responses</td> </tr> <tr> <td>-Poor Emotional Responses</td> <td>-Perseveration (Uncontrolled, repetitive actions, gestures, or words)</td> </tr> </tbody> </table> <p>4. Olfactory Bulb Cranial Nerve I, responsible for sensation of Smell</p>	Desired Effects:	Possible Side Effects:	-Diminished Rage	- Epilepsy	-Decreased Aggression	-Poor Emotional Responses	-Poor Emotional Responses	-Perseveration (Uncontrolled, repetitive actions, gestures, or words)
Desired Effects:	Possible Side Effects:								
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Table 16-6

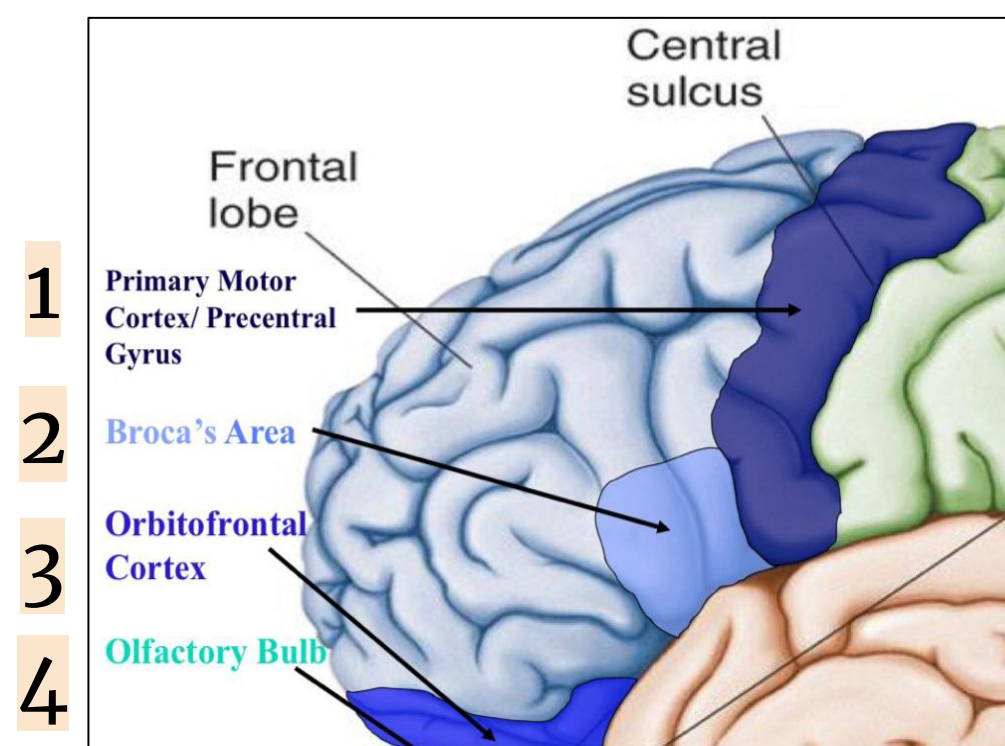


Figure 16-9

FOOTNOTES

1. The orbitofrontal cortex is the area of the prefrontal cortex that sits just above the orbits (also known as the eye sockets). It is thus found at the very front of the brain, and has extensive connections with sensory areas as well as limbic system structures involved in emotion and memory.
2. A lobotomy, or leucotomy, is a form of psychosurgery, a neurosurgical treatment of a mental disorder that involves severing connections in the brain's prefrontal cortex. The purpose of the operation was to reduce the symptoms of mental disorders, and it was recognized that this was accomplished at the expense of a person's personality and intellect. It's rarely performed today.

Parietal lobe

Definition	located deep to the Parietal Bone of the skull.
Function	<ul style="list-style-type: none"> - Senses and integrates sensations - Spatial awareness and perception (Proprioception - Awareness of body/ body parts in space and in relation to each other)
Cortical region	<ol style="list-style-type: none"> 1. Primary Somatosensory Cortex (Postcentral Gyrus) Site involved with processing of tactile and proprioceptive information. 2. Somatosensory Association Cortex Assists with the integration and interpretation of sensations relative to body position and orientation in space. 3. Primary Gustatory Cortex Primary site involved with the interpretation of the sensation of Taste. Located in parietal operculum of Insula

Table 16-7

- Parietal lobe is essential for our feeling of touch, warmth/heat, cold, pain, body position and appreciation of shapes of palpated objects.
- When damaged, the person loses the ability to recognize shapes of complex objects by palpation (palpation: examination of objects by touch) & develops Sensory Inattention on **opposite side**.
- If both sides of the patient are tested simultaneously, e.g. for touch, then the stimulus is appreciated only on the side contralateral to a normal parietal hemisphere.
- (the inability to feel a tactile stimulus when a similar stimulus, presented simultaneously in a homologous area of the body, is perceived)

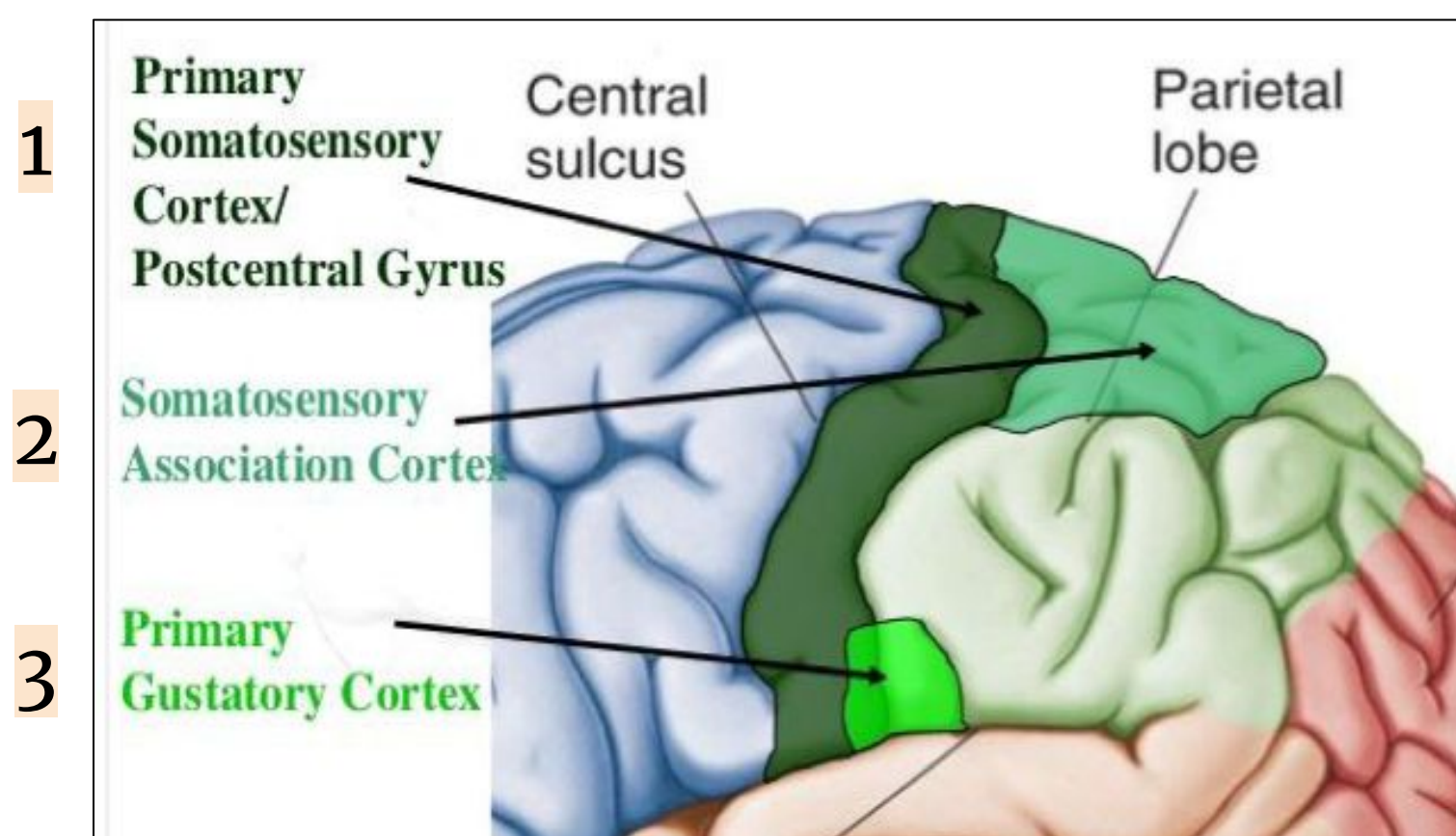


Figure 16-10

Temporal lobe

Definition	The Temporal Lobes are located on the sides of the brain, deep to the Temporal Bones of the skull.
Function	They play an integral role in the following functions: - Hearing - Organization/ Comprehension of language - Information Retrieval (Memory and Memory Formation¹)
Cortical region	<ol style="list-style-type: none"> 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. (dominant hemisphere) Understand auditory and visual information then send it to Broca's area. <p>Lesion may lead to:</p> <ul style="list-style-type: none"> • Wernicke's Aphasia Language comprehension is inhibited. The individuals have difficulty understanding written and spoken language • Memory impairment • can be associated with temporal lobe epilepsy².

Table 16-8

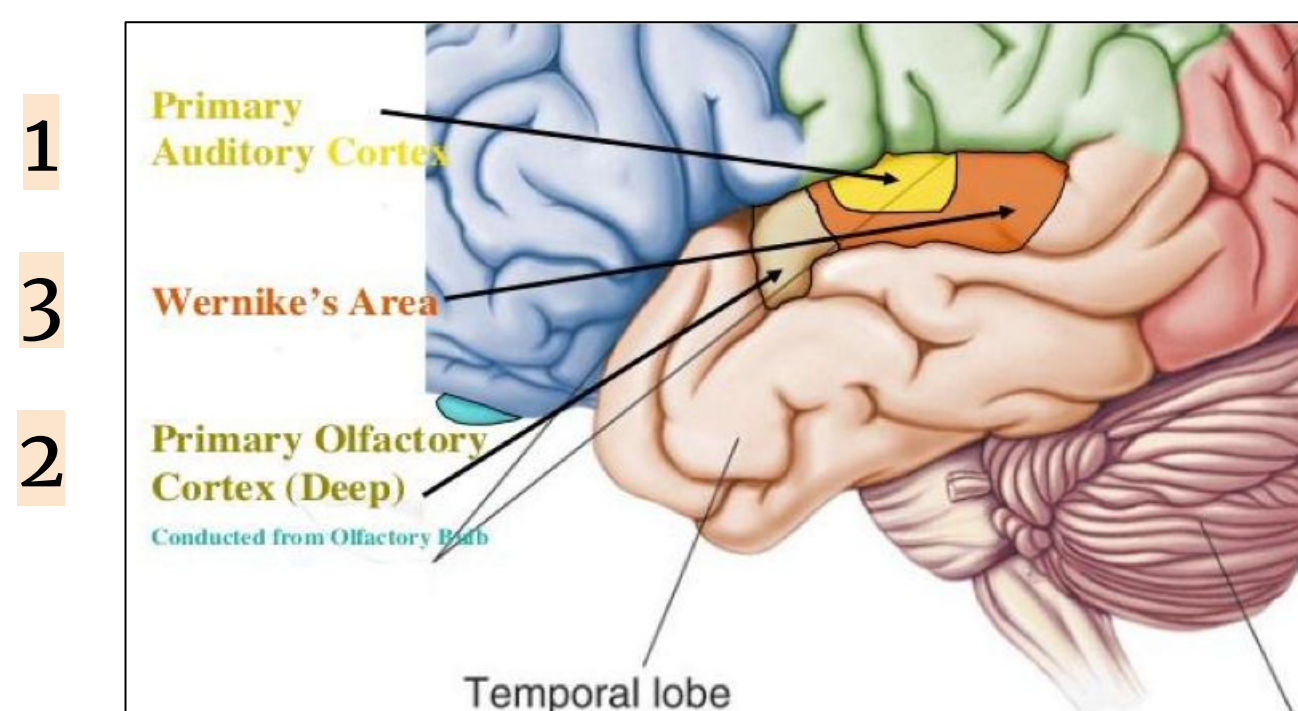


Figure 16-11

FOOTNOTES

1. The main parts of the brain involved with memory are the amygdala, the hippocampus, the cerebellum, and the prefrontal cortex. The temporal lobe communicates with the hippocampus and plays a key role in the formation of explicit long-term memory modulated by the amygdala.
2. Temporal lobe epilepsy (TLE) is a chronic disorder of the nervous system characterized by recurrent, unprovoked focal seizures that originate in the temporal lobe of the brain and last about one or two minutes. TLE is the most common form of epilepsy with focal seizures.

Functional Principles of the Cerebral hemispheres

Each cerebral hemisphere receives sensory information from, and sends motor commands to, the opposite side of body

The 2 hemispheres have somewhat different functions although their structures are alike

Correspondence between a specific function and a specific region of cerebral cortex is not precise

No functional area acts alone; conscious behavior involves the entire cortex

Dominant & Nondominant Hemisphere

- Functional differences between left and right hemispheres

Right cerebral hemisphere relates to:

- understanding & interpreting music,
- Non verbal visual Experience
- Spatial relation between the person & their surroundings
- Body language and intonation of peoples voices

In most people, **left hemisphere** (dominant hemisphere) controls:

- reading
- writing
- math
- decision-making
- logic
- speech
- language (usually)

QUIZ



MEDICINE438's
CNS PHYSIOLOGY

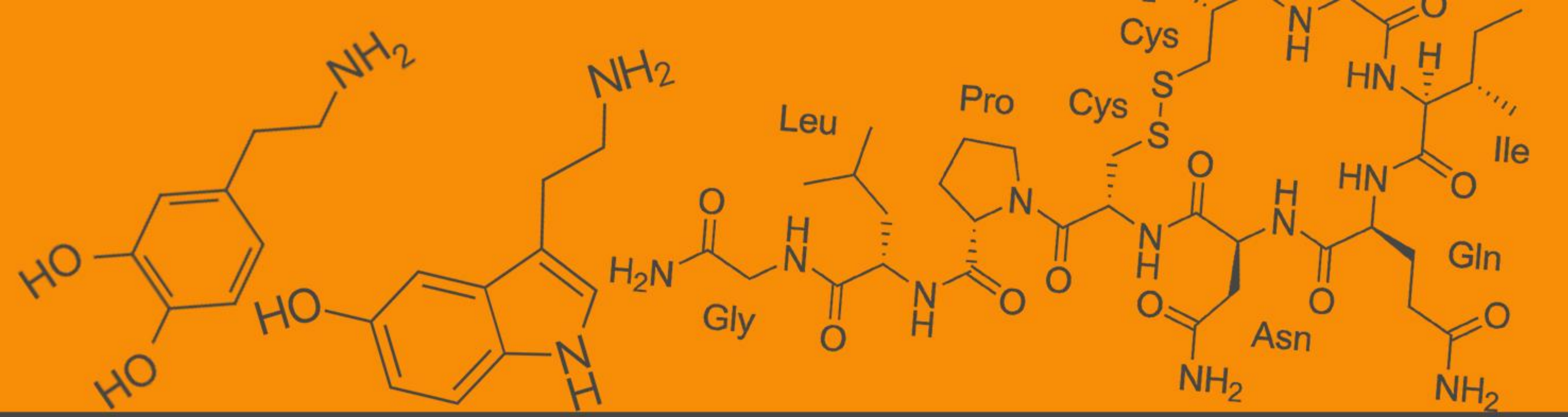
1. Which areas receive and analyze signals simultaneously from multiple regions of both the motor and sensory cortices as well as from subcortical structures ?
 - A) Primary Areas
 - B) Secondary areas
 - C) Associated areas
 - D) Primary sensory areas
2. Lesions in which area may lead to decreased aggression and hyperphagia?
 - A) Prefrontal Association Area
 - B) Limbic Association Area
 - C) Parieto-Occipitotemporal association areas
 - D) Area of Recognition of Faces
3. What is the site of naming objects ?
 - A) Wernicke's area, lies behind the primary auditory cortex in the posterior part of the superior gyrus of the temporal lobe
 - B) Angular gyrus area
 - C) Beginning in the posterior parietal cortex and extending into the superior occipital cortex
 - D) Lateral portion of anterior occipital lobe and posterior temporal lobe
4. Which one of the following is not related to lesion in the temporal lobe?
 - A) memory impairment
 - B) broca's aphasia
 - C) wernicke's aphasia
 - D) inability to recognize shapes of complex objects
5. Which one of the following cortical regions is found in the temporal lobe?
 - A) primary gustatory cortex
 - B) visual association area
 - C) broca's area
 - D) primary olfactory cortex
6. A person who has had a traumatic brain injury seems to be able to understand the written and spoken word but cannot create the correct sounds to be able to speak a word that is recognizable. this person most likely has damage to which area of the brain?
 - A) Broca's area
 - B) Prefrontal lobe
 - C) Wernicke's area
 - D) Angular gyrus

SHORT ANSWER QUESTIONS

1. What is the difference between Wernicke's area and broca's area?
2. List 3 of the cortical regions which are located in frontal lobe with their functions:

- 1) **Broca's Area:**
Controls facial neurons, speech, and language comprehension.
Wernicke's Area:
Understand auditory and visual information and send them to Broca's area.
- 2) - Olfactory bulb: sensation of smell
- Primary motor cortex: controlling movements of the body.
- Broca's area: Controls facial neurons, speech, and language comprehension.

ANSWER KEY: C, B, D, D, D, A



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REFERENCES

- Guyton and Hall Textbook of Medical Physiology
- Ganong's Review of Medical Physiology

