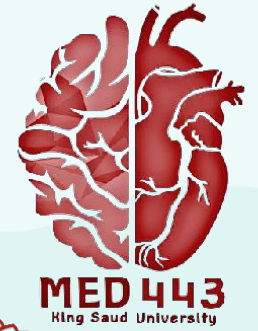
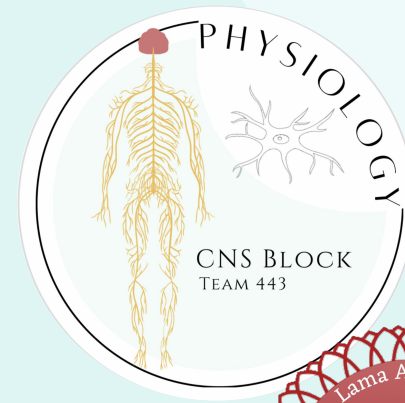




# Functions of Cerebral Hemispheres



## Color Index:

- Main text
- **Important**
- Girls Slides
- Boys Slides
- Notes
- Extra

[Editing File](#)



## Objectives:

At the end of this lecture the student would be able to discuss :

- 1 Understand that the nervous system can be classified in more than one way
- 2 Know Functional Anatomy of the CNS and Orientation of the cerebral cortex and spinal cord function.
- 3 Know that much of human physiology can be learned from observing the consequences of human lesions & diseases.
- 4 Be able to explain what is meant by telencephalon, diencephalon, brainstem, basal ganglia, cerebellum and spinal cord; & outline their function.
- 5 Understand that the functions of the cerebral hemisphere Know Functional Anatomy and functions of Cerebral lobes .
- 6
- 7 List the cerebral cortex layers, know the terms categorical hemisphere and representational hemisphere and summarize the difference between them.
- 8 Explain the three main types of functional areas in the cerebral cortex
- 9 Know the most important association areas of the brain and their functions



# The Nervous System

A network of billions of nerve cells linked together in a highly organized fashion to form the rapid control center of the body.

## Functions include:

Integrating center for homeostasis, movement, and almost all other body functions.

## Nervous Tissue

(highly cellular)

1- Neurons, functional & signal conducting cells

2- Supporting cells ( Neuroglia )

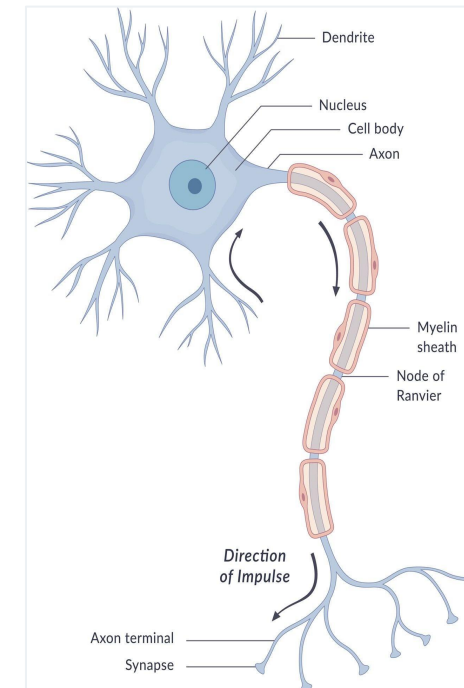
## Neurons

The functional and structural unit of the nervous system.

Specialized to conduct information from one part of the body to another

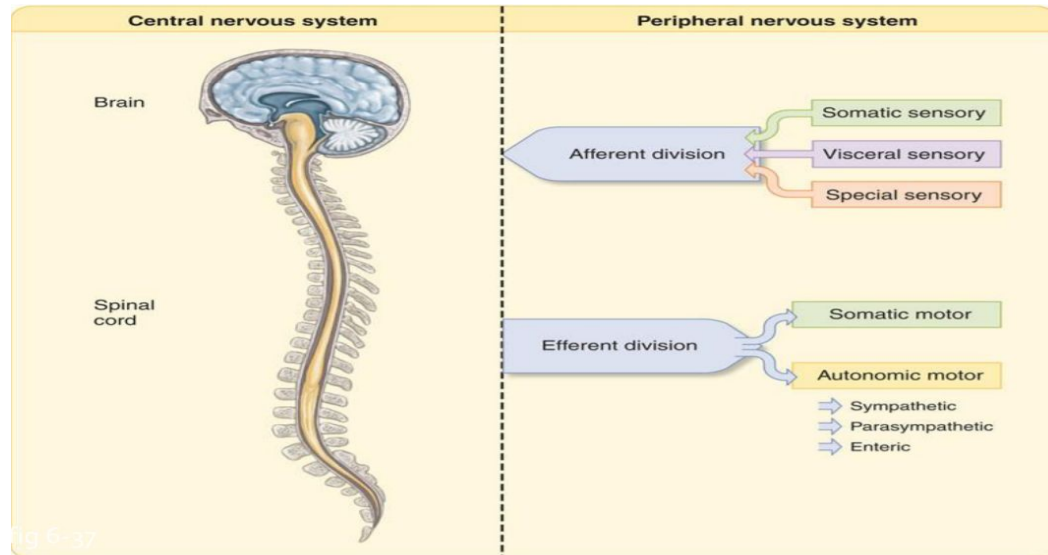
There are many, many different types of neurons but most have certain structural and functional characteristics in common:

- 1- Cell body (soma)
- 2- One or more specialized, slender processes (axons/dendrites)
- 3- An input region (dendrites/soma)
- 4- A conducting component (axon)
- 5- A secretory (output) region (axon terminal)





# Organization of the Nervous System



## Sensation

Monitors changes/events occurring in and outside the body. Such changes are known as stimuli and the cells that monitor them are receptors.

## Integration

The parallel processing and interpretation of sensory information to determine the appropriate response.

## Reaction

-Motor output.  
- The activation of muscles or glands (typically via the release of neurotransmitters (NTs)).

The nervous system ( NS) can be classified in more than one way:

### I) Central & Peripheral NS

A) Central Nervous System (CNS) : consisting of the brain and spinal cord.

B) Peripheral Nervous System (PNS) : Fibers outside the CNS.

### II) Sensory & Motor NS

A) Sensory : includes (i) sensory ( afferent ) fibers , ascending ( sensory ) pathways , & brain sensory centers.

B) Motor : includes brain motor centers , descending (motor) pathways & motor ( efferent ) fibers .

### III) Somatic & Autonomic NS

A) Somatic ( Voluntary) Nervous System

B) Autonomic ( Involuntary) Nervous System



# Brain regions

1

## Telencephalon

(1) **Cerebrum**

(2) **Basal Ganglia** ( collection of grey matter situated inside the cerebral hemispheres )

2

## Diencephalon



- ❖ Forms the central core of the forebrain
- ❖ 3 paired structures **Thalamus, Hypothalamus, Epithalamus.**
- ❖ All 3 are gray matter

### 1- Thalamus

- 80% of the diencephalon
- Sensory relay station where sensory signals can be edited, sorted, and routed except Olfaction.

### 2- Epithalamus ( Important )

- Above the thalamus
- Contains the pineal gland which release melatonin (involved in sleep/wake cycle and mood).

## 3- Hypothalamus

contains centers for autonomic and endocrine control

### Functions of hypothalamus:

1. Autonomic regulatory centre (Influences HR, BP, resp. rate, GI motility, pupillary diameter)
2. Emotional response( -Involved in fear, pleasure, - Drive centre: sex, hunger)
3. Regulation of body temperature
4. Regulation of food intake (Contains a satiety center)
5. Regulation of water balance and thirst
6. Hormonal control (- Releases hormones that influence hormonal secretion from the anterior pituitary gland. - Releases oxytocin and ADH.)

3

## Brainstem

- Midbrain
- Pons
- Medulla Oblongata

4

## Cerebellum



# Spinal cord and Spinal nerves

The spinal cord is generally cylindrical in shape, From it emerge 31 pairs of spinal nerves: 8 cervical, 12 thoracic, 5 lumbar, 5 sacral and, 1 coccygeal

The spinal cord, beside carrying sensory (ascending) and motor (descending) tracts, Also contains the centers of Spinal Reflexes

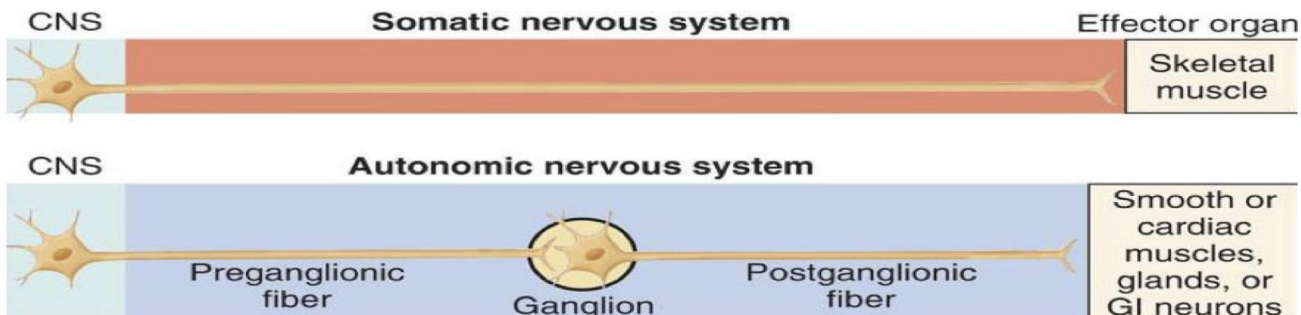
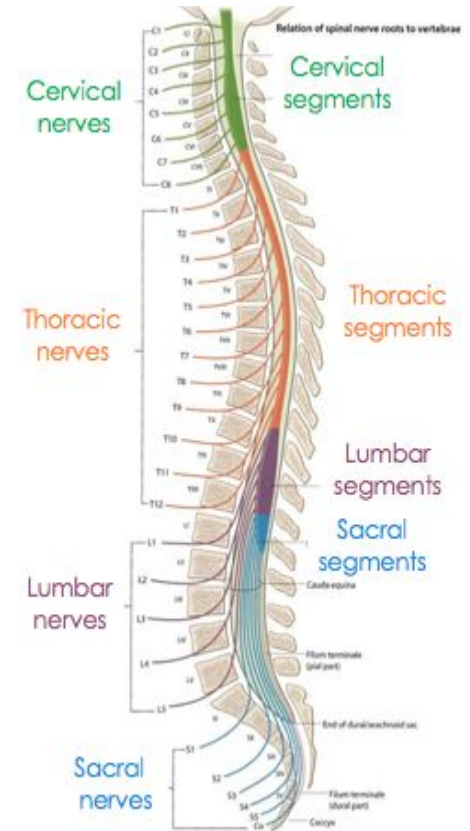
## Peripheral nervous system: efferent division

### Somatic

- Single neuron
- Innervates skeletal muscle
- voluntary control.

### Autonomic

- 2 neuron chain
- Innervates smooth, cardiac muscle, glands, -largely involuntary control





# Brain Regions

## Brainstem

The term "brainstem" is, in terms of anatomy, to group "all CNS structures that hang between the cerebrum and spinal cord" together.

Functions include:

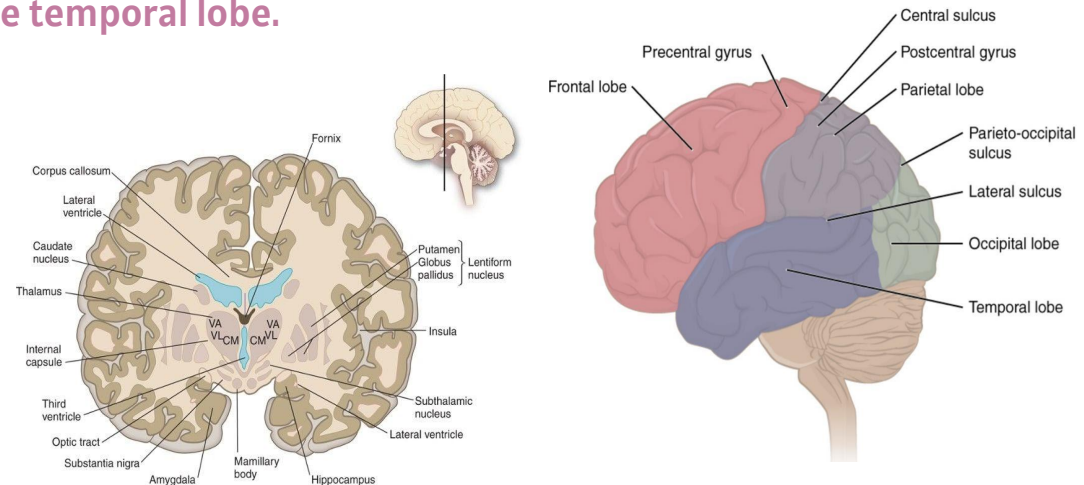
1. regulation of Consciousness , Wakefulness & Sleep
2. Respiratory , Cardiovascular and Gastrointestinal control
3. Balance ( Vestibular nuclei )
4. Moreover, it contains several Cranial Nerve nuclei.

## Cerebellum

Important for coordination of body movements and balance.  
It forms the centre where the learned movements are stored.

# Cerebrum

- The largest, most conspicuous portion of the brain.
- 2 hemispheres connected by commissural fibers of **corpus callosum**.
- Each of the two hemispheres controls functions on the opposite half of the body.
- Has an outer cortex of gray matter surrounding and interior that is mostly white matter, except for a few small portions. (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.
- The surface is marked by ridges called **gyri** separated by grooves called **sulci\***.
- **Lobes of the Cerebrum:**
  - The central sulcus separates the frontal lobe from the parietal lobe.
  - Bordering the central sulcus are 2 important gyri, the precentral gyrus and the postcentral gyrus.
  - The occipital lobe is separated from the parietal lobe by the parieto-occipital sulcus. The lateral sulcus outlines the temporal lobe.







# Cerebrum

## Cerebral cortex layers

- The functional part of the cerebral cortex is a thin layer of 2 to 5 millimeters thick, with a total area of about 25% of a square meter, estimated to contain over 80 billion neurons
- Microscopically the cortex consists of **six layers or laminae lying parallel to the surface**
- The layers are listed from outside to inside

I. Molecular layer

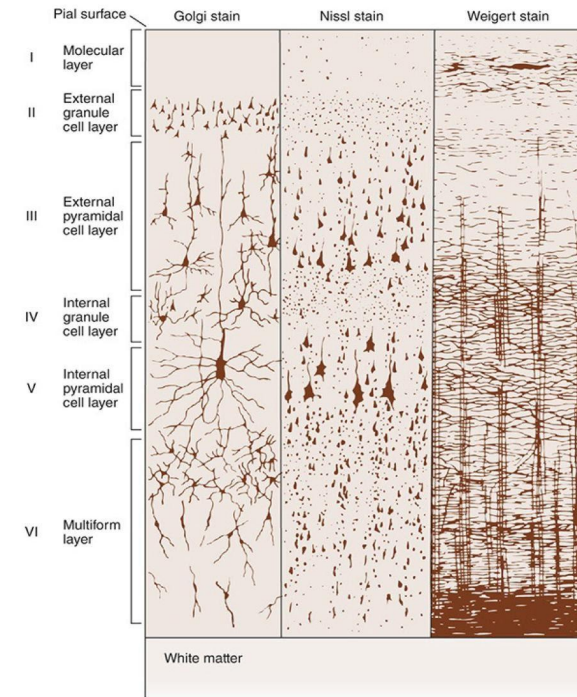
II. The external granular layer

III. Layer of pyramidal cells

IV. Internal granular layer

V. Large pyramidal cell layer

VI. Layer of fusiform or polymorphic cells



**FIGURE 14-1 Structure of the cerebral cortex.** The cortical layers are indicated by the numbers. Golgi stain shows neuronal cell bodies and dendrites, Nissl stain shows cell bodies, and Weigert myelin sheath stain shows myelinated nerve fibers. (Modified with permission from Ranson SW, Clark SL: *The*



# Cerebrum

The incoming sensory signal excites neuronal layer IV first; then the signal spreads toward the surface of the cortex and also toward deeper layers.

The neurons in layers II and III making short horizontal connections with adjacent cortical areas.



Layers I and II & III perform most of intracortical association function.

The neurons in layers V and VI send output signals to brain stem, spinal cord (V) & thalamus (VI).



# Cerebrum

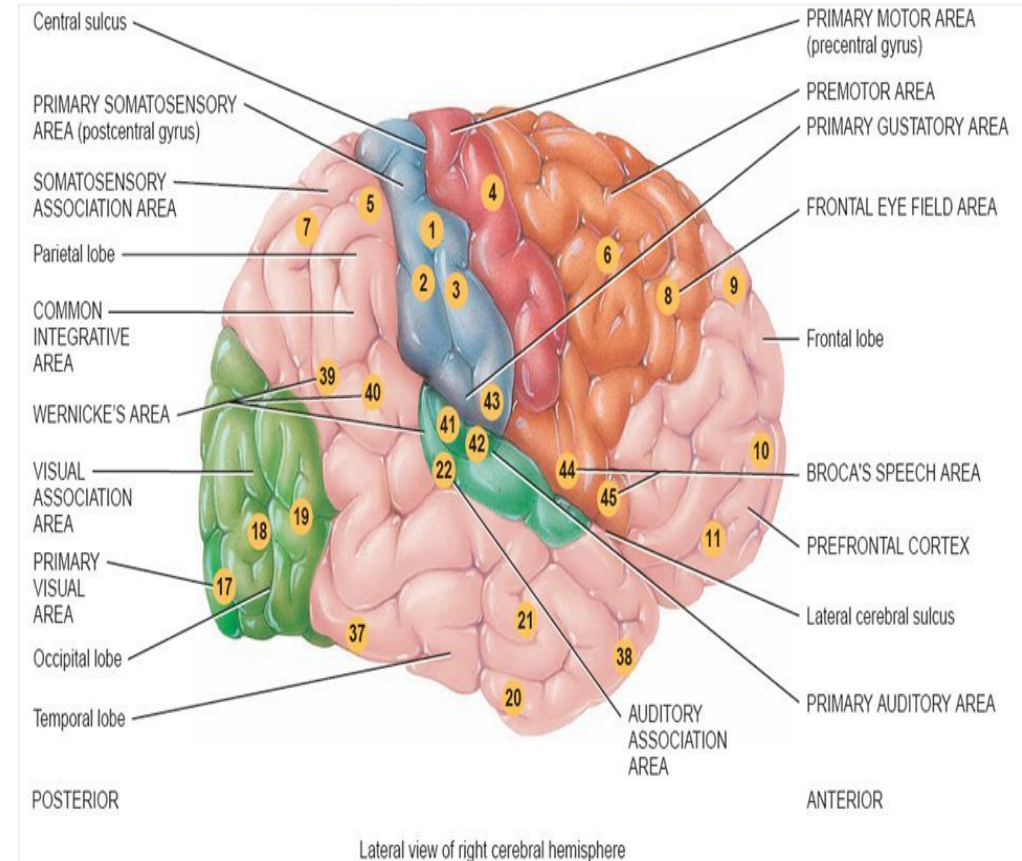
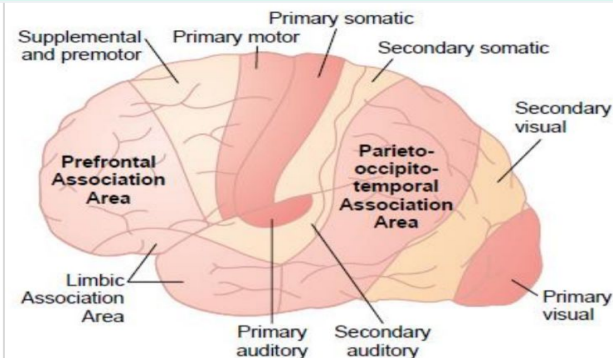
## Areas of brain

Primary areas	Secondary areas	Association areas
<p><b>1-The primary motor areas:</b></p> <p>Have direct connections with specific muscles for causing discrete muscle movements.</p> <p><b>2-The primary sensory areas:</b></p> <p>Detect specific sensations visual, auditory, or somatic transmitted directly to the brain from peripheral sensory organs.</p>	<p><b>Make sense out of the signals in the primary areas.</b></p> <p>Like supplementary area for sensation to detect shape &amp; texture</p>	<p><b>Receive and analyze signals simultaneously from multiple regions of both the motor and sensory cortices as well as from subcortical structures.</b></p> <p>Like in vision, association area is important to detect intensity of light, angles and so on.</p>

## Association areas:

### The most important association areas are:

- (1) Prefrontal association area
- (2) Parieto-occipito-temporal association area
- (3) Limbic association area.





# Cerebrum(Association areas)

## 1- Prefrontal association area

Is the anterior pole of frontal lobe. It contributes in the following functions:

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**

## 2- Parieto-occipitotemporal association areas

Area	Site	Function
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
Area for Language Comprehension	<b>Wernicke's area</b> , lies behind the primary auditory cortex in the posterior part of the superior gyrus of the temporal lobe	Higher intellectual function <b>the most important area for intellectual functions</b>
Area for Initial Processing of Visual Language (Reading)	Angular gyrus area	Make meaning out of the visually perceived words (lesion causes Agraphia (inability to Write), Alexia (word blindness), or Dyslexia (difficulty in learning about written language))
Area for Naming Objects <small>Area for naming objects is adjacent to occipital and temporal lobes for detection physical nature of objects by vision and for auditory stimuli respectively</small>	Lateral portion of anterior occipital lobe & posterior temporal	Naming objects



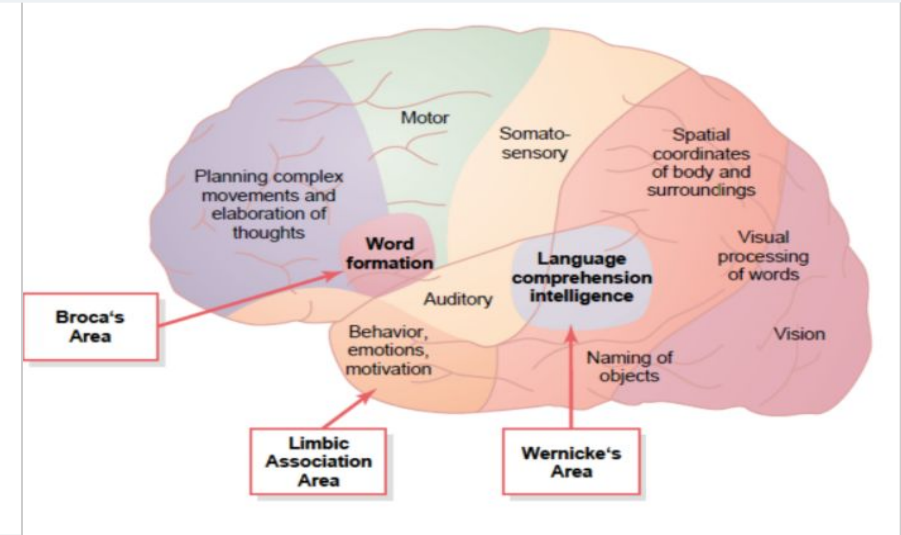
# Cerebrum (Association areas)

## 3- Limbic association area

Consists of anterior and inner portion of temporal lobe, **ventral portion of the frontal lobe**, and **cingulate gyrus on mid surface of each cerebral hemisphere**

Is primarily concerned with **emotion, behavior** and **motivational drive** for different tasks most importantly learning.

**Lesion of this area may lead to decreased aggression, lack of emotion, hypersexuality & hyperphagia** (زيادة الشهية في الأكل). also called **reward and punishment area**



## Faces' recognition area

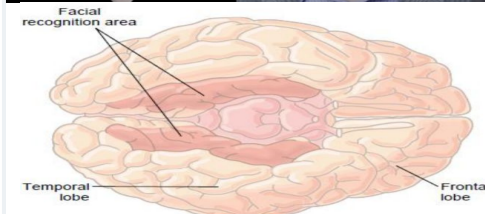
Located on the underside of the brain on the medial occipital and temporal lobes.

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**. its **only function is to recognize faces**



How do people with prosopagnosia see faces



# Frontal lobe



[helpful video](#)

## Location

Deep to the frontal bone of the skull. The frontal lobe of the brain is largest lobe account for 40% of cortical surface area

## Function

Memory Formation prefrontal area (working memory)  
 Decision Making prefrontal area (production of logically sequenced thoughts)  
 Personality prefrontal area  
 Reasoning prefrontal area (production of logically sequenced thoughts) And it's thought to be involved in anxiety disorder  
 Emotions, learning, behaviour.

## Region

**1-Primary Motor Cortex (Precentral Gyrus):**  
 Cortical site involved with controlling movements of the body.

**2-Broca's Area:**  
 plan of motor pattern for expressing of individual words.  
 Located on **Left Frontal Lobe** (dominant hemisphere), Damage lead to Broca's aphasia  
 Broca's Area receive information from wernicke area via arcuate fasciculus, then send the information to motor cortex to initiate the proper movement of the libs & larynx & tongue (via nuclei VII, IX, X, XI, XII CN) to produce speech

**Broca's Aphasia**  
 Results in the ability to comprehend speech (wernicke area is intact), but the decreased motor ability (or inability) to speak and form words.

**3-Orbitofrontal Cortex:** Site of Frontal Lobotomies, conscious analysis of odors  
**Desirable effect :** **side effect :**

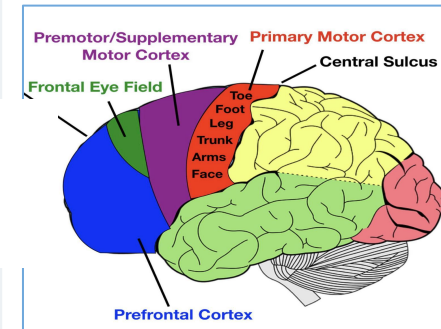
- 1 Diminished Rage
- 2 Decreased Aggression
- 3 Poor Emotional Responses

**4-Olfactory Bulb:**  
 Cranial Nerve I, Responsible for sensation of Smell.

**5-Premotor and supplementary motor areas:** planning/coordination of movements

**6- Frontal eye field:**  
 for conjugate eye movement

**7- Prefrontal cortex:**  
 involves in personality behavior and intellect (higher mental function)



neurosurgical treatment of a mental disorder. procedure in which the frontal lobes are separated from the rest of the brain by cutting the connecting nerve fibers

- 1 Epilepsy
- 2 Poor Emotional Responses
- 3 Perseveration (Uncontrolled, repetitive actions, gestures, or words)



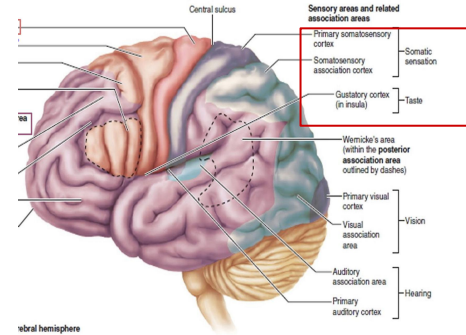
[helpful video](#)

# Parietal lobe

**Location** Deep to the Parietal Bone of the skull

**Function**  
1- Senses and integrates sensations (*conscious of somatic sensation*)  
2- Spatial awareness and perception  
(Proprioception - Awareness of body/ body parts in space and in relation to each other)

**Region**  
**Primary Somatosensory Cortex (Postcentral Gyrus)**  
Site involved with processing of tactile and proprioceptive information.  
(*conscious of somatic sensation*)  
**Somatosensory Association Cortex (analyzing)**  
Assists with the integration and interpretation of sensations *relative to body position and orientation in space.*  
(وانت مغمض عينك واعطيك قلم, بتعرف ان الي بيدك قلم)



**Primary Gustatory Cortex**  
Located in parietal operculum of Insula, Primary site involved with the interpretation of the sensation of Taste.

- Lesion**
- Parietal lobe is essential for our feeling of touch, warmth/heat , cold, pain , body position and appreciation of shapes of palpated object.
  - **When damaged , the person loses the ability to recognize shapes of complex objects by palpation (Astereognosis) (palpation = examination of objects by touch) & also develops Sensory Inattention on opposite side.**
  - **(Patients ignore stimuli from the contralateral portion of their bodies or the space around these portions. Although they do not have any apparent primary visual, auditory, or somesthetic defect)**
  - **The inability to feel a tactile stimulus when a similar stimulus, presented simultaneously in a homologous area of the body, is perceived.**

# Temporal lobe



[helpful video](#)

## Location

On the sides of the brain, deep to the Temporal Bones of the skull.

## Function

**Hearing.**  
**Organization/Comprehension of language.**  
**Information Retrieval (Memory and Memory Formation)**

## Region

**Primary Auditory Cortex**  
Responsible for hearing.

**Auditory association area**

**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) (receive information of visual cortex & auditory cortex then send the info to Broca's Area)  
**Located on the Left Temporal Lobe** (dominant hemisphere), Understand auditory and visual information and send them to Broca's area.

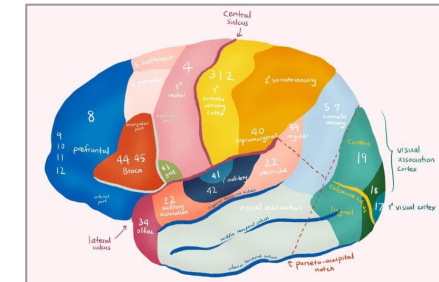
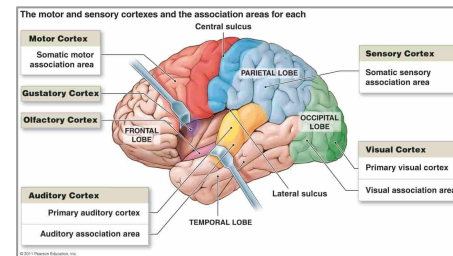
**Information Retrieval (Memory and Memory Formation)**

**Wernicke's Aphasia:** (patient can speak, but they mostly speak nonsense)

## Lesion

Language comprehension is inhibited. The individuals have difficulty:

- Understanding written and spoken language
- Memory impairment.
- Can be associated with temporal lobe epilepsy.







[helpful video](#)

## Occipital lobe

### Location

Deep to the Occipital Bone of the Skull.

### Function

Its primary function is the processing, integration, interpretation of **VISION and visual stimuli.**

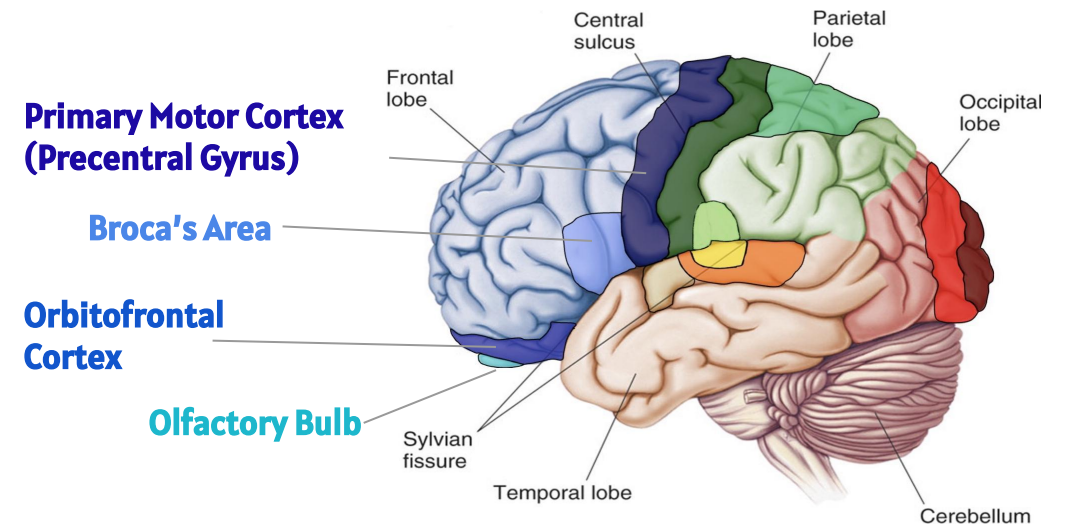
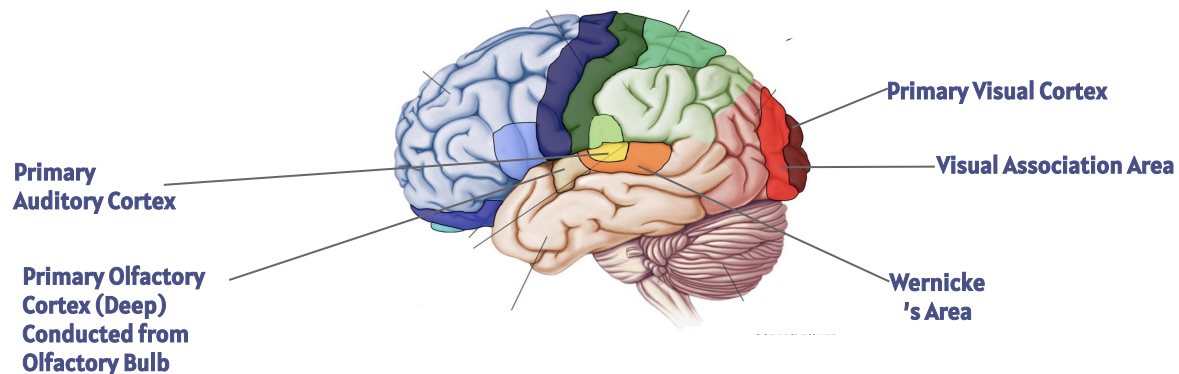
### Region

#### 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.





# Dominant and Non-dominant Hemisphere

Functional differences between left and right hemispheres

## Left cerebral hemisphere

**In most people, left hemisphere (dominant hemisphere) controls:**  
reading, writing, and math,  
decision-making, logic, speech  
and **language (usually)**



## Right cerebral hemisphere

**Right cerebral hemisphere relates to:**

1. understanding & interpreting music
2. Non verbal visual Experience (facial expression , gesture)
3. Spatial relation between the person & their surroundings
4. Body language and intonation of peoples voices



# Cerebrum

## Functional Principles of the Cerebral hemispheres

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

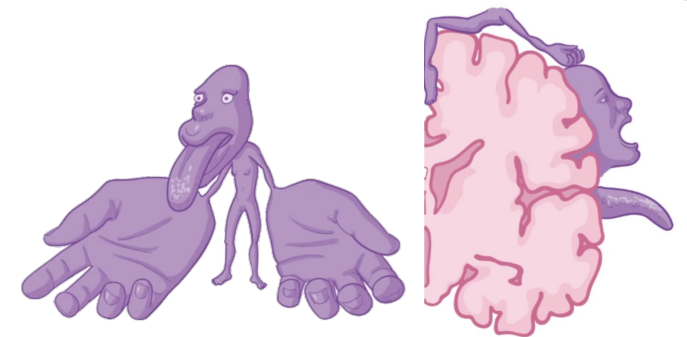
The 2 hemispheres have somewhat different functions although their structures are alike.

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.

Primary  
motor  
cortex

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



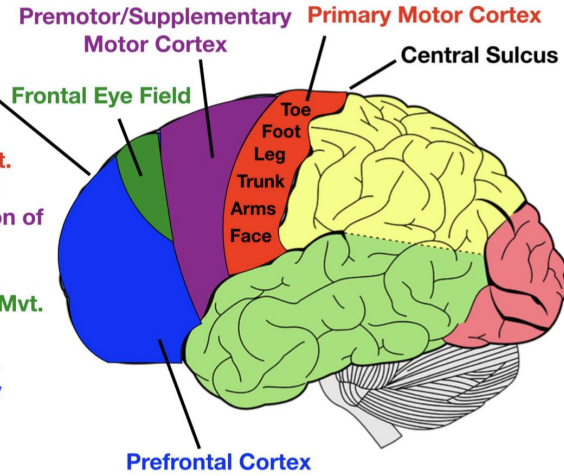


# Summary

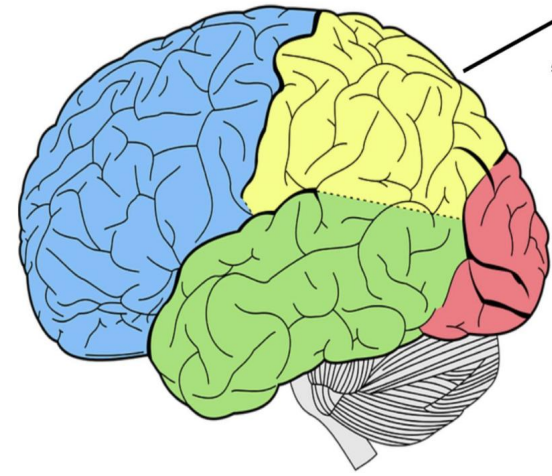
## Frontal

### Functional Areas

- Primary Motor Cortex
- Voluntary Muscle Mvt.
- Premotor/S.M.C (MAC)
- Planning/Coordination of Movement
- Frontal Eye Field
- Voluntary Rapid Eye Mvt.
- Prefrontal Cortex
- Executive Functions, Behavior, Personality



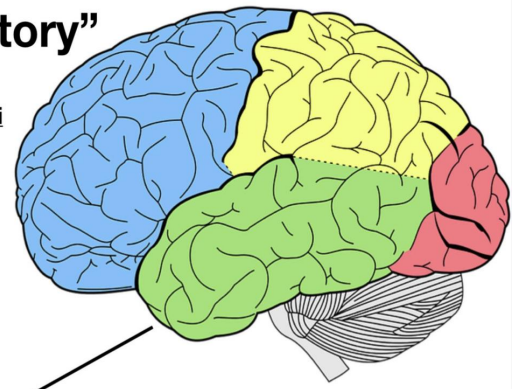
## Function: "Somatosensory" Parietal



- Awareness of Somatic Sensation
- Touch, Pain, Temperature, Pressure, Vibration
- Processing Somatic Sensation
- Analyzing, Recognizing, Memory of Somatic Sensation
- Proprioception
- Coordination of Visual, Auditory, and Somatosensory Stimuli
- Spatial & Body Awareness

## Function: "Auditory"

- Awareness of Auditory Stimuli
- Hearing Sounds
- Pitch, Frequency
- Processing Auditory Stimuli
- Analyzing, Recognizing, Memory of Auditory Stimuli



## Temporal



# TEST YOURSELF !

**Q1) Which of the following areas responsible for word formation?**

A) Broca's area

B) Wernicke's area

C) Premotor cortex area

D) Somatosensory cortex area

**Q2) which one of the following located in the parietal loop?**

A) Hearing center

B) Motor center

C) Somatosensory area

D) visual center

**Q3) Damage to the following area causes decrease in motor ability to speak**

A) Broca's area

B) Wernicke's area

C) Somatosensory area

D) Temporal lobe

**Q4) Which will be seen in Temporal lobe damage?**

A) Motor aphasia

B) Visual loss

C) Somatosensory loss

D) Hearing loss

Q1) A  
Q2) C  
Q3) A  
Q4) D



**SAQ**

**Mention the Functional differences between left and right hemispheres**

slide 18

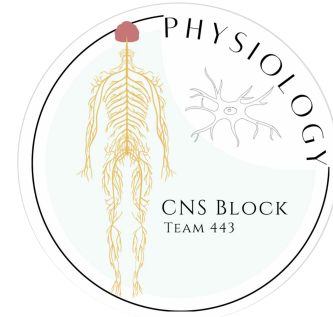
**Mention the function of Prefrontal association area**

slide 12

**List the cerebral cortex layers**

slide 9

# Team Leaders



 **Aseel Alsaif**

 **Aldanah Alghamdi**

 **Huda bin Jadaan**

 **Sultan Albaqami**

 **Fahad Almughaiseeb**

 **Hamad Alziyadi**

# Team Members

Bayan Alenazi

Renad alshehri

**Layan Alruwaili**

Norah Alhazzani

Haya Alzeer

Huda bin Jadaan

Haya Alajmi

Reena alsadoni

AlJoharah AlWohaibi

Raghad almuslih

Rahaf Alslimah

Jana Alshiban

Razan Alsoteehi

Lena Alrasheed

Layan Aldosary

Shahad Alzaid

Norah Almania

Lama Almutairi

Raghad Alhamid

Layla Alfrhan

Farah Aldawsari

Manar Aljanubi

Waad Alqahtani

Salma Alkhlassi

Shoug Alkhalifa

Sarah Alajajii

Sarah Alshahrani

Wafa Alakeel

Reemaz Almahmoud

Sarah Alshahrani

Hamad Alyahya

Mishal aldakhail

Ziyad Alsalamah

Omar Alamri

sultan almishrafi

Mohammad Alzahrani

Khalid Alanezi

sami Mandoorah

Abdullah alzamil

Mohammed Alqutub

Mohammed Bin Manee

Salmam Althunayan

faisal alzuhairy

Mohammed Alarfaj

Ryan alghizzi

Mohammed Maashi




Zeyad Alotaibi

**Nazmi Adel Alqutub**

Faisal Alshowier

Ziad Alhabardi

Osamah almubbadel

 Special Thanks to Physiology Team441  
 Team logo and design was done by Rafan Alhazzani  
 Thanks to ALEEN ALKULYAH for Helping with the design!

 [med443physioteam@gmail.com](mailto:med443physioteam@gmail.com)