Physiology Team 439

MED439
KING SAUD UNIVERSITY

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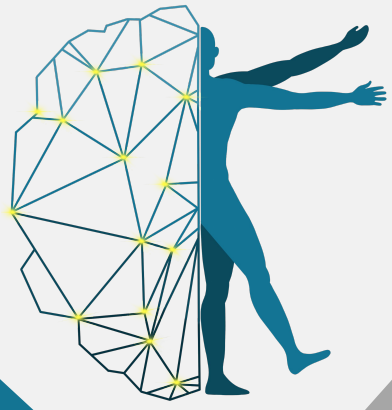


Functions of Cerebral Hemispheres

Objectives:

- Understand that the nervous system can be classified in more than one way
- Know Functional Anatomy of the CNS
- Orientation of the cerebral cortex and spinal cord functions.
- Know that much of human physiology can be learned from observing the consequences of human lesions & diseases.
- Be able to explain what is meant by telencephalon, diencephalon, brainstem, basal ganglia, cerebellum and spinal cord; & outline their function
- Understand that the functions of the cerebral hemisphere
- Know Functional Anatomy and functions of Cerebral lobes .

boys doctor:
the important things in this lecture are:
1- association areas
2- cerebral dominance

Color index:

- Important.
- Girls slide only.
- Boys slide only.
- Dr's note.
- Extra information.

Editing File

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.

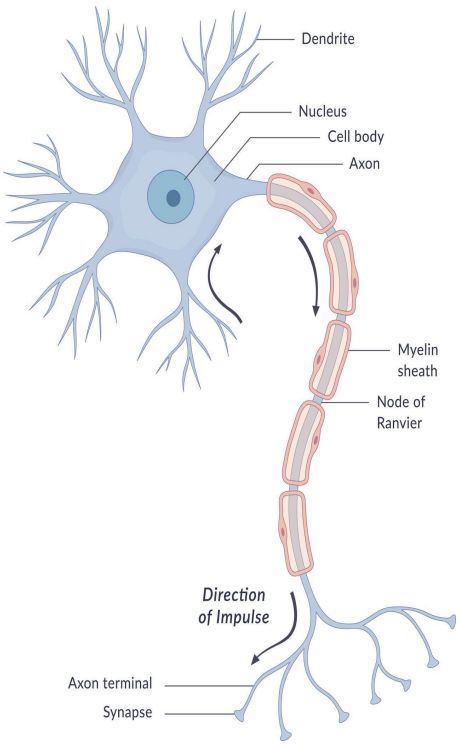
Nervous tissue:
Highly cellular

1. Neurons
Functional, signal conducting cells

2. Supporting cells

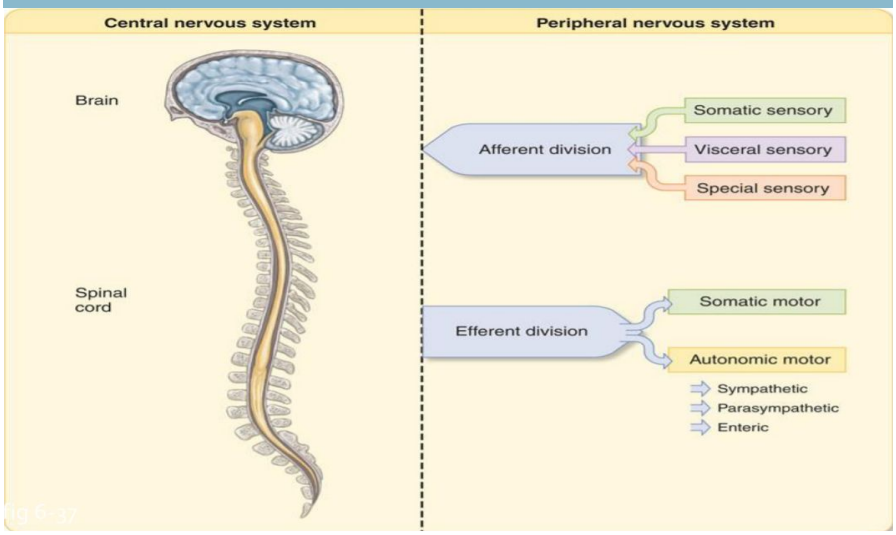
Neurons:

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



The Nervous System

Nervous system organization:



Basic Functions of the Nervous System:

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

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

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

Classification of the Nervous System:

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

The Nervous System: Brain regions

Brain Regions:

Cerebrum ,Diencephalon ,Brainstem ,Cerebellum

01 Telencephalon

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

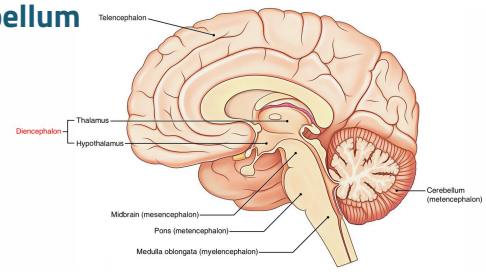
02 Diencephalon

(1) Thalamus (mainly a relay station for sensory pathways in their way to the cerebral cortex)
(2) Hypothalamus (contains centers for autonomic and endocrine control)

03 Brain stem

(1) Midbrain
(2) Pons
(3) Medulla

04 Cerebellum



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

Functions:

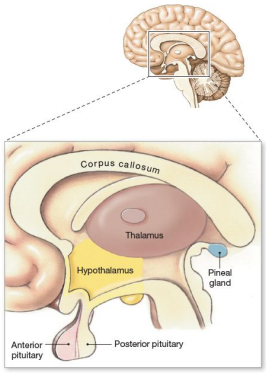
1-Autonomic regulatory centre
-Influences HR, BP, resp. rate, GI motility, pupillary diameter

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.

The Nervous System: Brain regions

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Brainstem:*

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

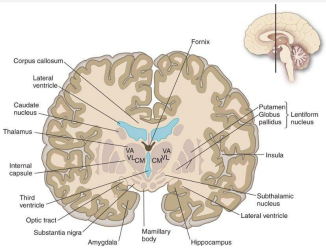
Functions include:
1. regulation of Consciousness , Wakefulness & Sleep
2. Respiratory , Cardiovascular and Gastrointestinal control
3. Balance (Vestibular nuclei)
4. Moreover, it contains several Cranial Nerve nuclei.

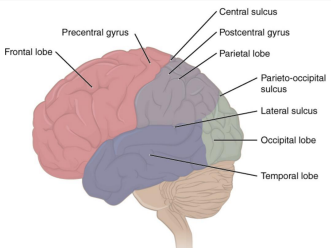
Cerebellum:*

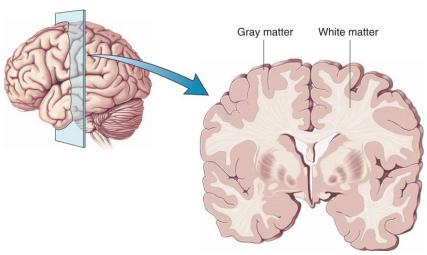
Important for coordination of body movements and balance.
It forms the centre where the learned movements are stored.

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.







The Nervous System: Cerebrum

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Cerebral Cortex Layers:

I	**Molecular layer**
II	**The external granular layer** — short processes, mainly interneurons
III	**Layer of pyramidal cell**
IV	**Internal granular layer**
V	**Large pyramidal cell layer**
VI	**Layer of fusiform or polymorphic cells**

layer IV is the receptive layer.
I, II and III contains a lot of interneurons

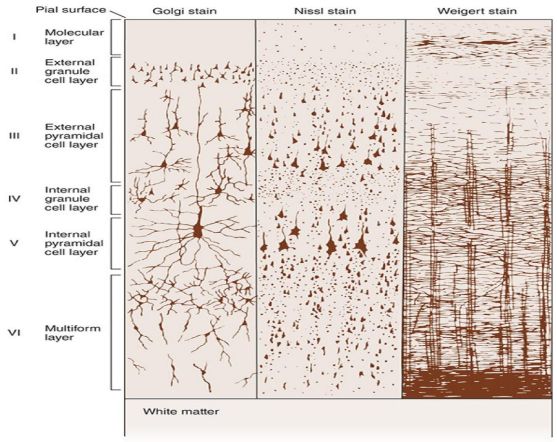
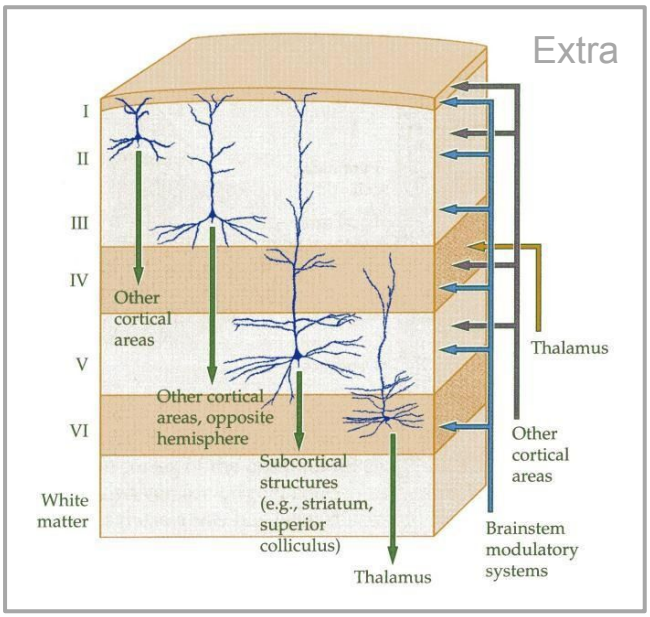


FIGURE 14–1 Structure of the cerebral cortex. The cortical layers are indicated by the numbers. Golgi stain shows neuronal cell bodies and dendrites, Nissl stain shows cell bodies, and Weigert myelin sheath stain shows myelinated nerve fibers. (Modified with permission from Ranson SW, Clark SL: *The*

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



The Nervous System: Cerebrum

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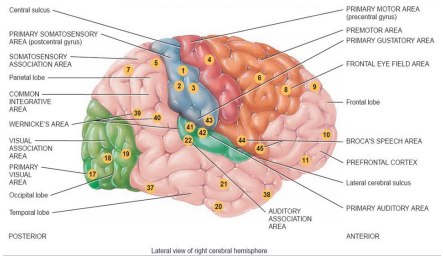


Areas of Brain

Primary areas:

1-The primary motor areas:
have direct connections with specific muscles for causing discrete muscle movements.

2-The primary sensory areas:
detect specific sensations— visual, auditory, or somatic—transmitted directly to the brain from peripheral sensory organs.

primary areas are mainly for perception of stimuli

Secondary areas*

make sense out of the signals in the primary areas.
like supplementary area
for sensation to detect shape and texture

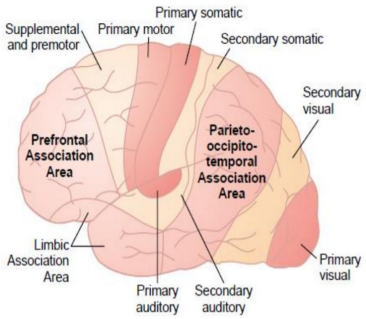
Association areas

receive and analyze signals simultaneously from multiple regions of both the motor and sensory cortices as well as from subcortical structures.
like in vision, association area is important to detect intensity of light, angles and so on

association areas were called tertiary but because they don't fit in primary or secondary their called association areas

Association Areas:

The most important association areas are:
(1) Prefrontal association area
(2) Parieto-occipitotemporal association area
(3) Limbic association area.



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)

lesion in this area can cause:
1- loss of prediction
2- loss of planning for future
3- personality changes
4- engaging in inappropriate acts in an inappropriate place and time

Lesions in this area lead to change in personality and behavior

working memory زي لما شخص يشوف رقم ويحفظه وبعدها يحط الرقم بالجوال ويتصل

Association Areas

2-Parieto-occipitotemporal Association Areas:

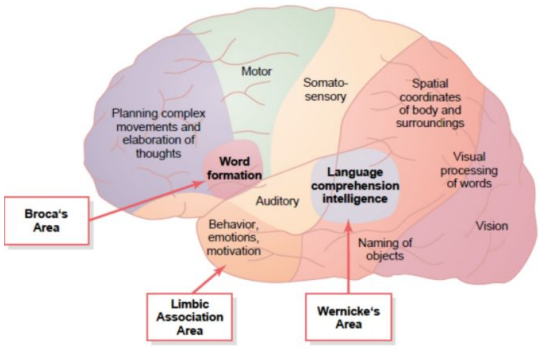
Area (Important)	Site	Function (Important)
Analysis of the Spatial Coordinates of the Body	beginning in the posterior parietal cortex and extending into the superior occipital cortex	computes the coordinates of the visual, auditory, and body surroundings
Area for Language Comprehension	Wernicke's area, lies behind the primary auditory cortex in the posterior part of the superior gyrus of the temporal lobe	higher intellectual function the most important area for intellectual functions
Area for Initial Processing of Visual Language (Reading)	angular gyrus area	make meaning out of the visually perceived words (lesion causes Dyslexia or Word Blindness)
Area for Naming Objects area for naming objects is adjacent to occipital and temporal lobes for detection physical nature of objects by vision and for auditory stimuli respectively	Lateral portion of anterior occipital lobe & posterior temporal	naming objects

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.

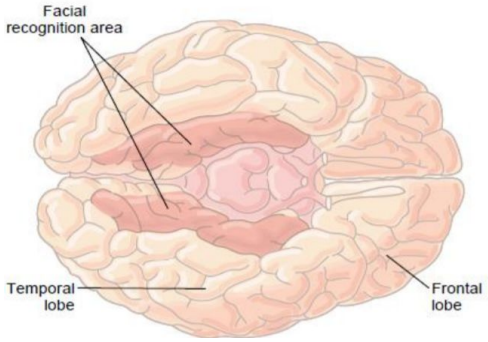
Lesion of this area may lead to decreased aggression, lack of emotion, hypersexuality & hyperphagia. also called reward and punishment area



Area of Recognition of Faces:

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

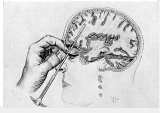


Lobes of the Brain

Frontal

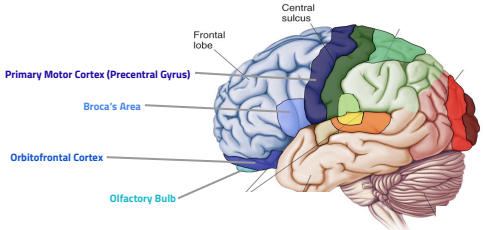
Location	Deep to the frontal bone of the skull
Function	• Memory Formation working memory • Emotions limbic system • Decision Making prefrontal • Reasoning and intellect • Personality prefrontal
Cortical Regions	**Primary Motor Cortex (Precentral Gyrus) :** Cortical site involved with controlling movements of the body. **Broca's Area :** plan of motor pattern for expressing of individual words. 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

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.



Desired Effects	Possible Side Effects
Diminished Rage	Epilepsy
Decreased Aggression	Poor Emotional Responses
Poor Emotional Responses	Perseveration (Uncontrolled, repetitive actions, gestures, or words)

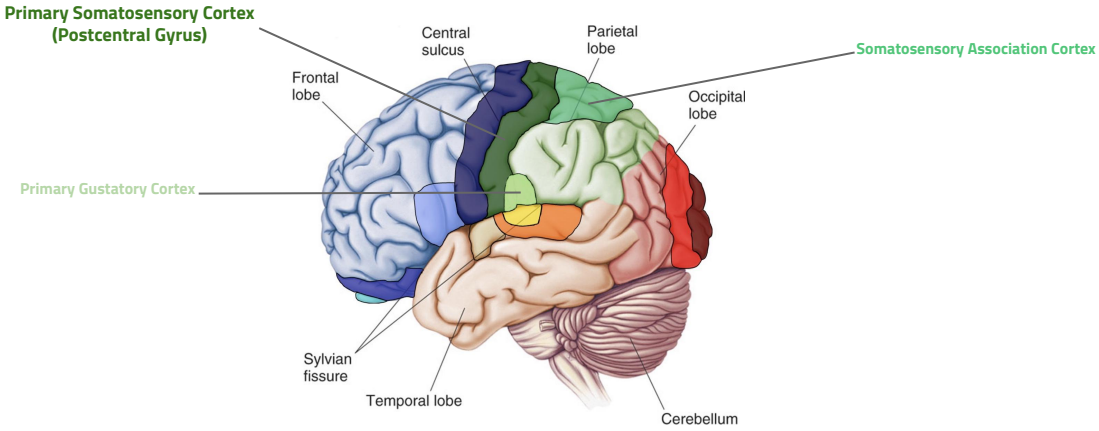
Olfactory Bulb:
Cranial Nerve I, Responsible for sensation of Smell.



Lobes of the Brain cont...

Parietal

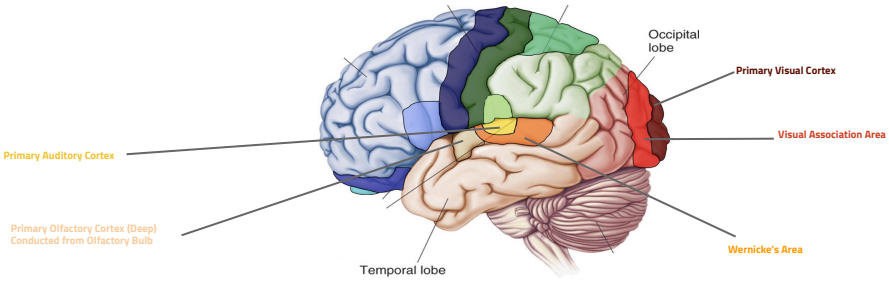
Location	deep to the Parietal Bone of the skull
Function	• Senses and integrates sensations • Spatial awareness and perception (Proprioception - Awareness of body/ body parts in space and in relation to each other)
Cortical Regions	**Primary Somatosensory Cortex(Postcentral Gyrus)** Site involved with 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. **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 objects . called stereognosis • When damaged , the person loses the ability to recognize shapes of complex objects by palpation (palpation = examination of objects by touch) & also develops Sensory Inattention on **opposite side.** also called sensory negligence • 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.



Lobes of the Brain cont...

Occipital

Location	deep to the Occipital Bone of the Skull.
Function	Its primary function is the processing, integration, interpretation of **VISION** and visual stimuli.
Cortical Regions	**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.



Temporal

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)
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 (dominant hemisphere) Understand auditory and visual information and send them to Broca's area. Information Retrieval (Memory and Memory Formation)
Lesion	• **Wernicke's Aphasia** Language comprehension is inhibited. The individuals have difficulty understanding written and spoken language. difficulty in understanding language • Memory impairment. • can be associated with temporal lobe epilepsy.

Functional Principles of the Cerebral hemispheres*

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1. Each cerebral hemisphere receives sensory information from, and sends motor commands to, the opposite side of body.
2. The 2 hemispheres have somewhat different functions although their structures are alike.
3. Correspondence between a specific function and a specific region of cerebral cortex is not precise.
4. No functional area acts alone; conscious behavior involves the entire cortex.

Dominant (categorical hemisphere) & Non-dominant (representational) Hemisphere

- **Functional differences between left and right hemispheres**
- **In most people, left hemisphere (dominant hemisphere)controls:**
  reading, writing, and math, decision-making, logic, speech and language (usually)
- **Right cerebral hemisphere relates to:**

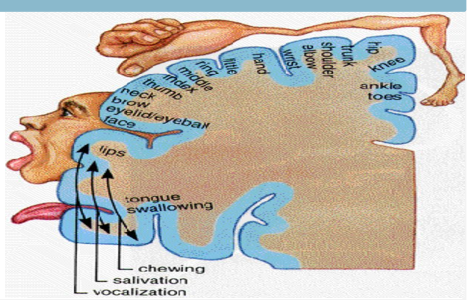
1. understanding & interpreting music
2. Non verbal visual Experience (facial expression , gesture)
3. Spatial relation between the person & their surroundings
4. Body language and intonation of peoples voices

96% of right handed individuals are left dominant
4% are right dominant
70% of left handed individuals are left dominant
15% are right dominant
15% are co-dominant

right cerebral hemisphere is mainly for satisfaction like music and art
it is postulated that if the dominant hemisphere got damaged early in life the non dominant hemisphere can take its functions

Primary Motor Cortex*

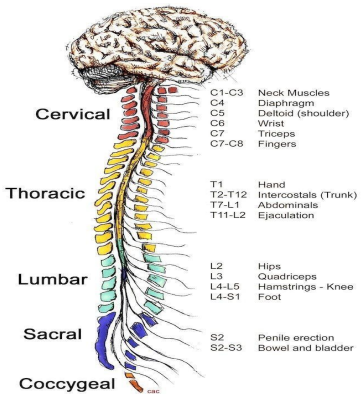
This graphic representation of the regions of the Primary Motor Cortex and Primary Sensory Cortex is one example of a HOMUNCULUS.



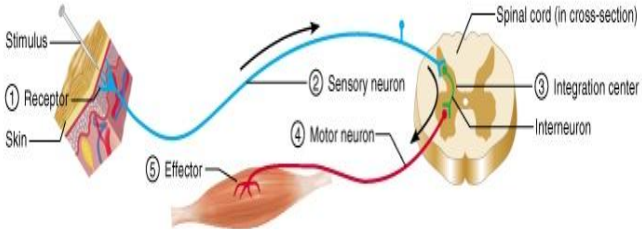
Spinal Cord and Spinal Nerves

The spinal cord is generally cylindrical in shape From it emerge 31 pairs of spinal nerves:

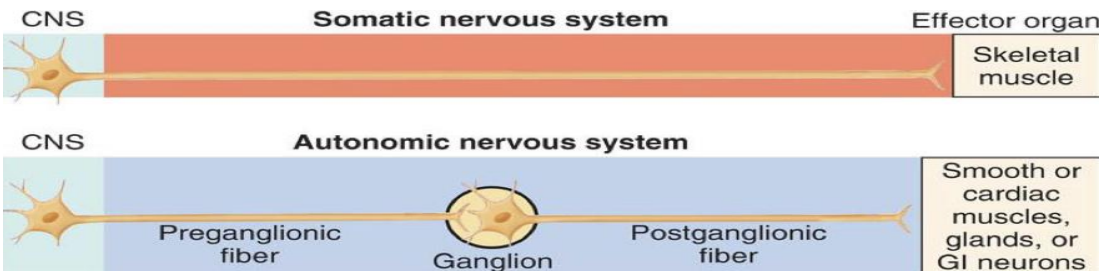
- 8 cervical
- 12 thoracic
- 5 lumbar
- 5 sacral and
- 1 coccygeal



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.

Summary

Lesions	Location	Causes or symptoms
Dyslexia	Area for Initial Processing of Visual Language (Reading) In Parieto-occipitotemporal association area	Word Blindness
Lesion in Prefrontal Association Area	Prefrontal Association Area	change in personality and behavior
	Limbic Association Area reward and punishment area	decreased aggression , lack of emotion , hyper sexuality & hyperphagia
prosopagnosia	on the underside of the brain on the medial occipital and temporal lobes "Area of Recognition of Faces"	Inability to recognize faces
Broca's Aphasia	Located on Left Frontal Lobe At the lower end of premotor area.	Results in the ability to comprehend speech, but the decreased motor ability (or inability) to speak and form words.
Lesion of somatosensory area sensory negligence	Parietal Lobe	the person loses the ability to recognize shapes of complex objects by palpation (palpation = examination of objects by touch)& also develops Sensory Inattention on opposite side
Wernicke's Aphasia	Temporal Lobe At the posterior end of the superior temporal gyrus	Language comprehension is inhibited. The individuals have difficulty understanding written and spoken language

MCQ & SAQ:

Q1: Which layer of the cerebral cortex is first to be stimulated by the incoming signal?
A. III
B. IV
C. II
D. V

Q2: Damage to which of the following area causes decrease in motor ability to speak?
A.Wernicke's area
B.Broca's area
C. Parietal lobe
D. Somatosensory area

Q3: Which area is responsible for higher intellectual function?
A. Area for reading
B. Area for naming objects
C. Area for language comprehension
D. Area for Analysis of the Spatial Coordinates of the Body

Q4: The primary auditory cortex lies primarily in which lobe of the cerebral cortex?
A.Limbic lobe
B.Occipital lobe
C.Parietal lobe
D.Temporal lobe

Q5: Which area is located on the underside of the brain on the medial occipital and temporal lobes?
A. Prefrontal
B. Limbic
C. Recognition of faces
D. Parieto-occipital

Q6: Which of the following is located in Parietal lobe?
A. Primary Visual Cortex
B. Primary Motor Cortex
C. Primary Gustatory Cortex
D. Wernicke's Area

answer key:
1: B
2: B
3: C
4: D
5: C
6: C

1- What are the main association areas of the brain?

2- What is the function of each?

3-What happens if Wernicke's area is damaged?

4- What are the major areas of the Temporal lobe?

A1: prefrontal, parieto-occipitotemporal, limbic

A2: slide 10-11

A3: Language comprehension is inhibited. The individuals have difficulty understanding written and spoken language.

A4: 1- Primary Auditory Cortex
2- Primary Olfactory Cortex
3-Wernicke's Area

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- Abdulaziz Alomar.
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- Abdullah Alanzan.
- Abdullah Alhumimidi.
- Abdulrahman Almegbel.
- Abdulrahman Barashid.
- Abdulrhman Alsuhaibany.
- Abeer Awwad.
- Ahmad Alkhayatt.
- Aljoharah Albnyan.
- Aljoud Algazlan.
- Almaha Alshathri.
- Arwa Al-Qahtani.
- Bader Alrayes.
- Bassam Alasmari.
- Bushra Alotaibi.
- Faisal Jazzar.
- Feras Alqaidi.
- Ghaida Alassiry.
- Ghaida Alshehri.
- Hamad Almousa.
- Haya Alanazi.
- Hind Almotywea.
- **Ibraheem Altamimi.**
- Ibrahim Alnamlah.
- **Joud Alarifi.**
- Khalid Altowaijeri.
- Khalid Almutlaq.
- Leen AlMadhyani.
- May Barakah.
- Mohamed Alquhidan.
- Mohammed Alkathiri.
- Murshed Alharby.
- Nada Bin Obied.
- Norah Alsalem.
- Norah Aldakhil.
- Nouf Alsubaie.
- Noura Alshathri.
- Nurah Alqahtani.
- Omar Alhalabi.
- Raed Alnutaifi.
- Rayan Jabaan.
- Reem Alqahtani.
- Sarah AlQuwayz.
- Saud Alhasani.
- Shaden Alobaid.
- Shahd Almezel.
- Shatha Aldossary.
- Shayma Alghanoum.
- Tarfah Alkaltham.
- Yara Alasmari.
- Yara Alomar.
- Yara Alzahrani.
- Yazeed Alqahtani.
- ziyad Alhosan.

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