9. Higher function of Neocortex.

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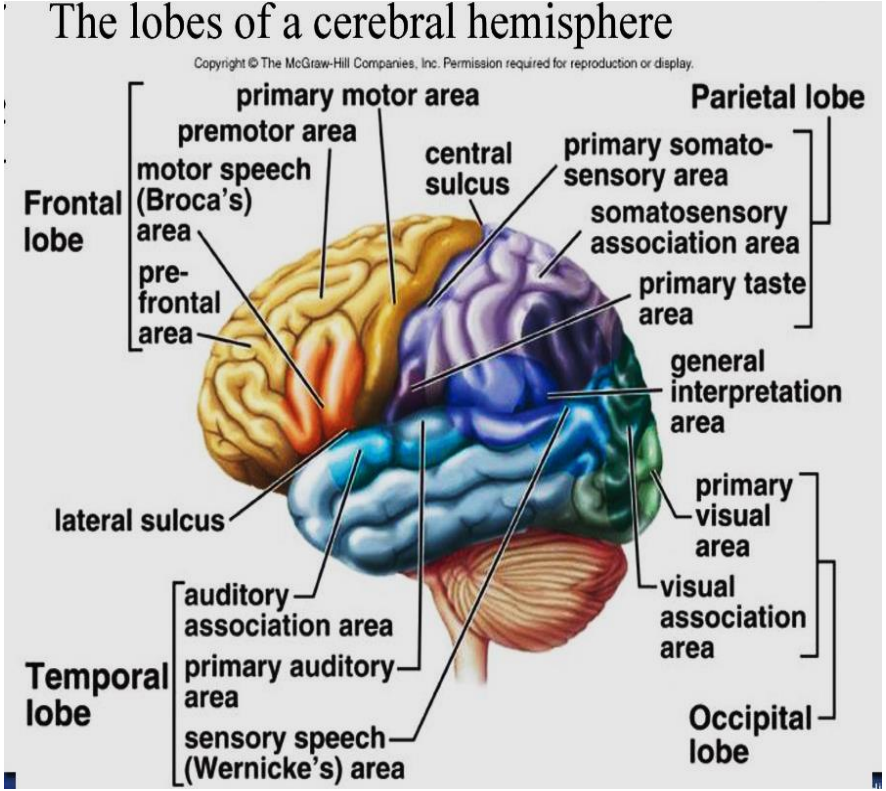
-In the human brain, the **neocortex** is the largest part of the cerebral cortex, which is the outer layer of the cerebrum. The neocortex is made up of **six layers**, labelled from the outermost inwards, I to VI.

- The neocortex is divided, into **frontal, parietal, occipital, and temporal lobes**, which perform different functions.

-For example, the **occipital lobe** contains the **primary visual cortex**, and the **temporal lobe** contains the **primary auditory cortex**. Further subdivisions or areas of neocortex are responsible for more specific cognitive processes. In humans, the frontal lobe contains areas devoted to complex language processing localized to the ventro-lateral pre-frontal cortex (**Broca's area**). The neocortex has also been shown to play an influential role in **sleep, memory and learning** processes. **Memories** appear to be stored in the neocortex, specifically the anterolateral temporal lobe of the neocortex.


The lobes of a cerebral hemisphere
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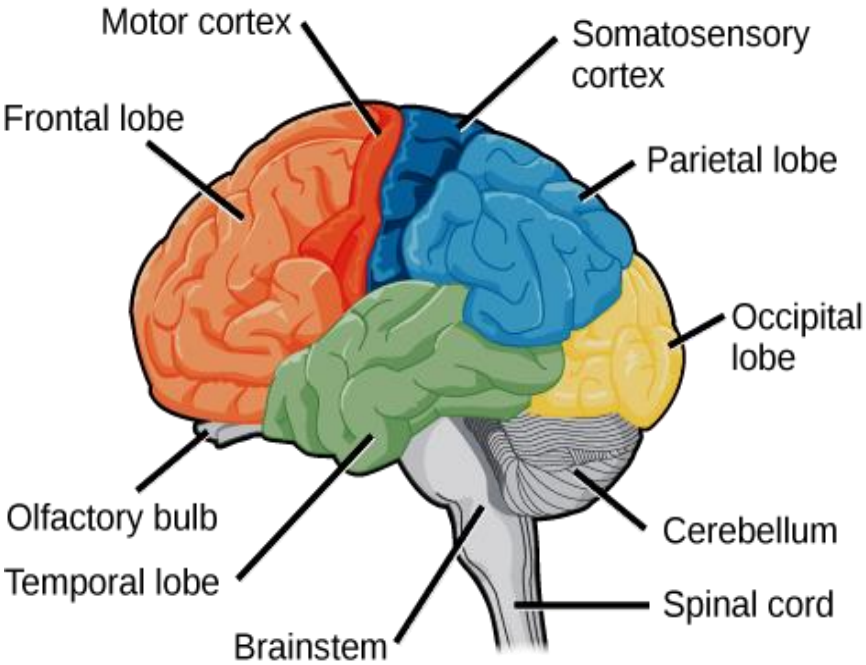
primary motor area
premotor area
motor speech (Broca's) area
pre-frontal area
Frontal lobe
central sulcus
Parietal lobe
primary somato-sensory area
somatosensory association area
primary taste area
general interpretation area
lateral sulcus
primary visual area
visual association area
auditory association area
primary auditory area
sensory speech (Wernicke's) area
Temporal lobe
Occipital lobe


Motor cortex
Somatosensory cortex
Frontal lobe
Parietal lobe
Occipital lobe
Olfactory bulb
Temporal lobe
Cerebellum
Spinal cord
Brainstem

- **The cerebral cortex** surface is greatly increased by presence of **sulci and fissures**.
-The cerebral cortex is formed of **2 cerebral hemispheres** which are separated by the longitudinal fissure .
-In the floor this fissure lies the "Corpus callosum" which connects the two cerebral hemispheres.
The cerebral cortex consists of 4 lobes : **frontal, parietal, temporal and occipital**. And according to physiological studies, **Brodman** divided cerebral cortex into **50** different areas numbered from 1-50 Brodman's area .

[I] <u>The frontal lobe:</u> Contain: -area **4** - area **6** - area **8**

<u>(1) Motor area 4:</u>

-It is the **primary motor** area.
-It occupies the precentral gyrus of the frontal lobe anterior to the central sulcus.
-It is highly **excitable** due to the presence of large pyramidal cells (**Betz cells**).

***<u>Representation of the body</u>:** The body is represented in an **upside down** (**head** is below while lower l**imbs** are up), however the head is in the **<u>correct position</u>** i.e eye brows are up and chin is down and **crossed manner** (Lt. area control Rt. side of the body), and the representation **depends on the activity** of the muscle not depend on size of muscle.

*** Layers of area 4:** The cells are arranged in **6** vertical columns.

- Functions:

1-It is the main origin of the **pyramidal tracts**. 2- Initiate the **fine discrete voluntary** movements.
3-**Facilitates** stretch reflex and muscle tone.

*** lesion of area 4:**

1- Paralysis of the muscles of the **opposite half** of the body . 2- Hypotonia and hyporeflexia ,
3- Appearance of Babinisk's sign .

N.B.: 1-Area **4** shares in the extrapyramidal tract , So activation of area 4 after pyramidal tract lesion give response.

2-Muscles of the body which act together as respiratory muscles are **bilaterally** represented in area **4** of both sides.

3-In area **4** there is representation of the movement rather than representation of isolated muscles .i.e. stimulation of certain site of area 4 causes contraction of whole flexors or extensors rather than contraction of certain muscle.

4-Excitability of area 4 is **increased** by increased activity of other areas as sensory, visual or auditory area also by **alkalosis**.

5-Excitability of area 4 **decreased** by acidosis, hypoxia or by suppressor areas (4s,8s).

(2) Premotor area 6:

- It lies in front of area 4 (separated by area **4s**). It is less excitable as it contains no Betz cells.

*** Representation:**

The body is represented in an **inverted and crossed** manner but is more rough than in area 4.

*** Functions:**

1-It is the main origin of **extrapyramidal** tracts but some origin of pyramidal.

2-It initiates generalized coordinated gross movements on the opposite side of the body.

3-It initiates subconscious associated movement as swinging of arm during walking.

4-It helps areas 4 in performing and initiating isolated skilled voluntary movements.

5-It **inhibits** muscle tone & stretch reflex. 6-It inhibits the grasp reflex.

7-It produces autonomic function on HR & ABP.

8- **It contains important areas:**

a- ***Broca's area:*** (word formation areas)(area **44**) it lies immediately anterior to area 4 and above the sylvian fissure in the dominant hemisphere, it is connected to area 4 to control movement of **speech muscle**.

b- ***Eye movement area:*** Lies above the Broca's area, it is concerned with voluntary moving of the eye towards objects, also control eyelid movements.

c- ***Head rotation area:*** Lies above eye movement area, it is concerned with directing the head towards different objects.

d- ***Hand skilled area:*** Lies anterior to area 4 (region of hand & finger). The **memory for voluntary skilled movements** of the hand is retained in this area.

e- ***Exner's area 45*** **(writing center)**: Lies above Broca's area, it control the movements of arm muscle during writing via connection with area 4.

*** Lesion of area 6:**

1-**Paresis** (sever muscle **weakness**) in opposite side. 2-**Increase** muscle tone and exaggerated deep reflexes.

3-Reappearance of Babniski's sign (fanning of 4 toes).

4-Motor apraxia: loss of ability to perform skilled educated movement due to damage of hand skilled area.

5-Motor aphasia: the person cannot express himself by **spoken words** due to damage of Broca's area.

6-Loss of co-ordinated movement of eye and head due to lesion in eye movement and head movement areas.

7-Motor agraphia: the person cannot express himself by **written words** = damage of Exner's area **45**.

8-Autonomic disturbances. 9-Reappearance of Grasp reflex

(3) Area 8 (frontal eye field)

-It occupies the posterior part of the middle frontal gyrus.

- It is responsible for conjugate deviation of both eyes in the opposite side and share in accommodation reflex to near vision . - It is the origin of the **cortico-nulcear tract**.

[II] The parietal lobe:

Contains: -Sensory area 3, 1, 2 (area I). -Sensory area II -Sensory association area.

[A] Primary somatic area:

(1) Somatic sensory area I: In the post central gyrus of cerebral cortex (area 3, 1, 2).

***Representation of the body:** The body is represented in an **upside down** and **crossed manner** and large area for lips, face and fingers especially thumb. according to tactile acuity and number of receptors All sensations from any part of the body are represented in its area.

*** Functions:**

It receives impulses from PVNT so act a center for fine touch, proprioceptive sensation, vibration, fine gradations of temp.

*** lesion:** At first loss of all sensations in **opposite side**, then the protopathic sensations only are recovered.

***(2) Somatic sensory area II*:** In upper wall of lateral fissure inferior to postcentral gyrus.

Representation: of the body is less sharp than area I and **face** lies anteriorly, **arm** centrally while **legs** posteriorly.

Functions: - A cortical center of **pain**.
- Play a role in sensory control of motor function.

It receives impulses from **both sides** of the body, from sensory area - I and from visual and auditory area.

[B] Somatic association area: (area 5 & 7*):* *In* parietal cortex behind sensory area I.

Function*:* receive impulses from sensory area I, PVNT and visual & auditory cortex. So it is concerned with the meaning of sensory information (**stereognosis**). **Lesion:** causes **Asteriognosis**: failure to recognize any object.

[III] The temporal lobe:

contains: -Auditory sensory area (area 41 & 42) (concerned with **hearing sensation** from both sides).
-Auditory psychic area (area 22) (concerned with **interpretation** of auditory impulses).

[IV] The occipital lobe: contains: -Visual sensory area (area 17) , which is the primary visual center)
- Visual association area (area 18 & 19) , which is concerned with **interpretation** of visual impulses)

- ***The parieto-temporo-occipital association area: (Wernike's area or area 37)***

-It is concerned with **interpretation** of different sensations and present in the supra-marginal and angular gyri.

-It receives impulses from: • somatic association areas (area **5,7**) parietal
• visual interpretative areas (area **18, 19**) occipital. • auditory interpretative areas (**area 22**) temporal.

-This area is more developed in **one hemisphere** (dominant hemisphere) (left side in right handed people) and concerned with **speech**.

- **Lesion** leads to failure to **pick up meaning of spoken & written words** with **aphasia**.

Speech

-It represents the highest function of cerebral cortex. -It may be in the form of written or spoken words.

***Centres of speech**: (in the dominant hemisphere)

(1) Sensory speech centres:

a-Visual speech centres (area 18, 19) in occipital lobe to understand written words.

b-Auditory speech centres (area 22) in temporal lobe to understand spoken words.

(2) General interpretative area *(Wernik's area)*

-Responsible for understanding the meanings and beginning the response to these words.

-It is a connection between sensory and motor centers.

(3) Motor speech centers:

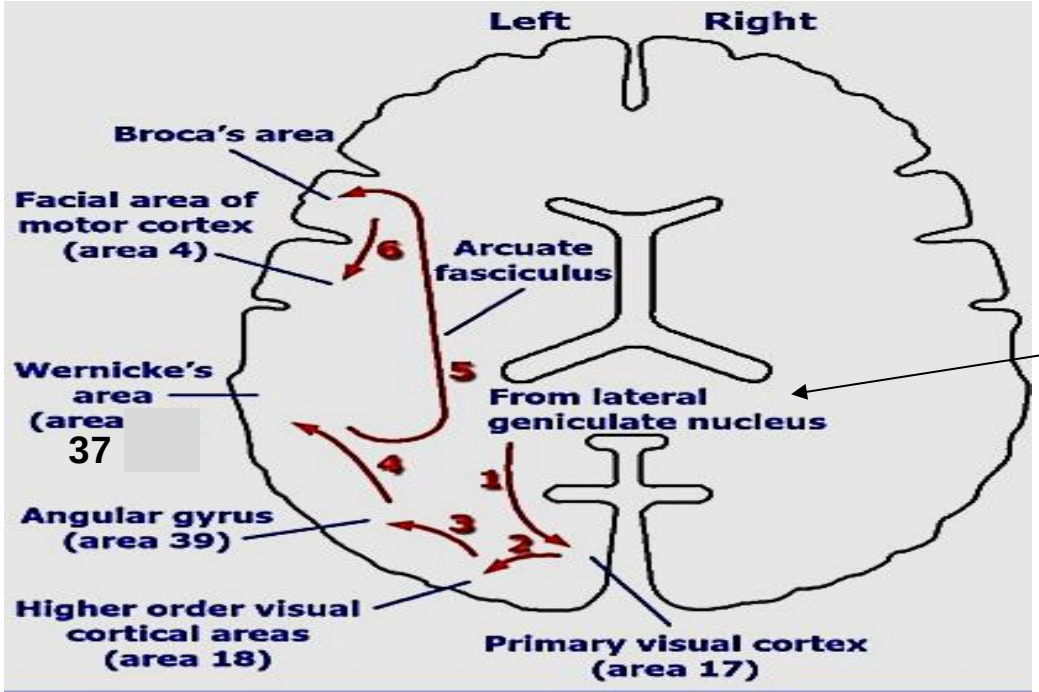
a-Broca's area: (face region in premotor area 6) essential for **vocalization** of speech.

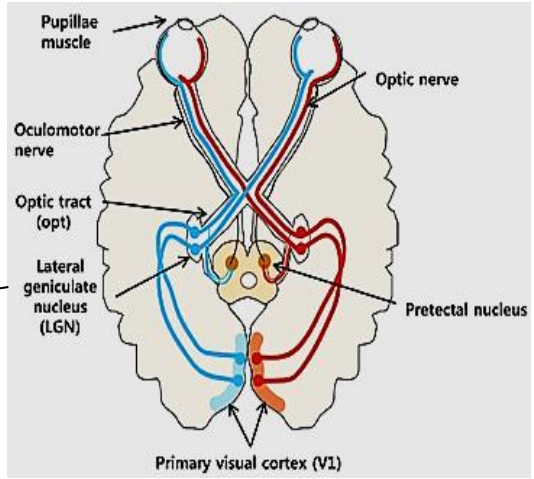
b-Exner's area: (Hand region in premotor area 6) essential for expression of speech by **writing**.

***Act of speech:**

(1) Spoken speech:

Autitory sensory areas (areas **41 & 42**) perceive the spoken words → auditory association areas (area **22**) to understand words → general interpretative area (**Wernicke's area**) to understand the meaning and begin response by → impulse to Broca's area to produce words → face area in area 4 → pyrmaidal tract to cranial nerve nuclei → to speech ms. (muscles of lips, tongue and larynx) → **spoken speech**.





(2) Written speech:

Visual sensory area (area17) perceive written words → visual association areas (18, 19) to understand → general interpretative area (Wernicke's area) to full comprehension → Exner's area → hand area in motor cortex → pyramidal & extrapyramidal tracts to AHCs of hand ms. → expression of speech by writing.

*** Aphasia = disturbance of speech:**

It is the inability to express thoughts by **spoken or written** words due to vascular lesion in the dominant hemisphere.

(1) Sensory Aphasia:

(a) Visual aphasia: (word blindness)

- The patient sees but can't understand written words.
- Due to lesion in visual speech centres (18, 19).

(b) ***Auditory aphasia****: (word deafness)*

-The patient hears but can't understand spoken words. -Due to lesion in **auditory speech centers** (22)

(c) ***General sensory aphasia****: (more common)*

- The patient fails to understand and interpret the meaning of words and fails to express his thoughts into words.
- Due to lesion in general interpretative area.

(2) Motor aphasia:

(a) ***Broca's aphasia****: (Verbal or vocal)*

-The patient understands spoken or written words and knows what he wants to say but he can't express himself by spoken words.

-Due to lesion in Broca's area (area 44) (speech ms. are intact).

(b) ***Agraphia****:*

-The patient understands spoken or written words and knows what he wants to write but he can't express himself by written words.

-Due to lesion in Exner's area (area 45) (Hand ms. are inatct).

(3) Global aphasia: -This is combination of **sensory & motor** aphasias due to excessive cerebral lesions.

Memory

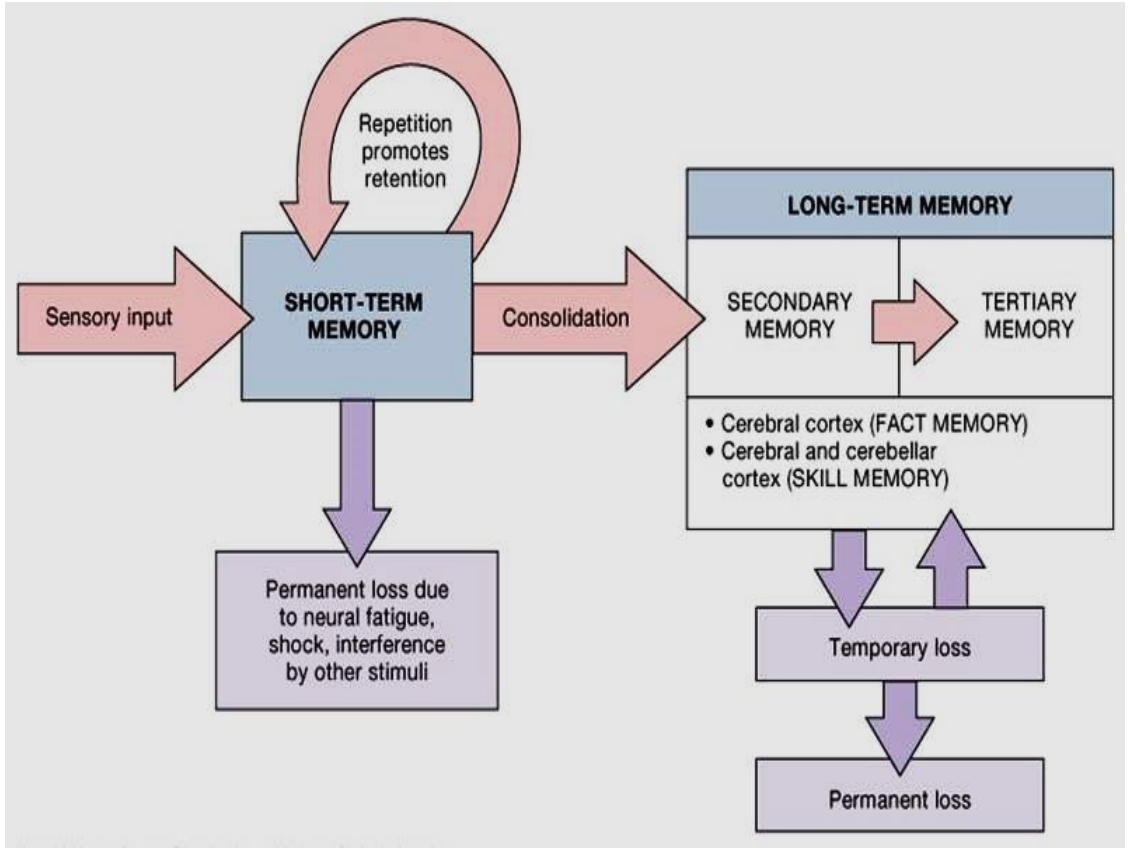
- Memory can be defined as **positive recollections** of the previous thoughts or educated information due to proper stimulation.
- **Negative memory:** by the **basal limbic region** which determine the information is important or no, the brain ignore many information and remember one memory only at certain moment.

- **Memory can be classified into:**

(1) Immediate memory:

-Such as remember telephone number for few seconds .

-The mechanism is reverberating circuit or presynpatic facilitation (prolonged Ca^{++} channel openning).



2) Short-term memory:

-Which lasts for **few minutes** up to days due to temporary changes in either presynaptic or postsynaptic membranes of certain neurons.

The process includes:

1) Stimulation of the facilitator neurons cause release of serotonin.

2) **Serotonin** activates a receptors in the sensory terminals causing activation of adenyle cyclase enzyme which leads to formation of cyclic AMP.

3) **Cyclic A.M.P** activates protein kinase in cell membrane causes phosphorylation of some proteins in cell membrane which leads **to blockage of potassium channels** in cell membrane .

4) Blockage of K^+ channels leads to prolongation of action potential in pre-synaptic terminal with subsequent prolonged activation of **Ca^{++} pores** leads to maintained Ca^{++} influx with more and maintained release of chemical transmitter on postsynaptic neurons.

(3) Long-term memory:

Actually is due to **actual structural changes** at the synapses,

1) Permanent adhesion of synaptic vesicles to the pre-synaptic membrane .

2) Marked increase in surface area of pre-synaptic membrane which across it release of transmitter occur

3) Increase in enzymes and in protein synthesis which activate processes of transmitter formation and release.

Long-Term vs Short-Term Memory

CHARACTERISTIC	SHORT-TERM MEMORY	LONG-TERM MEMORY
Time of Storage after Acquisition of New Information	Immediate	Later; must be transferred from short-term to long-term memory through consolidation; enhanced by practice or recycling of information through short-term mode
Duration	Lasts for seconds to hours	Retained for days to years
Capacity of Storage	Limited	Very large
Retrieval Time (remembering)	Rapid retrieval	Slower retrieval, except for thoroughly ingrained memories, which are rapidly retrieved
Inability to Retrieve (forgetting)	Permanently forgotten; memory fades quickly unless consolidated into long-term memory	Usually only transiently unable to access; relatively stable memory trace
Mechanism of Storage	Involves transient changes in functions of pre-existing synapses, such as altering amount of neurotransmitter released	Involves relatively permanent functional or structural changes between existing neurons, such as formation of new synapses; synthesis of new proteins plays key role

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Thank You