Limbic system
نسخة 2023

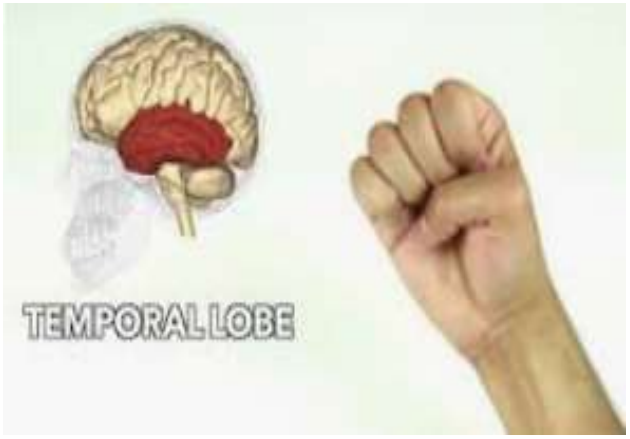
Tricks to remember the structures of the brain

Limbic system is responsible for voluntary and involuntary movement, and all the emotions you feel (love, sadness, likeness, adoration), and is composed of:

1-Premotor cortex: in the frontal lobe, is considered as an engine of movement for the whole body

2-somatosensory cortex: in the parietal lobe, is responsible for the sensation

* There will be immigration of impulses between premotor and somatosensory areas, so if you move you arm (by premotor cortex) you will sense and feel it's position in the space (by somatosensory cortex)



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3- Ocular cortex: in the occipital lobe, is responsible for vision (the impulses start from optic nerve which send them into opticchiasma then to the lateral geniculate body in the thalamus

4-auditory cortex: in the temporal lobe, it's main function is hearing

- *temporal lobe also has an equilibrium function through vestibular system

- *the main function of hypothalamus is visceral regulation (so it does regulate heat, cooling, hormones, etc..)

* To see limbic system, we need to remove the temporal lobe (which looks like a fist) and a small are of frontal and parietal lobes, and thus we can see insula (which is located deeply in the cortical area)

- Interposed Between hypothalamus and neocortex

*so limbic system is an interconnected system that connects between neo-cortex or isocortex and diencephalon

- Providing bridge between endocrine, visceral, voluntary, emotional responses (Papez circuits)

Limbic system Consists of a complex network of neurons that interconnected a number of associated structures of the brain, it's components are:

1-cerebral compononets:

A-Cingulate gyrus (superior portion of limbic lobe)

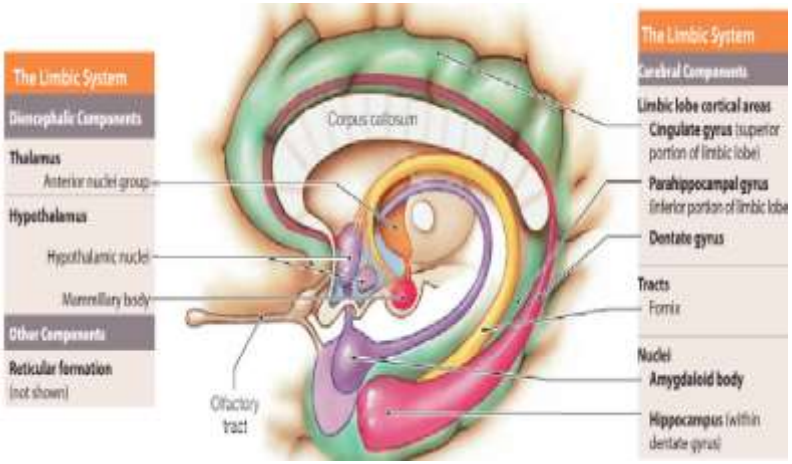
B-Parahippocampal gyrus (inferior portion of limbic lobe)

C-Dentate Gyrus

D-hippocampus (within dentate gyrus)

E-Fornix (as a tract)

F-amygdaloid body (as a nuclei)



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2-Dinecephalon Components:

A-thalamus (especially anterior nuclei group)

B-Hypothalamus (especially Hypothalamic nuclei and mammillary body)

3-other components:

A- reticular formation

*Hippocampus will bound the thalamus and will go lateral to the lateral ventricle to make Fornix, then it will bind with thalamus by anterior nuclei group)

Mnemonics for the Major components of Limbic system

- **Hippo is wearing a HAT**
- **Hippo**: Hippocampus
- **H**:Hypothalamus
- **A**: Amygdaloid body
- **T**: Thalamus

Hypothalamus

Hypothalamus is a central regulation for all major things in our body, and is called 6 aches, is located in the diencephalon

Pineal gland very tiny regulate sleep cycle ,Parinaud syndrome
sunset eyes

Hypothalamus has many nuclei:

1-Anterior hypothalamus, which is responsible for cooling AC

2-Posterior hypothalamus, which is responsible for Heating

3-Lateral hypothalamus, which is responsible for Hunger

4-Ventromedial nucleus, which is responsible for satiety

5-Suprachiasmatic nucleus which is responsible for circadian rhythm

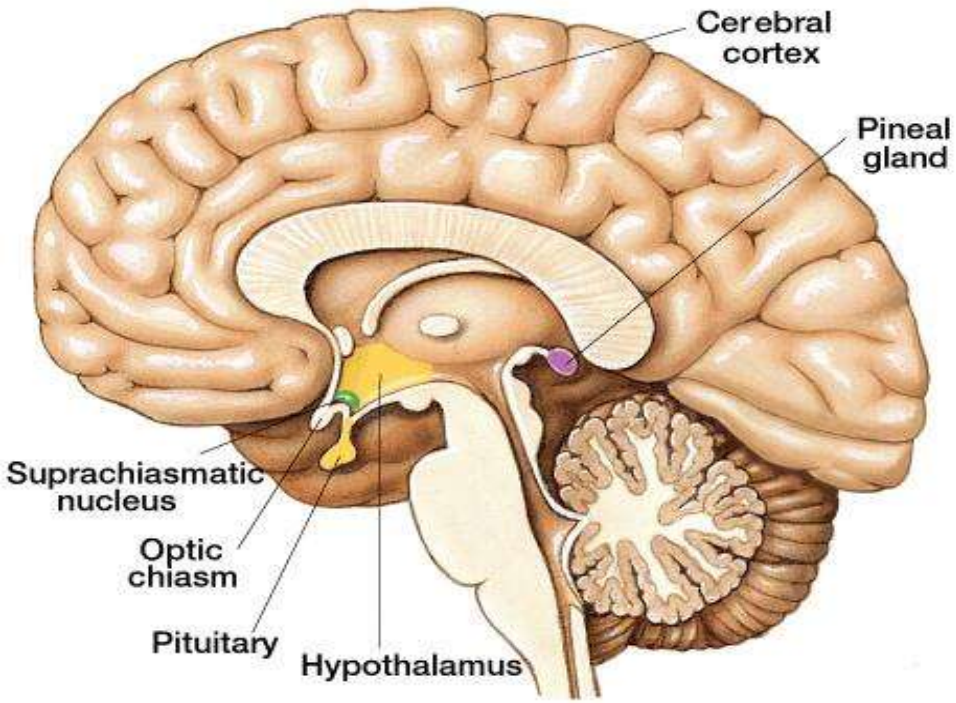
6-Supraoptic nucleus (both supraoptic and suprachiasmatic are responsible for vision)

7-Paraventricular nucleus, parental viewing is needed (for sexual things)

*Mammilary body is located in the inferior part of hypothalamus

*Pitutary gland is located in the anterior part of hypothalamus

*Pituitary stalk connects between mammillary body and pituitary gland



Thalamus (rest room for sensory information)

Is located in the diencephalon in subcortical region, Is considered as a rout for sensory neurons to cerebral cortex (as all the sensory neurons have to come to thalamus first to process informations then go to the cortex, **except olfactory/smelling impulses that will go to the cortex without going to the thalamus, so smelling is the fastest sensation in our body مهم****

Thalamus contains many nuclei:

1-VPL (ventroposteriolateral), which receive sensation from arms and legs

2-VPM (ventroposteriomedial) which receive sensation from face and mouth

3- Lateral geniculate nucleus is responsible for vision

4- Medial geniculate nucleus is responsible for hearing

5-big faccular nuclei, responsible for Conscious awareness and wakefulness

*So, thalamus send Somatosensory information to parietal lobe

-Any damage to thalamus will cause coma

Basal ganglionea

Is located in both side of thalamus, deeply in the forebrain (Basal ganglia and cerebral cortex are considered as a part of telencephalon) ,basal ganglia is composed of:

1-Dorsal stratum, which is composed of:

A-Caudate, responsible forcognitive memory and sleep (with prefrontal cortex)

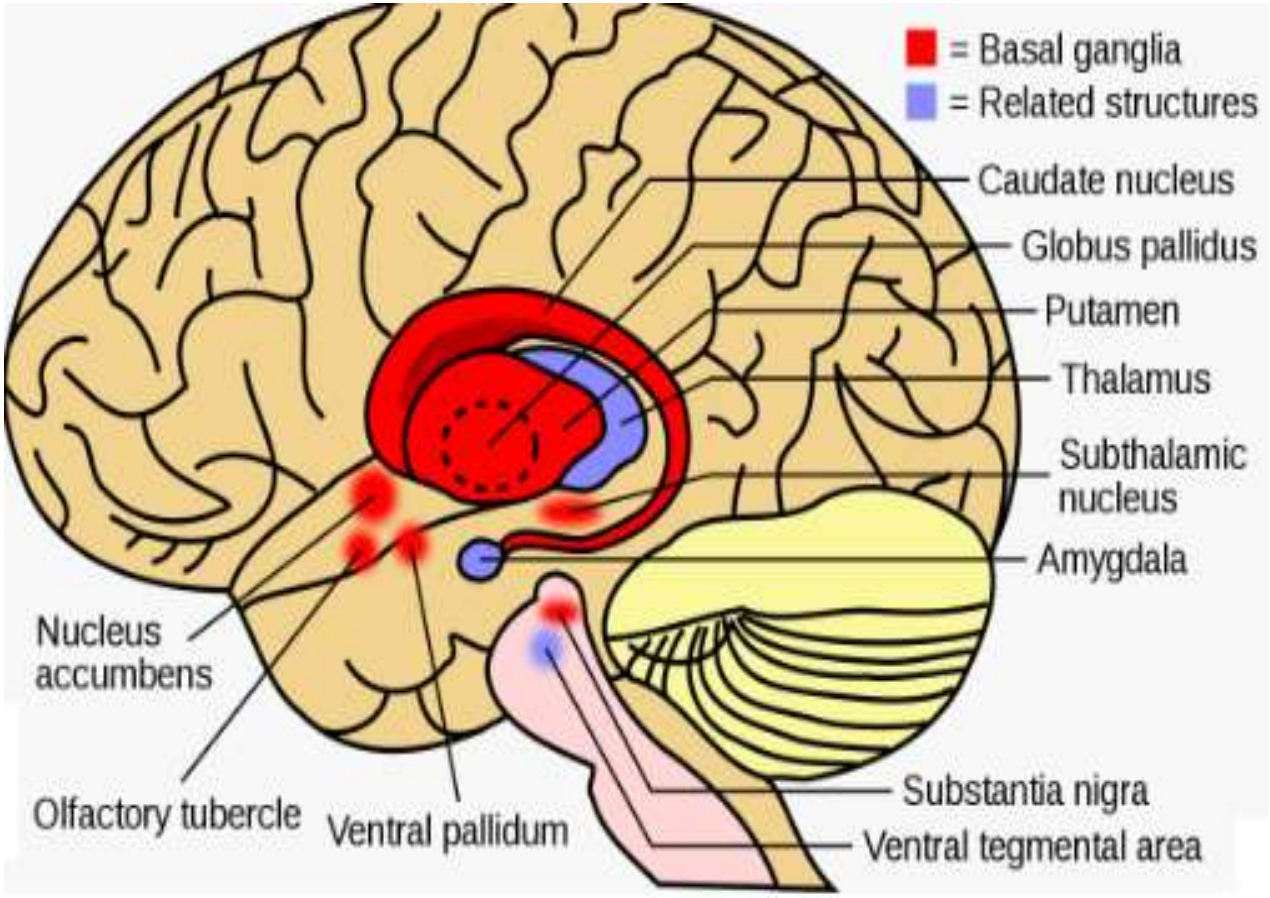
B-Lenticular that is devided to:Putamen, and globus pallidus, Putamen is responsible for motor function

C-Substantia nigra, which is very important in posture and balance, so any impairment in sub.nigra will cause Parkinson and rigidity in movement

D-Subthalamic nuclei, any impairment of it will cause hemiballismus (involuntary movement of limbs)

2-Ventral striatum, which is composed of:

- Nucleus accumbens
- Olfactory tubercle


= Basal ganglia
= Related structures
Caudate nucleus
Globus pallidus
Putamen
Thalamus
Subthalamic nucleus
Amygdala
Nucleus accumbens
Olfactory tubercle
Ventral pallidum
Substantia nigra
Ventral tegmental area

Basal ganglion

- Is located Deep in the forebrain

- Integrate all cortical activity in one output (so, voluntary and memory impulses have to go to basal ganglia after the cortex, in order to filtrate the unwanted and involuntary information as it eliminate and execute all the impulses except motor one's that are related to posture, memory, voluntary movement)

Behavior (bad or good day)

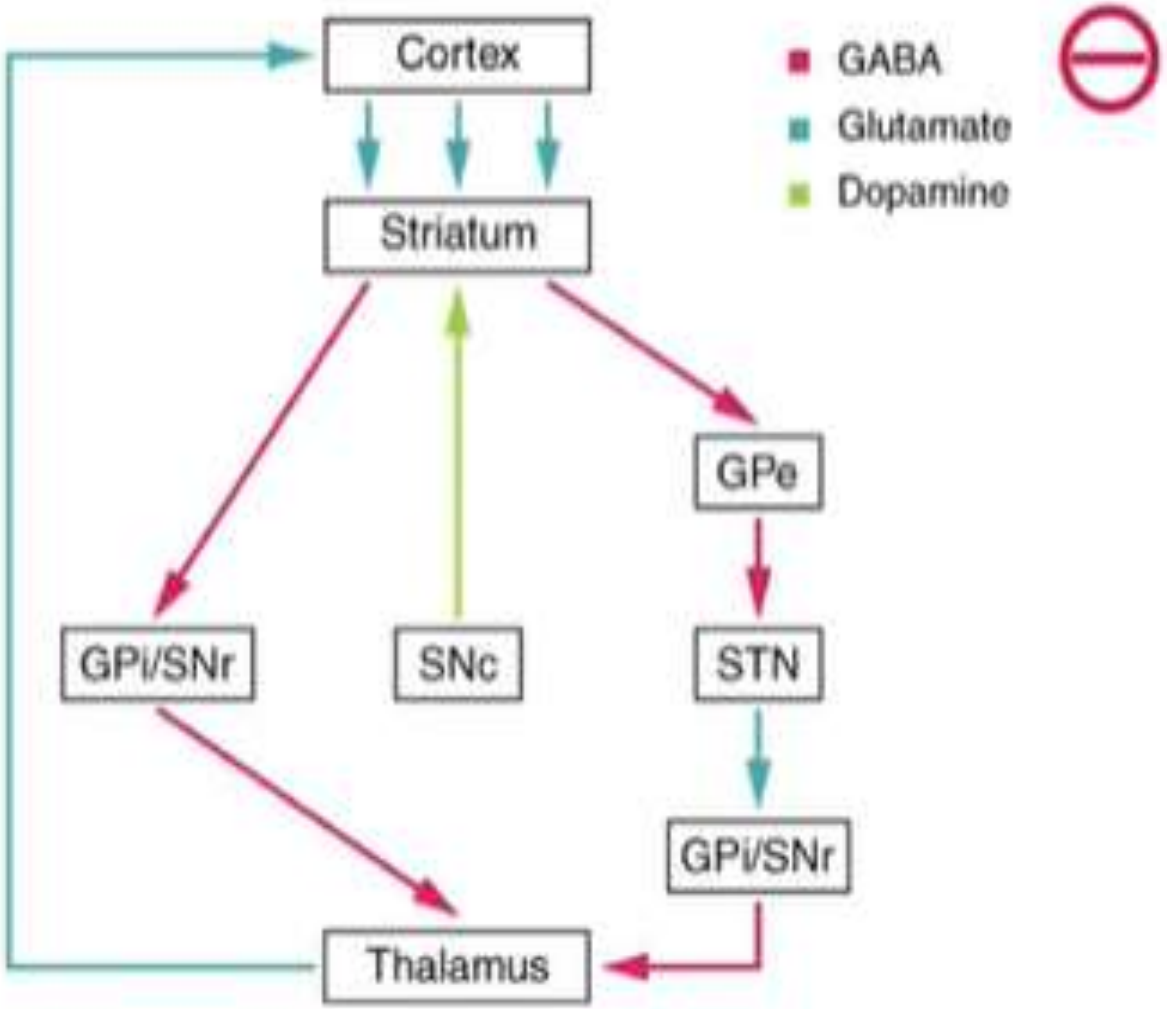
Basal ganglion functions:

1-Integration of output posture (basal ganglia is responsible for smooth and straight voluntary movement, so it regulates reticulospinal tract (motor tracts) that goes to internal capsule then to spinal cord to produce flexion/extension, any impairement on basal ganglia will produce hemiballismus)

2-Learning and cognition , and make body language

3-Emotional aspect of behavior tone of voice

The direct and indirect pathways



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- Basal ganglia has two Pathways:

A-direct pathway)excitatory)

Pathway:motor impulses go through cortex as excitatory one to activate striatum, then striatum send inhabatory impulses to internal globus pallidus which in turn sends inhabatory impulses to thalamus, then thalamus sends excitatory impulses to the cortex, which sends again excitatory impulses to straiatum and so on ....

The goal: is to make and excite movements

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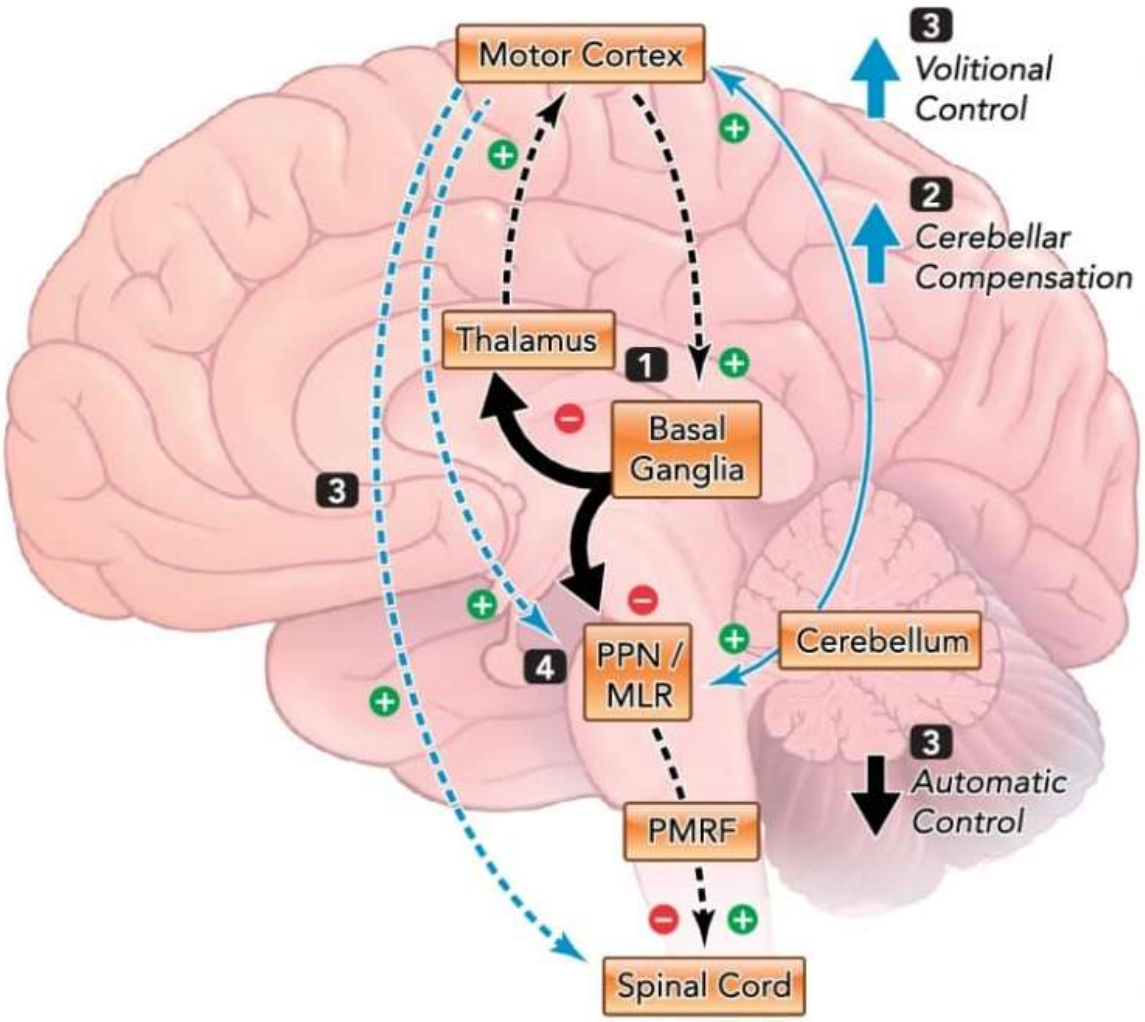
- **B-indirect pathway)inhabatory pathway)**

Pathway: cortex send excitatory impulses to the striatum, then striatum that will send inhabatory impulses to external globus pallidus which in turn sends inhabatory impulses to subthalamic nuclei, then subthalamic nuclei will send excitatory impulses to substantia nigra and internus globus pallidus, those two will send inhabatory impulses to thalamus which in turn send excitatory impulses to cortex and so on....

Goal: to prevent and execute unwanted involuntary movements, thus you can do smooth and straight movements)make slow movements)



Gait Slowness

1 Overactive inhibitory output from the basal ganglia reduces corticospi drive and *contributes to slowed gait.*

2 Increased cerebellar activity *may partially compensate for the overactive basal ganglia inhibition.*

Gait Variability and Asymmet

3 Increased volitional (i.e. cortico-spinal), and reduce automatic control of locomotion *contributes to variability of gait.*

Postural instability

4 Dysfunctional brainstem activity *contributes to postural instability, hypokinesia, and rigidity.*

The correlation of basal ganglion and other organs

Motor cortex will send impulses to basal ganglia that will send impulses to:

A-thalamus)explained above)

B-MLR)mesoencephalic repsonse(in mid brain, is responsible for posture, which will send impulses to PMRF)pontomedullary reflex(that is important for posture and it connects between pons and medulla

***Any impairment on those areas will cause instability**

Amygdala

It is responsible for detection of the correlation between the emotion or any sense(visual, auditory, smelling) and the stimulus/threat that produces it

- It will make what is called **Pavlovian association** (as if you hear new sound for the first time, and you know that this animal/ person produces it, the amygdala will correlate those things together to produce an emotion you feel once you hear the sound again)

- So, amygdala is responsible for **Threat detection** and **Capture environmental stimuli and save them in the retrieval memories in hippocampus**

Processing memory

Memory is classified according to how much it reside into your brain to two types: **short term memory, long term memory**

Long term memory is subdivided into :

A-**Declarative conscious** ,it is responsible for remembering friend name

Declarative conscious is classified into:

1-Episodic memory for association) To remember social relationships and people)

2-Semantic memory, is responsible for remembering numbers

*Prefrontal cortex process and save short term memory

*Hippocampus is responsible for convert and encode short into long memory

B-Non declarative not conscious ,like) driving a bike ,playing guitar(As the memory remains in muscle or body memory not by recalling(basal ganglion responsible for this)

Long term potential (convert short to long memory

*Short term memory remains only for several hours

To make a thing)Hobby(on your long term memory, you have to practise a lot and repeat what you do and activate your brain so:

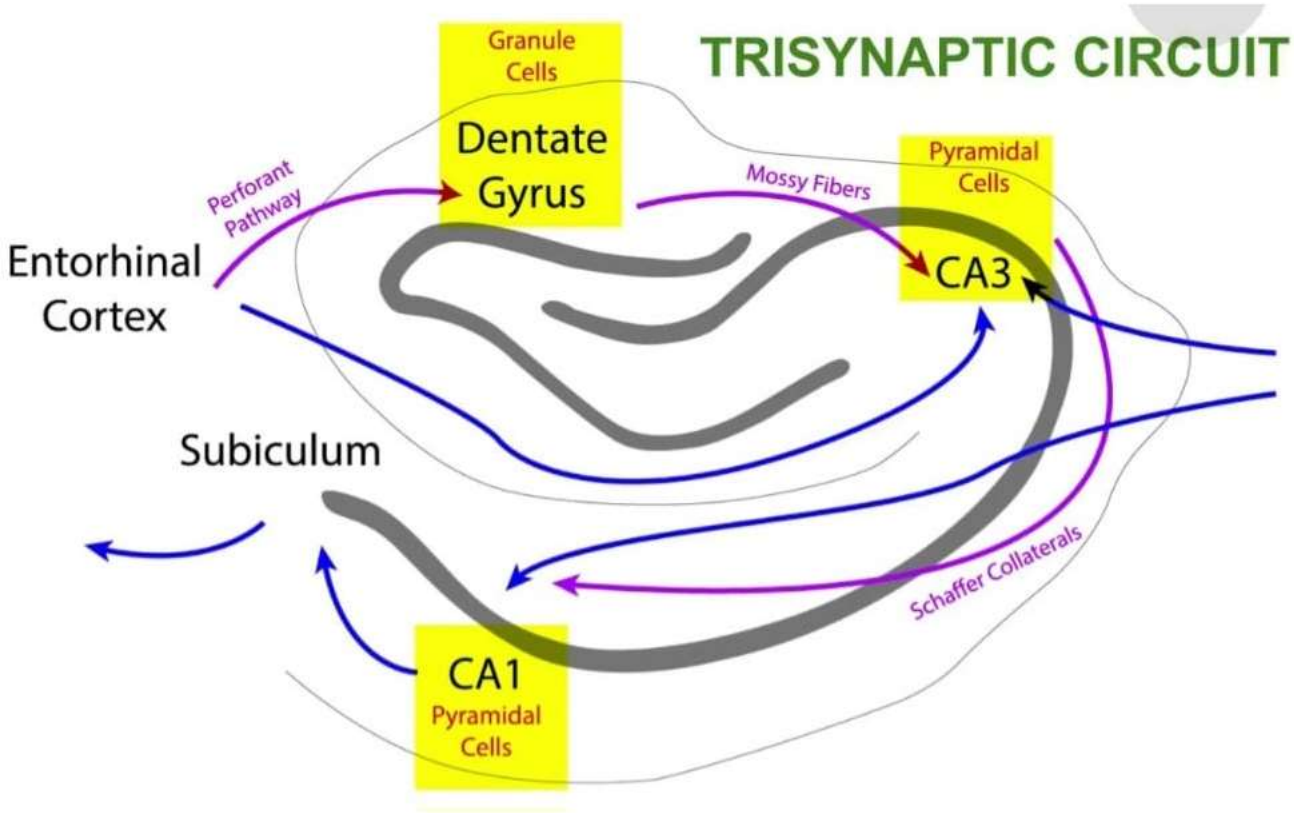
A-Your brain secrete Glutamate that will bind with AMPA and NMDA receptors, then it will induce sodium inflow to the brain that will induce calcium inflow

B-then Calcium activate several protein kinase

C-Phosphorylation of AMPA occurs (by protein kinase)

D-That induce more Na conduction and more receptors AMPA

***if sodium continue to flow Inside the brain tissue, it will stimulate the brain to make new synthesized protein, like dendritic spine, and make more synaptic connections =)long term memory)**


TRISYNAPTIC CIRCUIT
Granule Cells
Dentate Gyrus
Perforant Pathway
Entorhinal Cortex
Mossy Fibers
Pyramidal Cells
CA3
Subiculum
Schaffer Collaterals
CA1
Pyramidal Cells

Neuroplasticity (use it or lose it)

- **Neuroplasticity : is the ability of the brain to modify it's action and gain new skills and functions by making new synaptic connections and proteins through practising, learning and activating your brain**
- Is related to Learning and Brain repair that will change Synaptic connection over time by what is called(Use it or lose it)
- Chemical synapse in temporary short-term memory will change to be in Long lasting memory through high frequency and repeated Practises(long term potential) so it will make new connections neurons and changes in cortical areas

*Neurotransmitter will be switched and replaced by another neutrotransmitters due to behavioral changes

***If someone has a brain stroke and he was paralysed as a complication, he can walk again through rehabiliation)making new synaptic connections)**

- **Phantom limb sensation**(In somatosensory lobe, the medial part is responsible for upper limbs and head, while the lateral part is responsible for lower limbs, so if someone's arm had been amputated, he will feel and sense his arms presence as if it was there due to the synaptic connections between head and upper limbs)

- Events and Actions are Remarkable in children as their brain developing (so their brain will learn faster than adult's one)

- Thus **,**if a child experience Bad or horror events ,He will response in Negative and maladaptive way which cause trauma

- By activating your brain and reading , it remains Busy ,healthy and effective