

  
كلية الطب البشري  
Faculty of Medicine

  
الجامعة السعيدية  
1916 - 1910

# CNS Module-Spring 2021

## Physiology Lectures

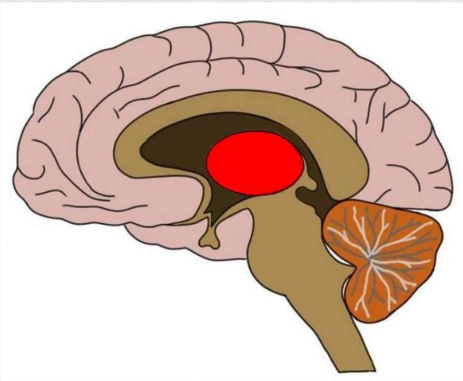
### Lecture 8&9

### Topic 4: Diencephalon and Limbic System

Presented by:  
**Dr.Shaimaa Nasr Amin**  
Associate Professor of Medical Physiology

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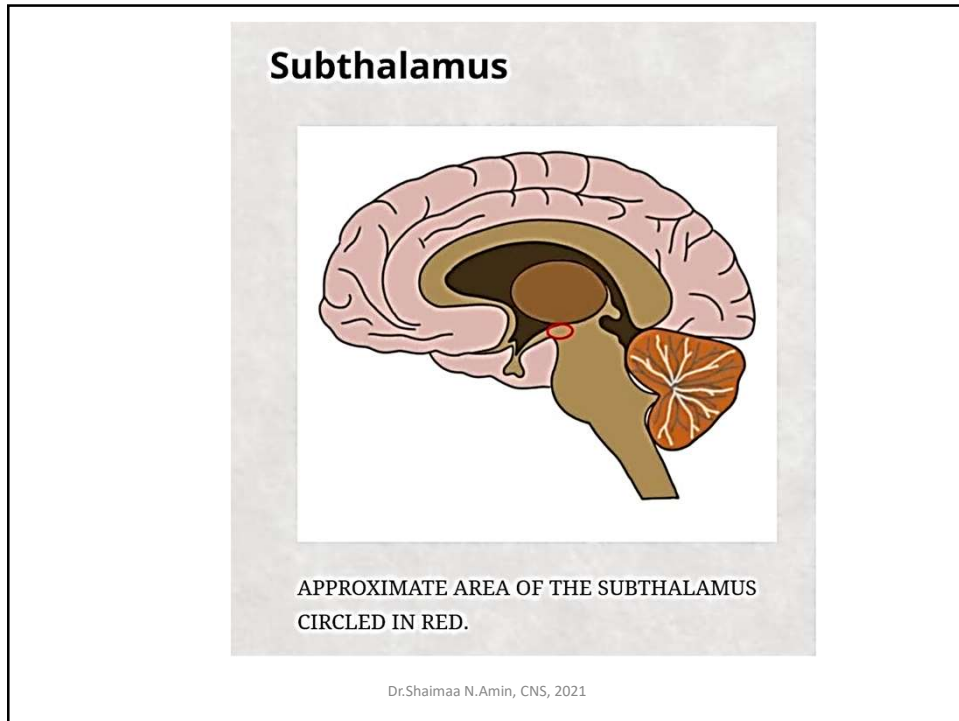
## Thalamus



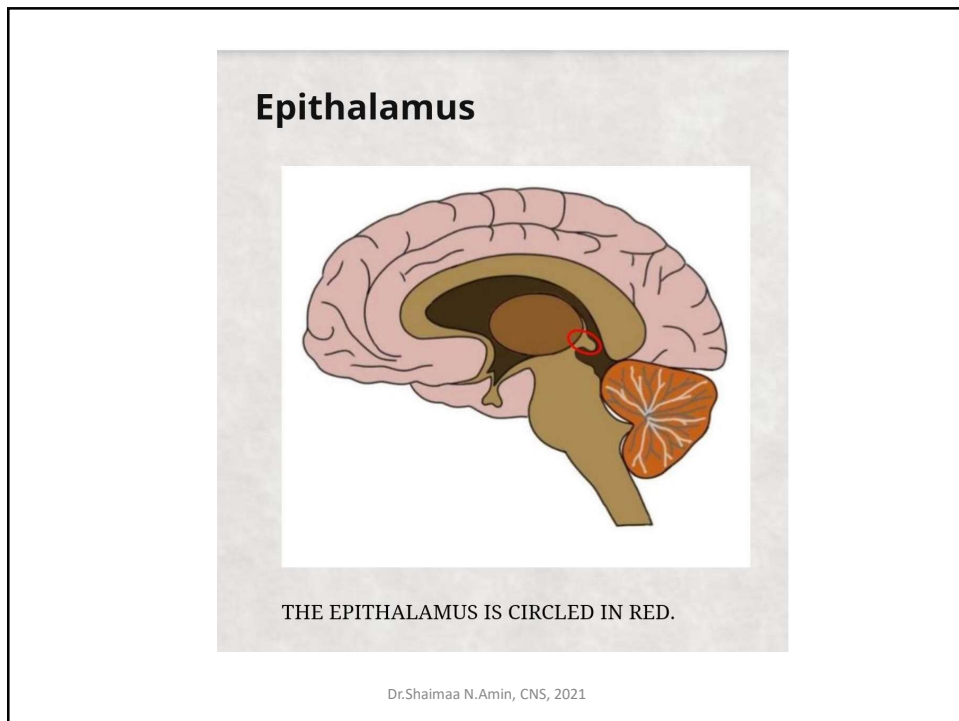
THE THALAMUS COLORED IN RED. THERE ARE TWO OF THESE STRUCTURES IN AN INTACT BRAIN. THEY ARE SYMMETRICAL AND POSITIONED SIDE-BY-SIDE ONE ANOTHER.

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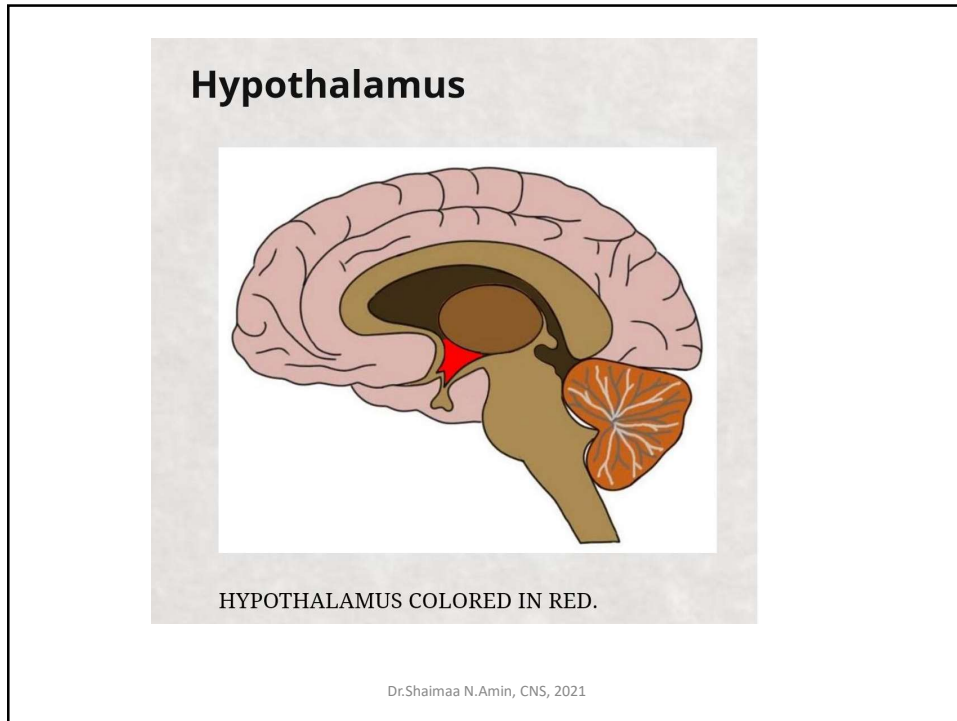
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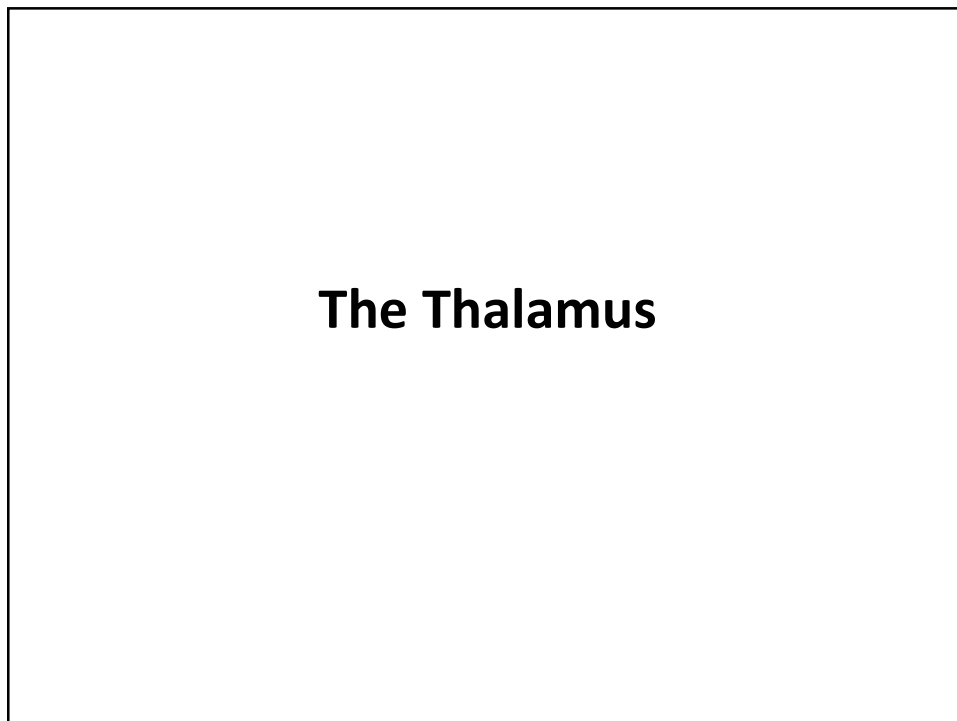
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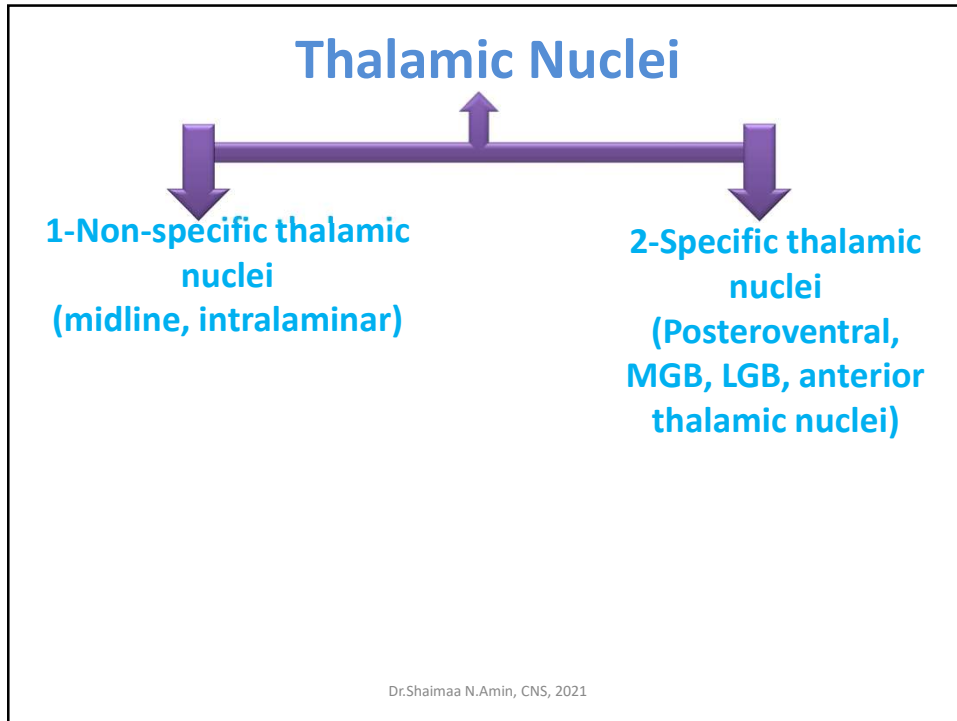
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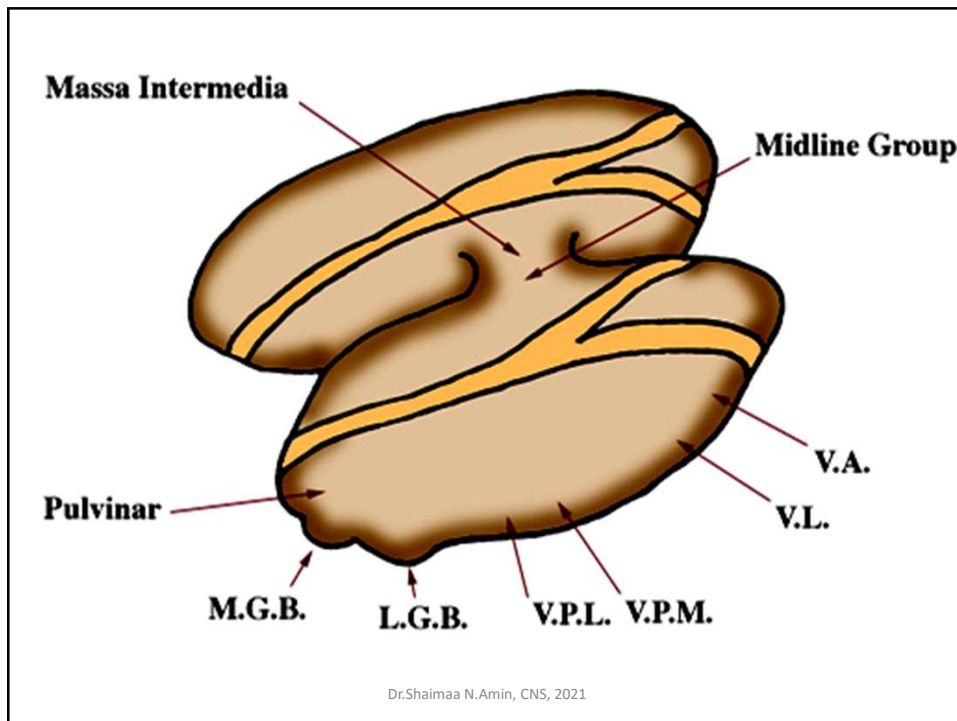
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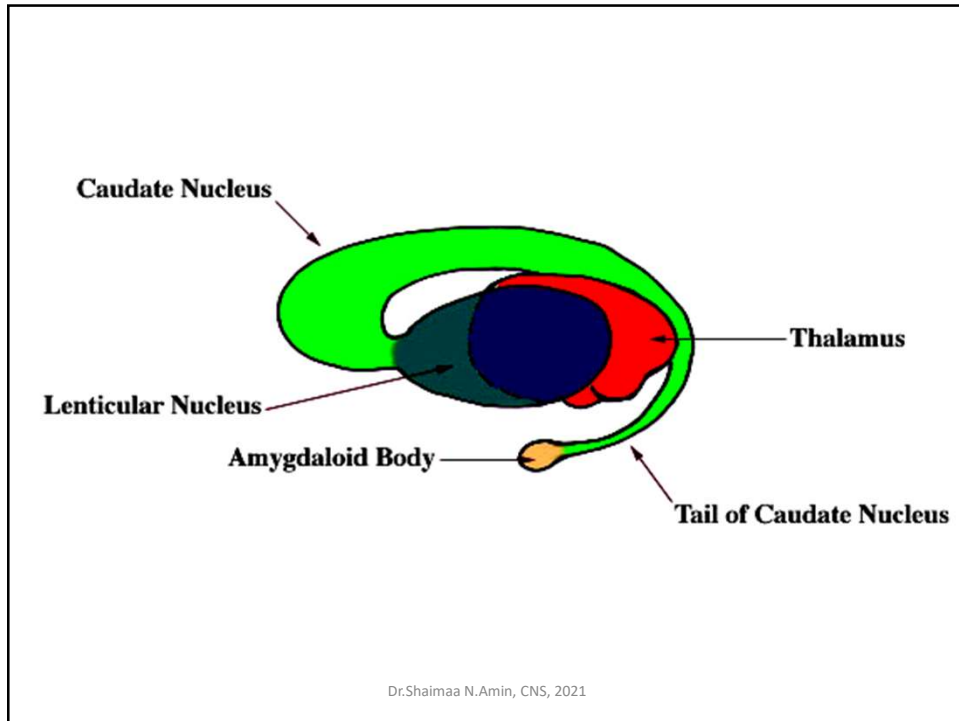
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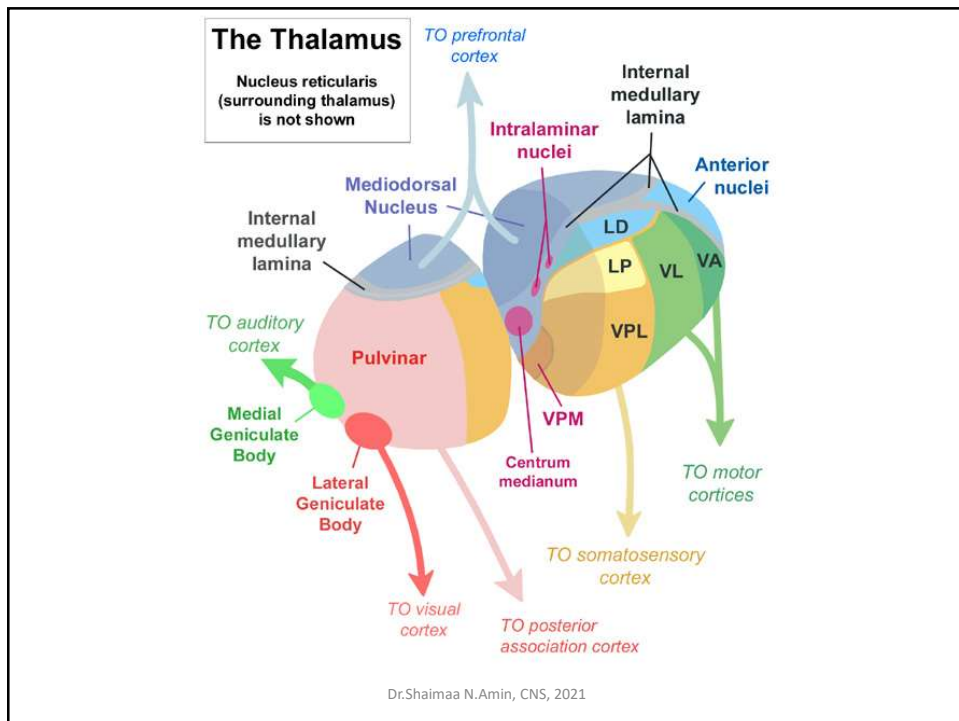
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## Functions of the thalamus

- 1- It is a relay station for all types of sensation, except olfaction, on the way to their respective centers in the cerebral cortex.
- 2- The thalamus also relays signals, concerned with motor function, from the basal ganglia and cerebellum to the motor areas of the cerebral cortex.

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## Functions of the thalamus

- 3- It relays autonomic signals and those related to emotional reactions through their ways to the hypothalamus and limb system.
- 4- It also has a role in coding, storing and recalling memories.
- 5- Impulses from non-specific thalamic nuclei are concerned with excitability of the cortex.

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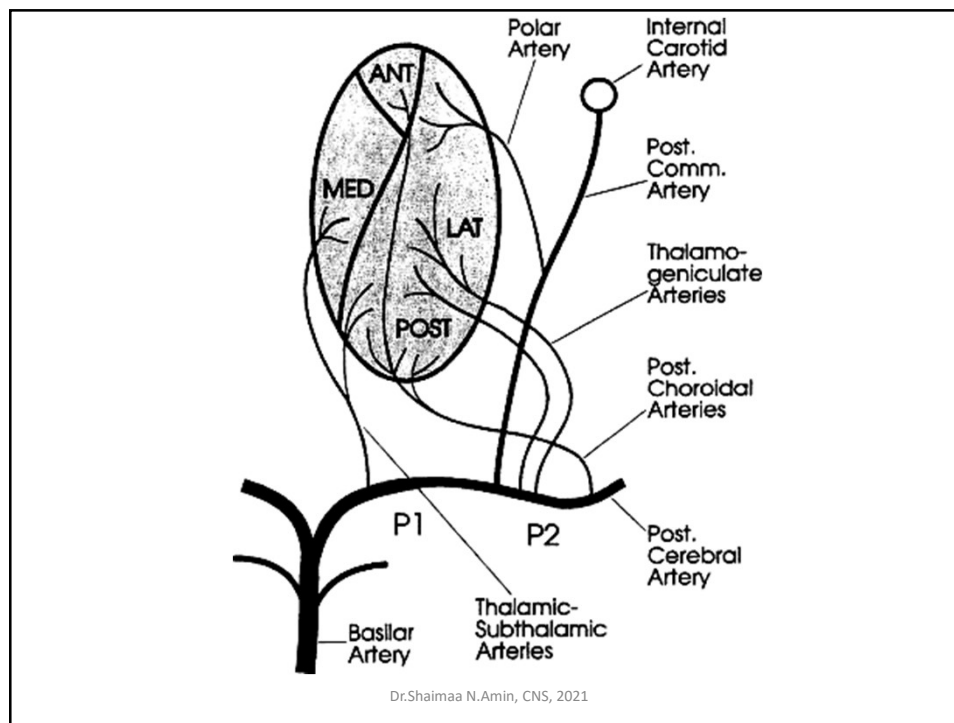
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## The Thalamic Syndrome

It is due to thrombosis of the arterial supply of the thalamus, which results in damage of the posterior thalamic nuclei, leaving the medial and anterior group of nuclei intact.

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**The Patient presents with:**

- 1- Loss all sensation on the opposite side of the body.**
- 2- Ataxia.**
- 3- 2ry hyperalgesia.**
- 4- Emotional disturbance.**

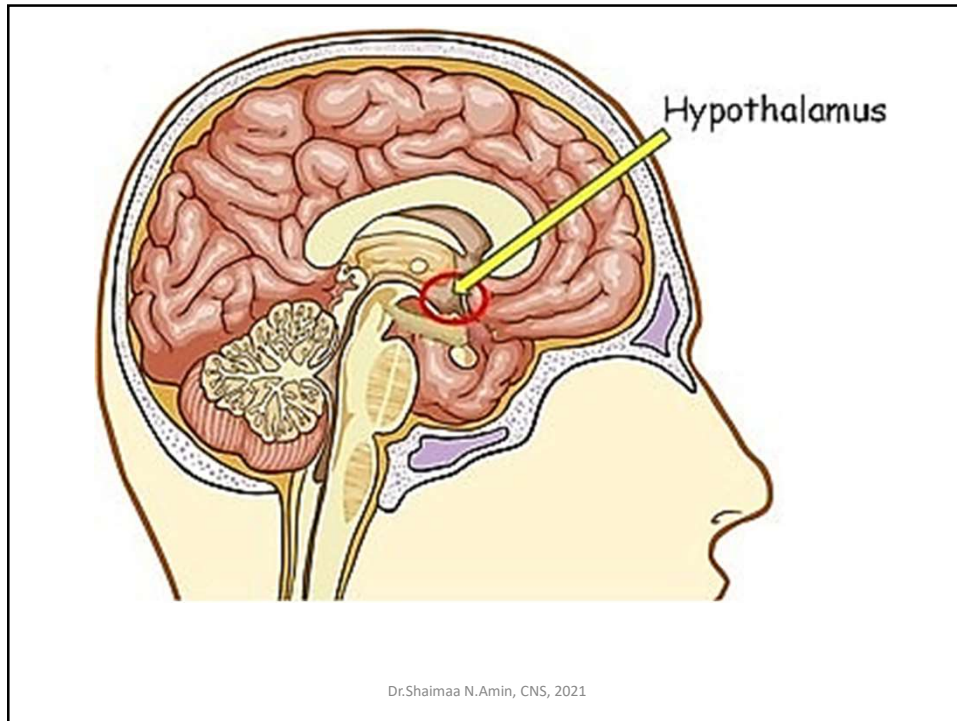
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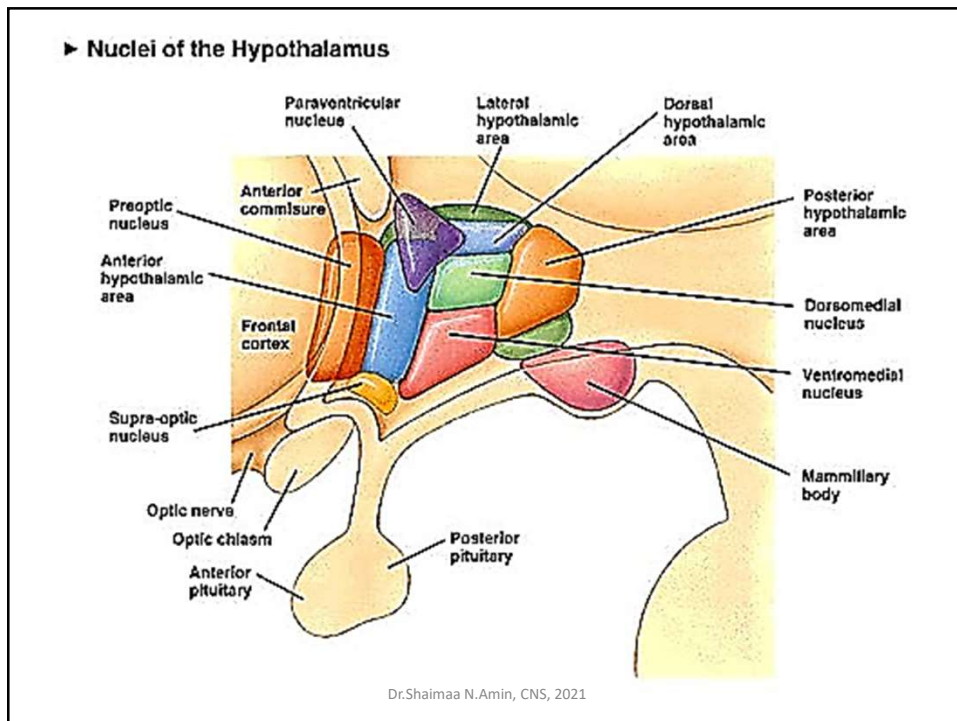
## **Hypothalamus**

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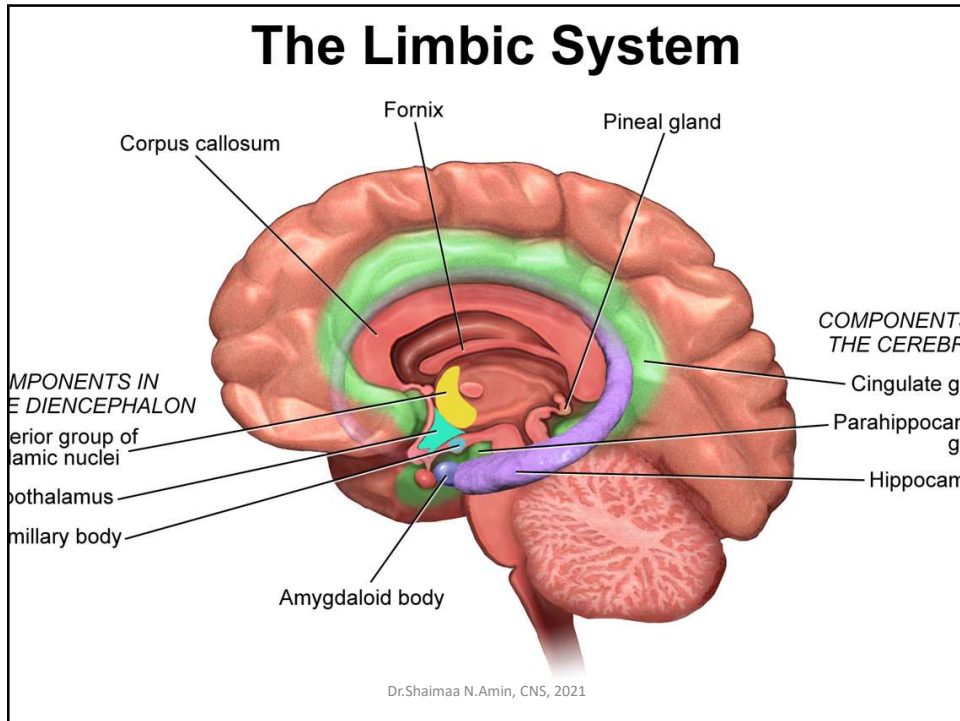




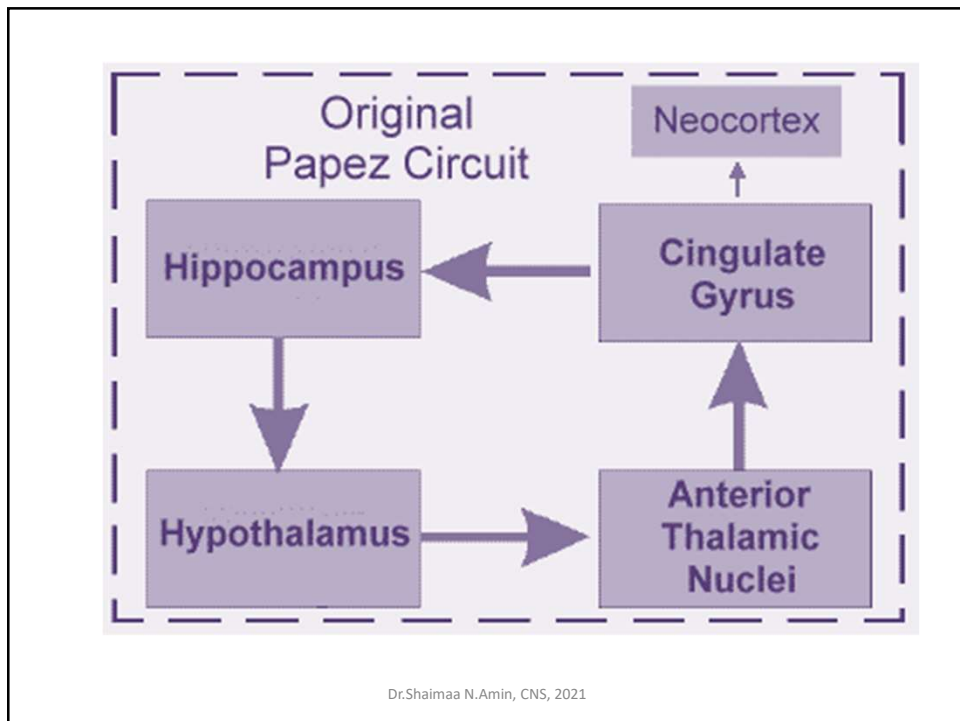
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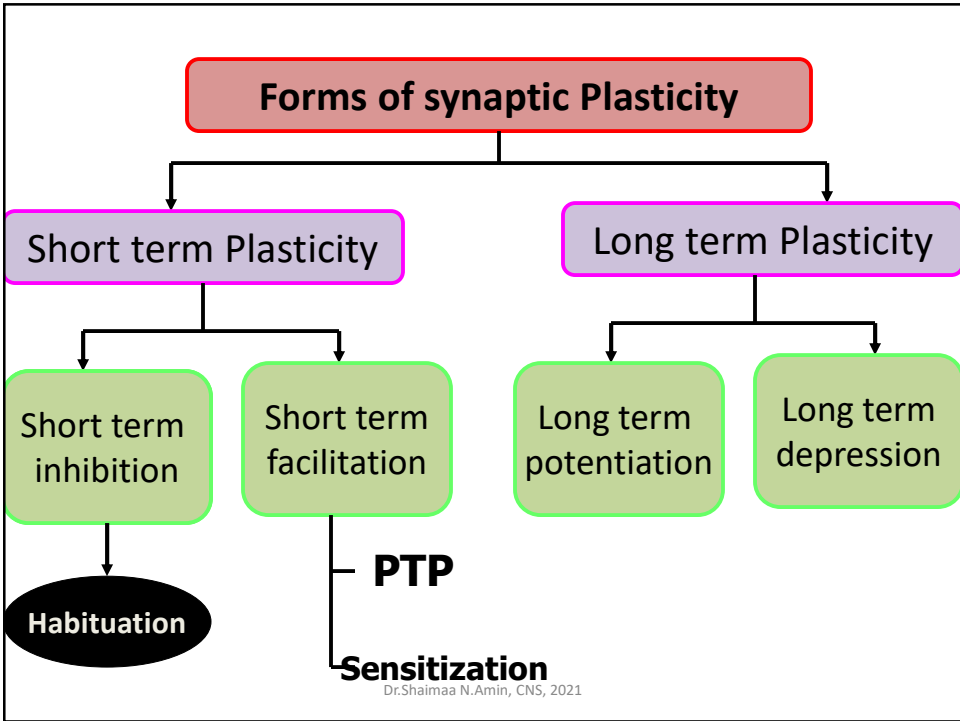


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# Memory and synaptic Plasticity

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## 1) Short term inhibition Habituation

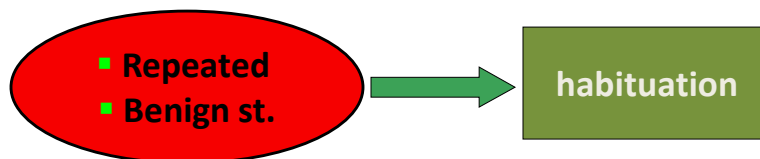
- Gradual loss of postsynaptic neuron response to a **benign** stimulus when it is repeated.
- **Ionic basis:**

Gradual inactivation of  $\text{Ca}^{++}$  channels  $\longrightarrow$   
 $\downarrow$  in intracellular  $\text{Ca}^{++}$   $\longrightarrow$   $\downarrow$  chemical  
 transmitter release.

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## 1) Short term inhibition Habituation



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## 2) Short term Facilitation

### 1. Post tetanic potentiation (basis of immediate memory)

Continous discharge from the postsynaptic neurons for seconds to minutes after stoppage of **brief tetanizing train** of impulses to a presynaptic neuron

#### Ionic basis:

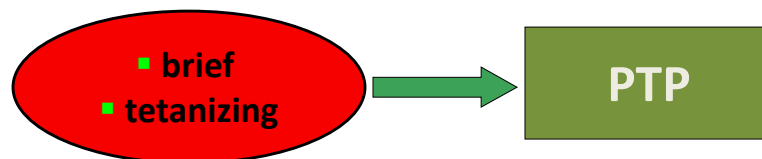
Accumulation of  $\text{Ca}^{++}$  in the presynaptic neuron by the repeated stimulation  $\longrightarrow$   $\uparrow$  in the N.T. release.

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## 2) Short term Facilitation

### 1. Post tetanic potentiation (basis of immediate memory)



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## 2. Sensitization (basis of short term memory)

Prolonged augmented response of the postsynaptic neuron due to application of a **noxious** stimulus accompanying a **benign** one to which the subject is habituated

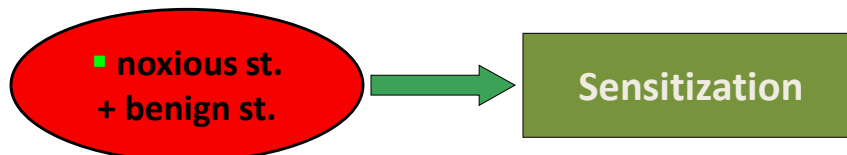
### **Ionic basis:**

Presynaptic facilitation.

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## 2. Sensitization (basis of short term memory)



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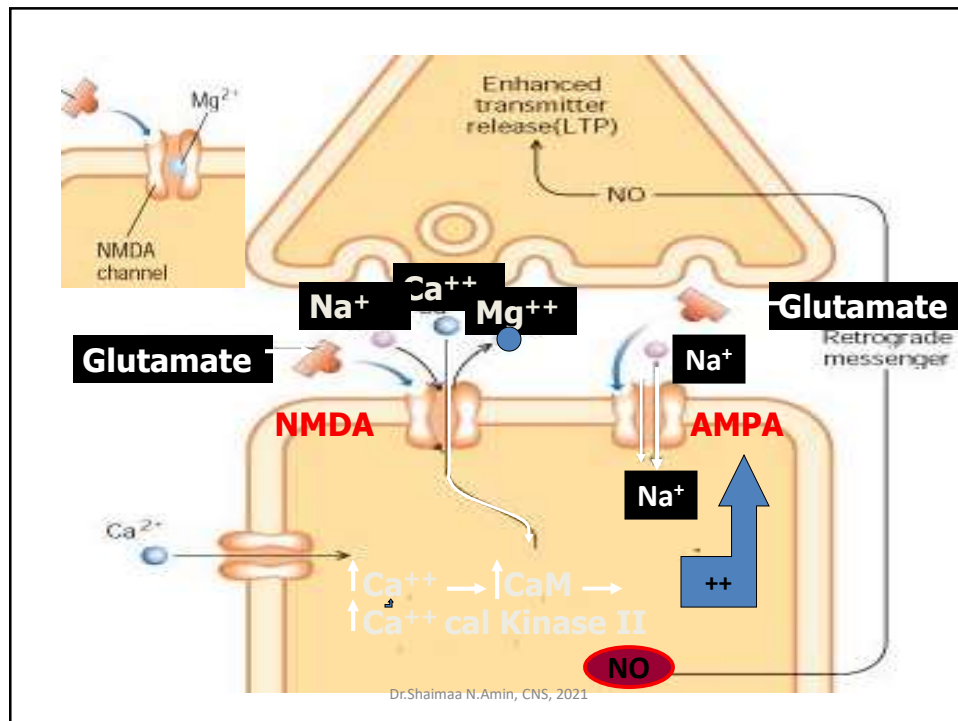
## Long term Plasticity

### 1. Long term potentiation

- Rapidly developing persisting enhancement of postsynaptic neuron response after repeated stimulation of presynaptic neurons.
- It lasts for days or weeks.
- Occurs in various areas of CNS especially in the hippocampus.

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## 2. Long term Depression (LTD):

Presynaptic neuron stimulation ~~pro~~longed depression of postsynaptic neuron.

### Ionic basis:

Occurs if presynaptic neuron stimulation  $\longrightarrow$  depolarization of postsynaptic neuron less than 20mv (threshold for NMDA receptors to open).

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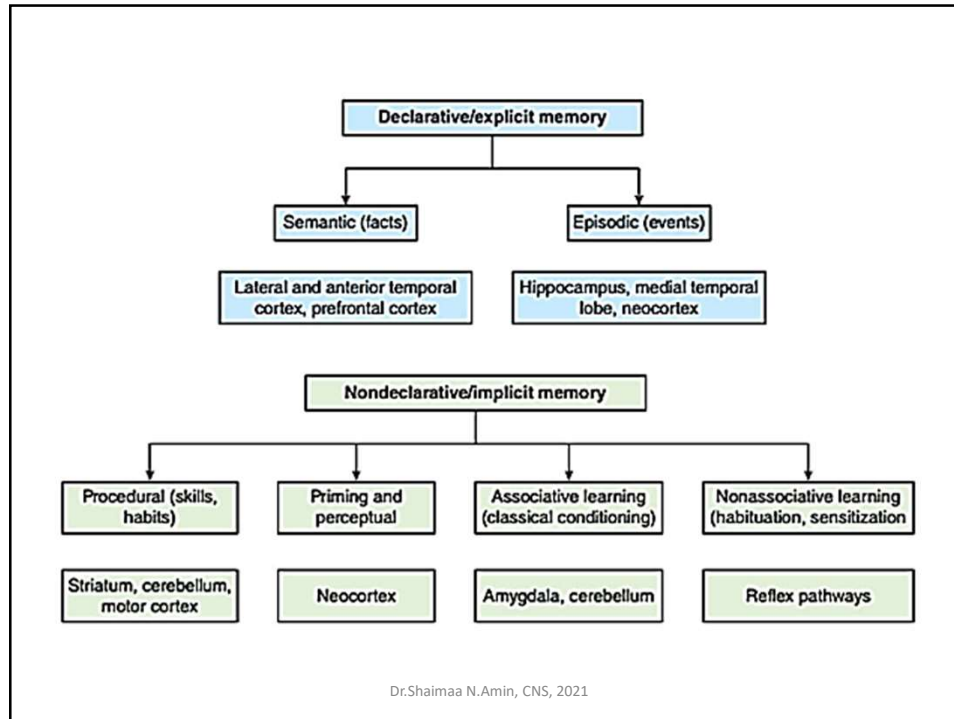
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Type of S. plasticity	Stimuli	Ionic basis
Habituation	<ul style="list-style-type: none"> <li>▪ Repeated</li> <li>▪ Benign</li> </ul>	Inactivation of presy. $Ca^{++}$ ch.
PTP (immediate m.)	<ul style="list-style-type: none"> <li>▪ Brief</li> <li>▪ tetanizing</li> </ul>	Presy. $Ca^{++}$ accumulation
Sensitization (STM)	<ul style="list-style-type: none"> <li>▪ Noxious + benign</li> </ul>	Presynaptic facilitation
LTP	<ul style="list-style-type: none"> <li>▪ as PTP (brief &amp; repeated)</li> </ul>	Activation of NMDA
LTD	Slower st. of presyn. n.	Closure of NMDA

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There are 2 main types of memories :

(A) **Implicit (reflexive) memory** (= memory of which the person is *unconscious or unaware*). It includes (1) *Associative and nonassociative learning* (see above) (2) *Learned skills* (= *skill memory*) (3) *Habits* (e.g. *driving cars becomes a habit by training and occurs automatically without need for conscious recall of information*) (4) *Priming* (= *facilitation of recognition of words or objects by previous exposure to them*).

(B) **Explicit or declarative memory** (= *conscious recall of information*) which includes the following types :

(1) **Short-term (primary or recent) memory** : This is memory that lasts a few seconds to a few minutes (or at most a few hours) then fades away unless it is converted to long-term memories..

(2) **Long-term (secondary or remote) memory** : This is memory that lasts for long times (*years and may be for the whole life*).

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### CONSOLIDATION OF MEMORY

This is the conversion of *short-term memory into long-term memory*. It requires 5-10 minutes for minimal consolidation and 1- 4 hours for more strong consolidation. Therefore, *short-term memory is vulnerable during the first 5 minutes* (i.e. it is liable to be erased) if disrupted by external stimuli such as anesthesia, electroshock or hypothermia.

#### ***Mechanism of consolidation***

This is produced (and also accelerated and potentiated) by *rehearsal of the short-term memory* i.e. repetition of the information in mind again and again (so consolidation is reduced in mentally-fatigued persons). It involves *protein synthesis in neurons* (so drugs and antibiotics that inhibit protein synthesis do not affect short-term memory but prevent its consolidation).

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### THE MEMORY TRACES

Memories are stored in the brain through *facilitation of synaptic transmission*. The facilitated (or new) pathways are called **memory traces**, and once they are established, they can be activated by the mind to reproduce the memories. They can occur at all levels of the nervous system but *particularly in the cerebral cortex*.

New informations are first *processed in the hippocampus*, and what proves to be significant is *codified into specific classes* that will be *consolidated then stored in association with other memories of the same type*. This is *necessary to search for various memories when required*.

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## LEARNING

### (A) Non-associative learning

This is learning about *a single stimulus that is repeated many times*. There is 2 forms of this type :

(1) **Habituation** : This is a gradual decrease in the response to a particular stimulus when repeated. This learns the individual to ignore a large number of nonsignificant stimuli (so it is considered a *negative memory*). It is due to a decrease in  $Ca^{2+}$  in the nerve endings that mediate the response (page.42)

(2) **Sensitization** : This is potentiation of the response to a particular stimulus when repeated (so it is considered a *positive memory*). It occurs if the stimulus is coupled once with an unpleasant (or a pleasant) stimulus. It is due to prolongation of the action potential in nerve endings.(page 43)

### (B) Associative learning

This is learning by *pairing of stimuli*, and the best example in this case is learning through **conditioned reflexes**. In such reflexes, the subject is learned to respond to stimuli that normally do not produce responses. These stimuli are called *conditioned stimuli (CS)*, while the stimuli that normally produce the response are called the *unconditioned stimuli (US)*.

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