

# 13 Physiology of Consciousness **CNS**



## Sources

- girls' slides
- boys' slides

## Objectives

- (1) Levels of consciousness/ definition
- (2) Functional divisions of RF.
- (3) Overview of functions of RF.
- (4) Anatomical components of RAS.
- (5) Connections of RAS.
- (6) Neurotransmitters of RAS.
- (7) Functions of RAS.



RAS and thalamus function

[http://youtu.be/jl3B8\\_qKmFQ](http://youtu.be/jl3B8_qKmFQ)

# What is Consciousness?

- Is the brain state in which a person is being aware of the self and surroundings .
- It is a product of electrical activity of the brain.

## Notice :

a person with a **Flat EEG** can not be conscious .

## What are the levels of consciousness?

### 1- Normal Consciousness

- state of normal arousal , being fully awake and aware of the self and surroundings

### 2- Clouded consciousness

- person conscious but mentally confused
- e.g., in cases of drug or alcohol intoxication , high fever associated with malaria or septicemia , dementia (الخراف) , etc

### 3-Sleep

- person unconscious ( in relation to the external world & surroundings ) , but is arousable ( can be aroused )

### 4- Coma

- person unconscious and not arousable

# What are brain Structures involved in the conscious state?

Consciousness depends upon interactions between :

1- Reticular Formation ( RF).

2- Thalamus

3- Cortical Association areas

## 1- Reticular formation

- regulates many vital functions including the sleep/awake cycle.
  - It is a polysynaptic network located in the pons, midbrain and upper medulla.
    - poorly differentiated.

It consists of 3 parts:

### (B) Paramedian Reticular Formation

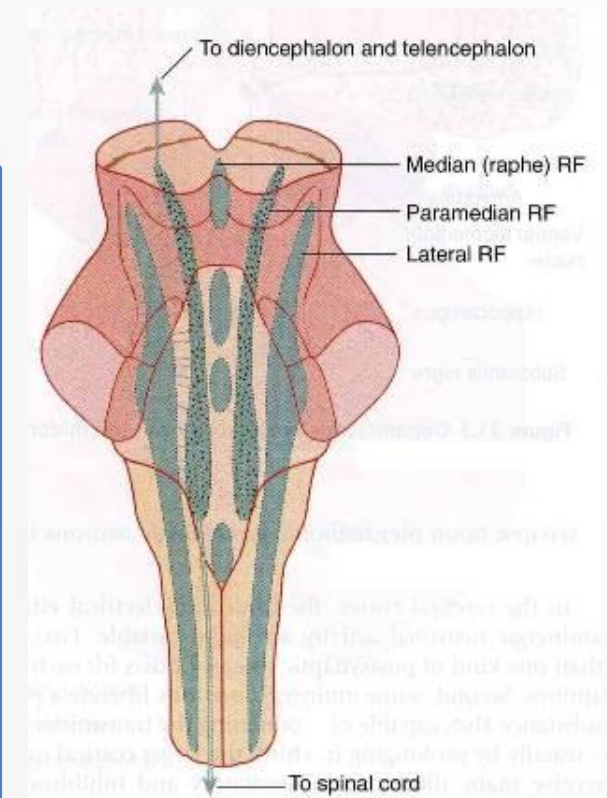
-Has **large** cells.

Region	Contain	Projects onto
Receives signals from lateral reticular formation	-	cerebral hemispheres.
Nucleus coeruleus	noradrenergic neurones	cerebral cortex
Ventral tegmental nucleus	Dopaminergic neurones	directly to the cortex
-	Cholinergic neurones	thalamus

### (A) Lateral Reticular Formation

-Has **small** neurones

Receives	from
vestibular information	median vestibular nerve
auditory information	superior olivary nucleus
Visual information	superior colliculus
Olfactory information	medial forebrain bundle
touch and pain	ascending tracts



### (C) Raphe nuclei (Median RF):

-In the midline of the reticular formation.

-Contain serotonergic projections to the brain and spinal cord.

# WHAT ARE THE FUNCTIONS OF RETICULAR FORMATION?

## 1- Somatic motor control:

- Reticulospinal tracts

## 2. Cardiovascular control :

- The reticular formation includes the **cardiac and vasomotor centers** of the medulla oblongata.

## 3. Pain modulation :

- The reticular formation is one means by which **pain signals** from the lower body reach the cerebral cortex. It is also the origin of the descending **analgesic pathways**. The nerve fibers in these pathways act in the spinal cord to block the transmission of some pain signals to the brain.

## 4. Sleep and consciousness :

- The reticular formation has projections to the thalamus and cerebral cortex . It plays a central role in states of consciousness like alertness and sleep. Injury to the reticular formation can result in **irreversible coma**.

## 5. Habituation:

- This is a process in which the brain learns to ignore repetitive, meaningless stimuli while remaining sensitive to others.

For example of this is when a person can sleep through loud traffic in a large city, but is awakened promptly due to the sound of an alarm .

# 2- Thalamus:

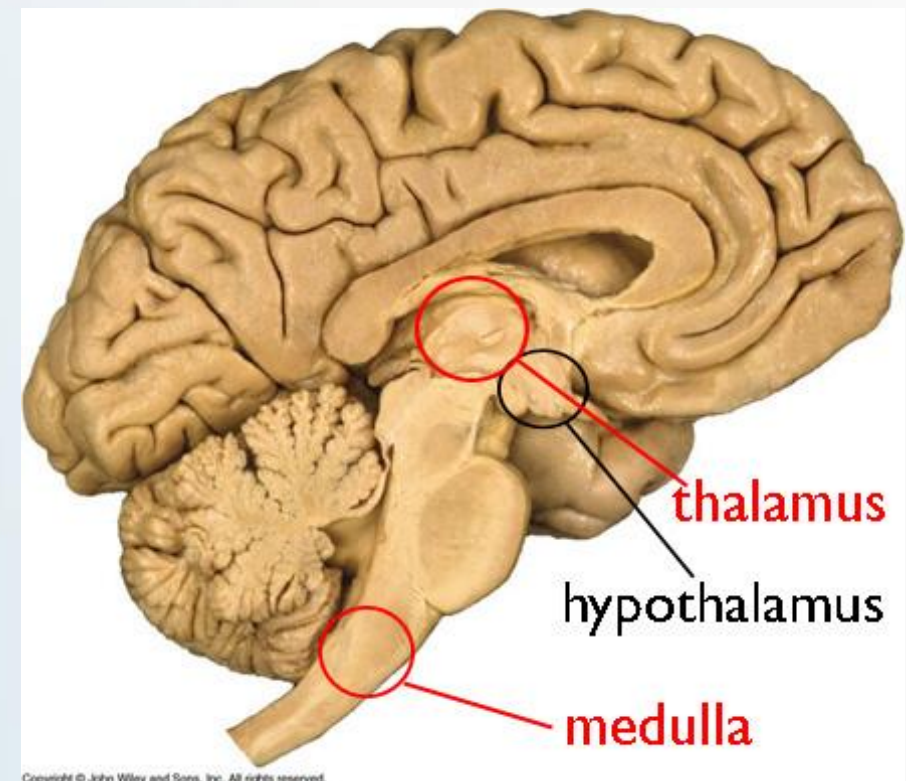
- Found in the mid-part of the diencephalon .
- split up into a number of different nuclei.

-Cholinergic projections from the thalamus are responsible for:

1-Activation of the cerebral cortex.

2-Regulation of flow of information through other thalamic nuclei to the cortex via projections into reticular nuclei.

3-Tuberomammillary nucleus in the hypothalamus projects to the cortex and is involved in maintaining the awake state.

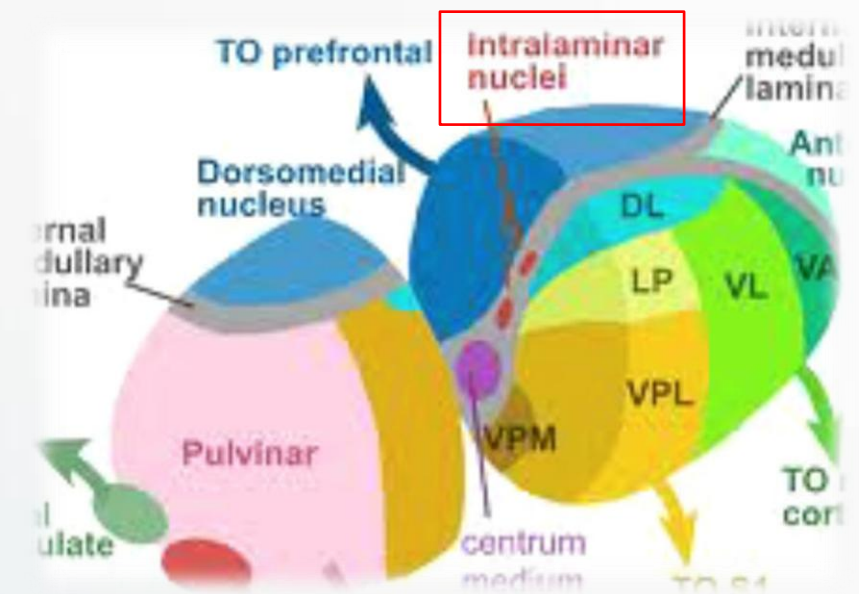


# Anatomical components of RAS (reticular activating system):

- Composed of several neuronal circuits .
- connecting the brainstem to the cortex .
- originate in the upper brainstem reticular core and project through synaptic relays in the rostral intralaminar and thalamic nuclei to the cerebral cortex.
- As a result, individuals with bilateral lesions of thalamic intralaminar nuclei are (**lethargic** **عميق** **or** **somnolent** **مخدر**).

## -Several areas traditionally included in the RAS are:

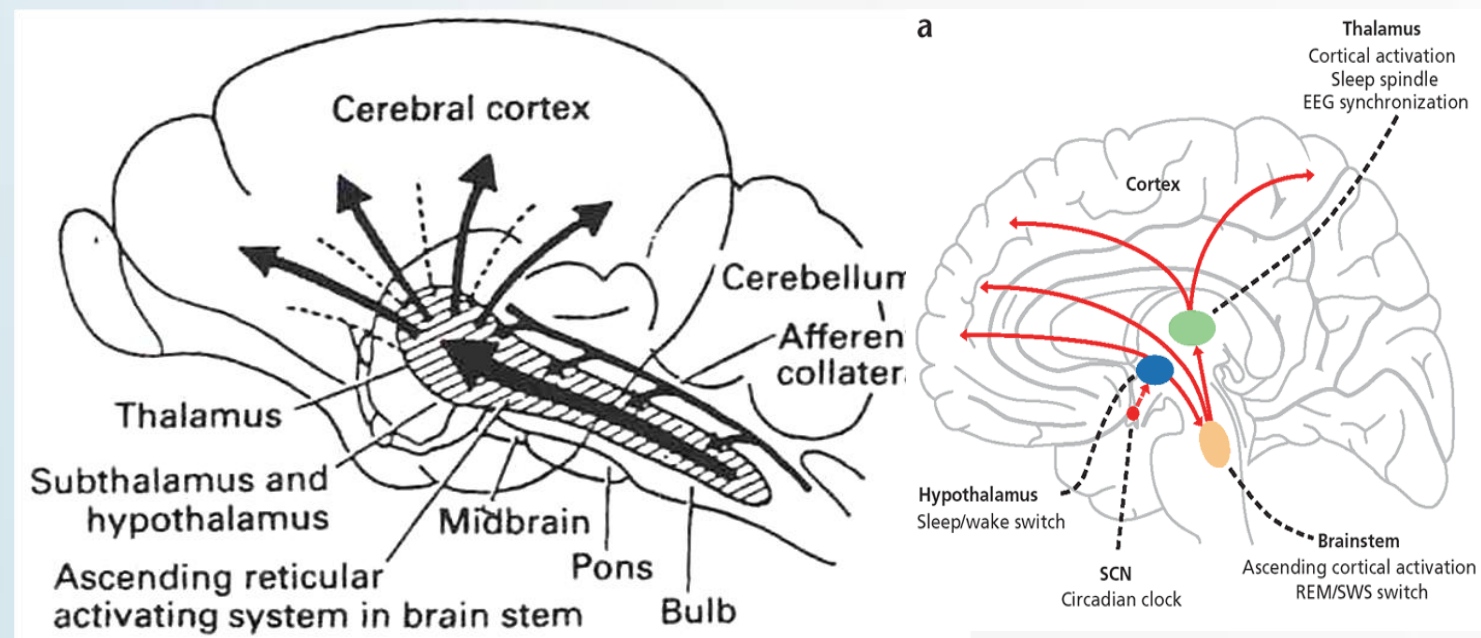
- 1-Midbrain Reticular Formation.
- 2-Mesencephalic Nucleus (substantia , red nucleus etc...).
- 3-Tegmentum of mid brain .
- 4-Dorsal Hypothalamus.
- 5- Thalamic Intralaminar nucleus .



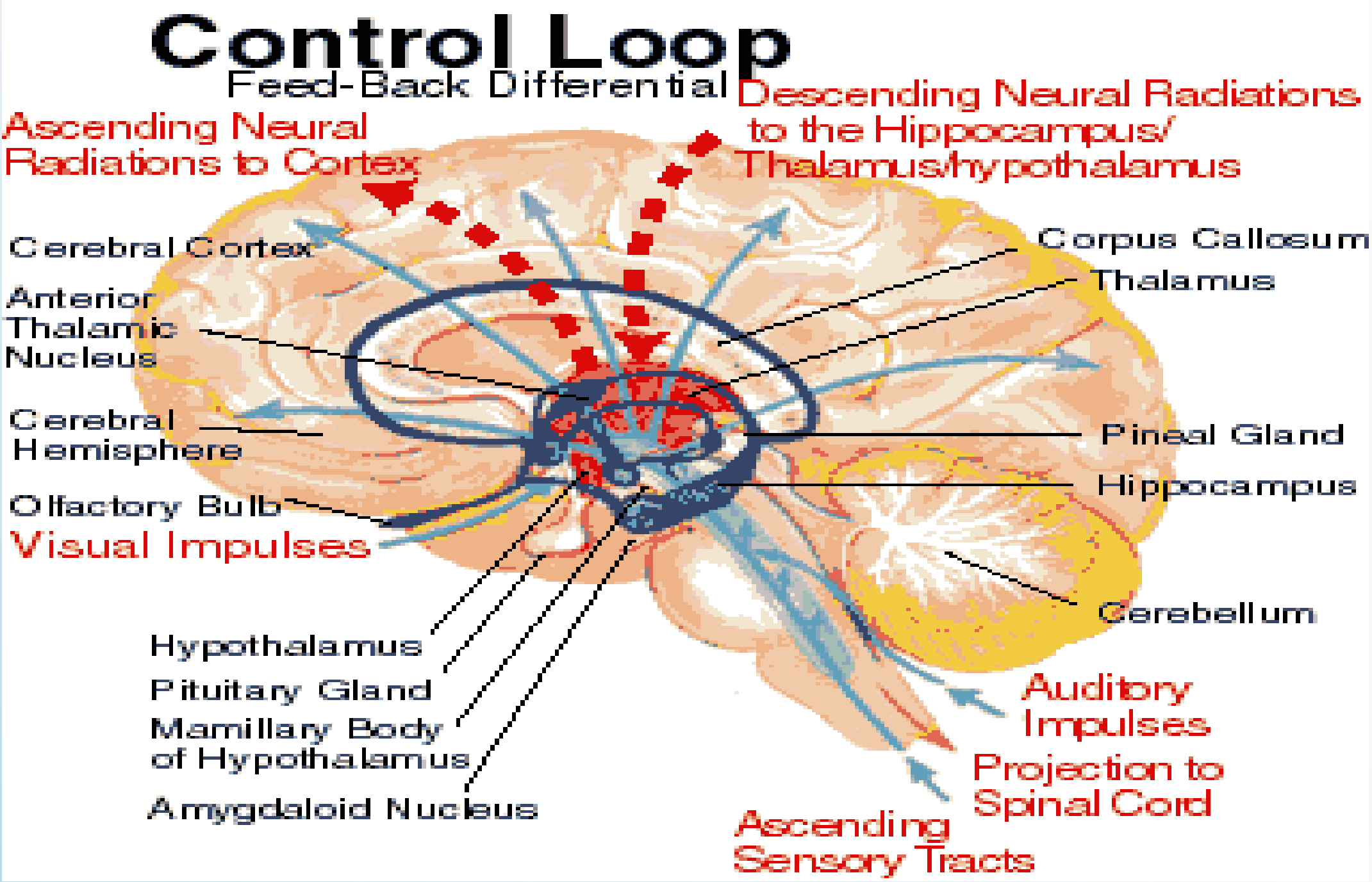
Thalamus

## RAS

- There is an area called **Bulboreticular Facilitory (Excitatory area)** in reticular formation especially in the upper pons and midbrain. This area is essential for wakefulness .
- Lesion in the mid-pons makes the animal spends the rest of its life unconscious .



# Sensory inputs to RAS





# Functions of RAS

## 1- Regulating sleep-wake transitions

## 2-Attention

## 3-RAS and learning

-The **main function** of the RAS is to modify and potentiate thalamic and cortical functions resulting in (EEG) desynchronization.

-Low voltage fast burst brain waves (EEG desynchronization) are associated with wakefulness and REM-sleep.

-During non-REM sleep, neurons in the RAS will have a much lower firing rate large voltage slow waves .

-The physiological change from a state of deep sleep to wakefulness is reversible and mediated by the RAS.

-Stimulation of the RAS produces EEG desynchronization by suppressing slow cortical waves.

-In order that the brain may sleep, there must be a reduction in ascending afferent activity reaching the cortex by suppression of the RAS

# Functions of RAS

1- Regulating sleep-wake transitions

2-Attention

3-RAS and learning

The reticular activating system also helps mediate transitions from relaxed wakefulness to periods of high attention.

The RAS is the center of **balance** for the other systems involved in learning, self-control or inhibition, and motivation.

When functioning normally, it provides the neural connections that are needed for the processing and learning of information, and the ability to pay attention to the correct task.

# WHAT HAPPENS IF RAS IS NOT WORKING PROPERLY?

## If RAS is depressed

- An under-aroused cortex, with difficulty in learning, poor memory, little self-control, and so on.
- lack of consciousness or even coma.

## If the RAS is too excited, and aroused the cortex or other systems of the brain too much

- hyper-vigilance, touching everything, talking too much, restless, and hyperactive will happen .

## INDICES OF LEVEL OF CONSCIOUSNESS

### -Appearance & Behavior :

posture ( sitting , standing) , (open eyes),(Facial expression),responds to stimuli ( including the examiner's questions about name , orientation in time & place& other general Qs like who is the president)

### -Vital signs :

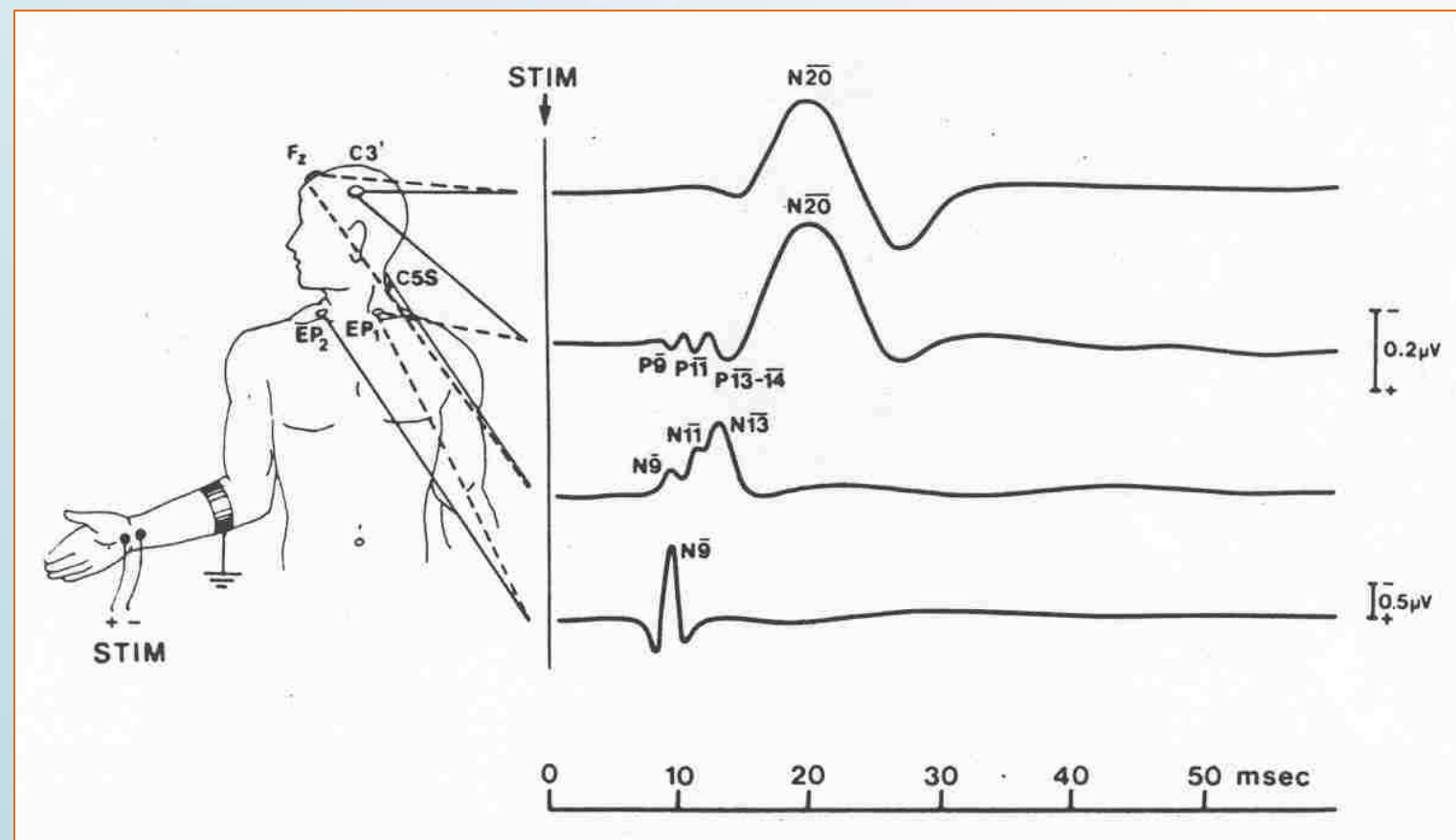
Pulse , BP, respiration , pupils , reflexes , particularly brainstem reflexes , etc )

-EEG → Each of these states ( wakefulness , sleep , coma and death ) has specific EEG patterns .

-Evoked potentials ( in cases of Brain Death ).

## -Brain Death Confirmatory Testing with Somatosensory Evoked Potentials:

-Stimulation of a sense organ can evoke a cortical response that can be recorded by scalp electrode over the primary receiving cortical area for that particular sense .



# SUMMARY

## 1-What is consciousness ?

Is the brain state in which a person is being aware of the self and surroundings

## 2-What are the levels of consciousness?

(1) Normal Consciousness

(2) Clouded consciousness

(3) Sleep

(4) Coma

## 3-what Is the function of Reticular formation?

Somatic motor control ,Cardiovascular control ,Pain modulation , Habituation, Sleep and consciousness

## 4-what will happen if there is a lesion in mid-pons of the animal?

the animal spends the rest of its life unconscious.

## 5-what is the function of RAS ?

The main function of the RAS is to modify and potentiate thalamic and cortical functions resulting in (EEG) desynchronization.

## 6-what will happen if RAS stimulated?

Stimulation of the RAS produces EEG desynchronization by suppressing slow cortical waves.

# SUMMARY

## Consciousness

<b>Def.</b>	Is the brain state in which a person is being aware of the self and surroundings .	
<b>Levels</b>	1- Normal Consciousness	
	2- Clouded consciousness	
	3-Sleep	
	4- Coma	
<b>Structures involved</b>	<b>1- Reticular Formation ( RF).</b>	(A) Lateral Reticular Formation
		(B) Paramedian Reticular Formation
		(C) Raphe nuclei (Median RF).
	<b>2- Thalamus</b>	Cholinergic projections
<b>3- Cortical Association areas</b>		
<b>RAS</b>	<b>Areas</b>	Midbrain Reticular Formation.
		Mesencephalic Nucleus (mesencephalon)
		Thalamic Intralaminar nucleus
		Dorsal Hypothalamus.
		Tegmentum.
	<b>Functions</b>	1- Regulating sleep-wake transitions
		2-Attention
3-RAS and learning		

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# CNS Block