Physiology of 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

4 levels of consciousness

- 1- Normal consciousness
- 2- Clouded consciousness
- 3- Sleep
- 4- Coma

Level 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.

Drug or alcohol intoxication

High fever associated (malaria or septicemia, dementia , etc)

- (3) Sleep :
- Person unconscious (in relation to the external world & surroundings)
- but is arousabale

- (4) Coma : person unconscious and not arausable

brain Structures involved in the conscious state:

- 1- Brain stem Reticular formation
- 2- Thalamus
- 3- Hypothalamus
- 4- Ascending projection pathways
- 5- Wide spread area in the cerebral cortex

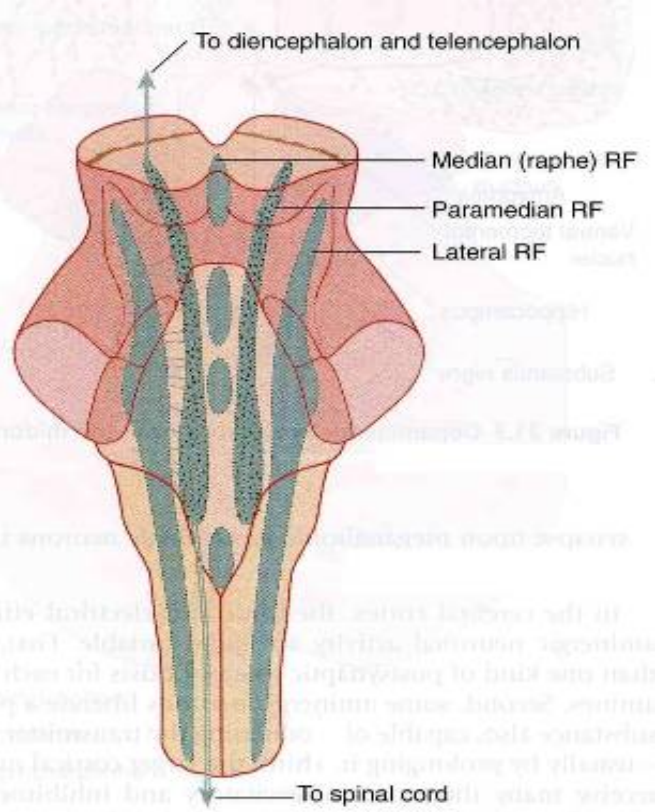
1- Reticular formation

Set of interconnected nuclei that are located throughout the brainstem (Pons, Midbrain, Upper medulla), and the thalamus

Role in behavioral arousal

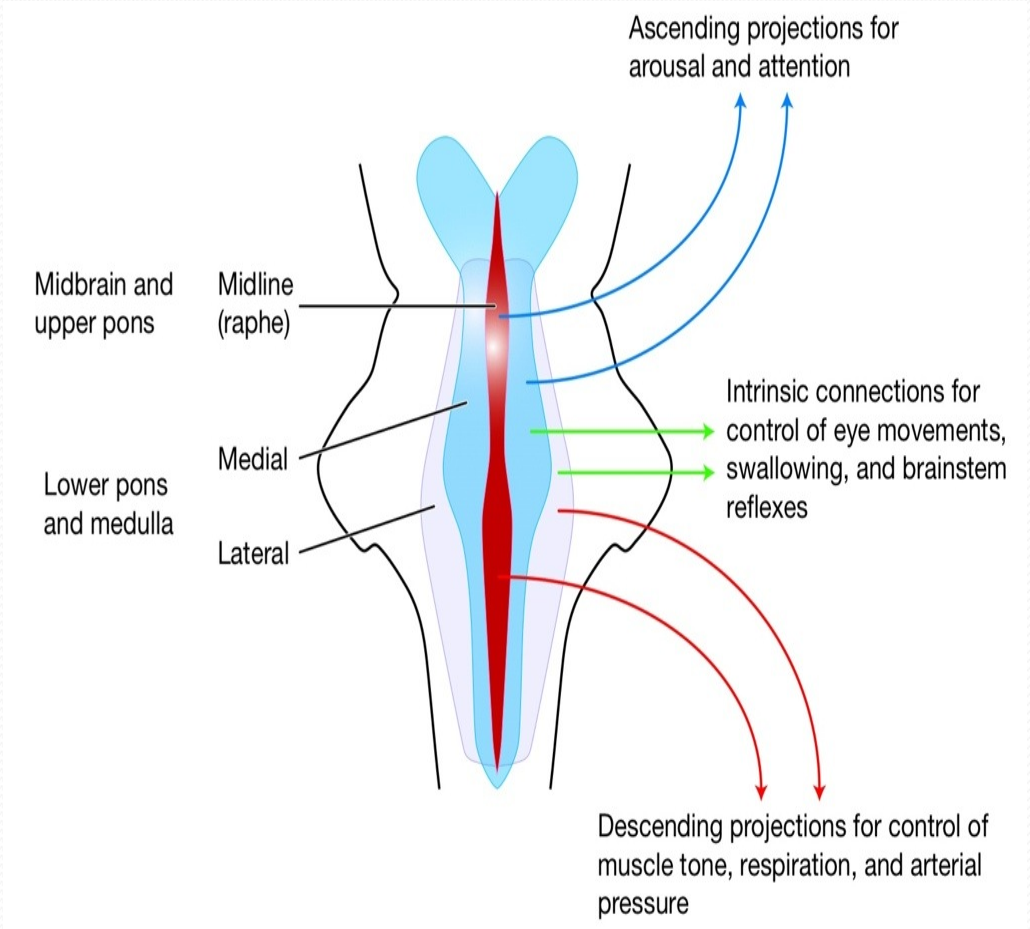
Role in consciousness (sleep/awake cycle)

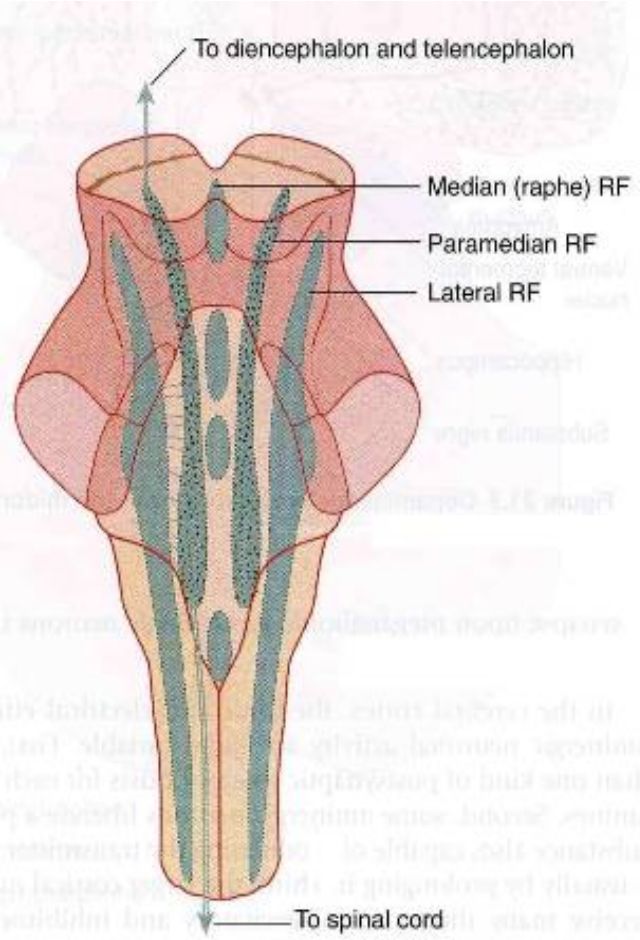
Connect the brain stem to the CC



consists of 3 parts:

Lateral Reticular Formation
Paramedian Reticular Formation
Raphe nuclei (Median RF)





Lateral Reticular Formation

Has small neurones

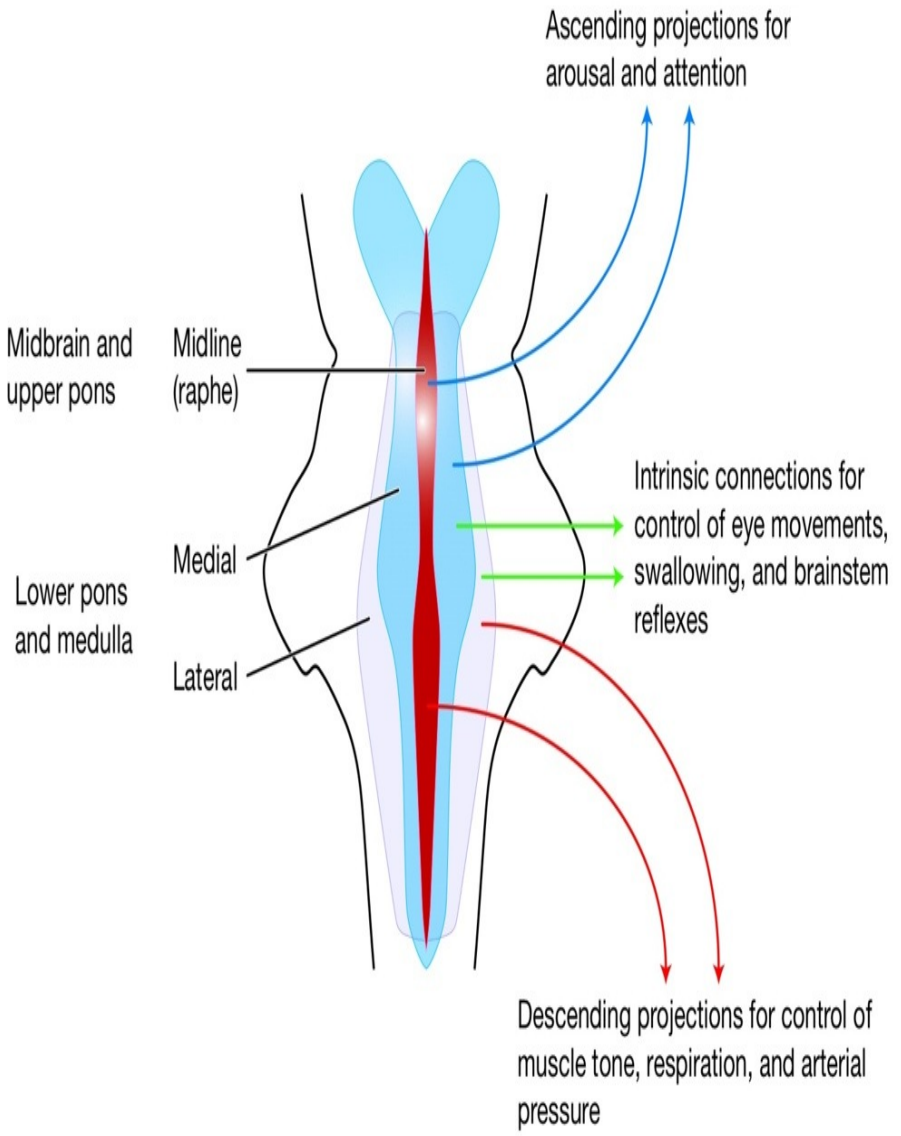
Receives information from ascending tracts for touch and pain.

Receives **vestibular** information from median vestibular nerve.

Receives **auditory** information from superior olivary nucleus.

Visual information from superior colliculus.

Olfactory information via medial forebrain bundle



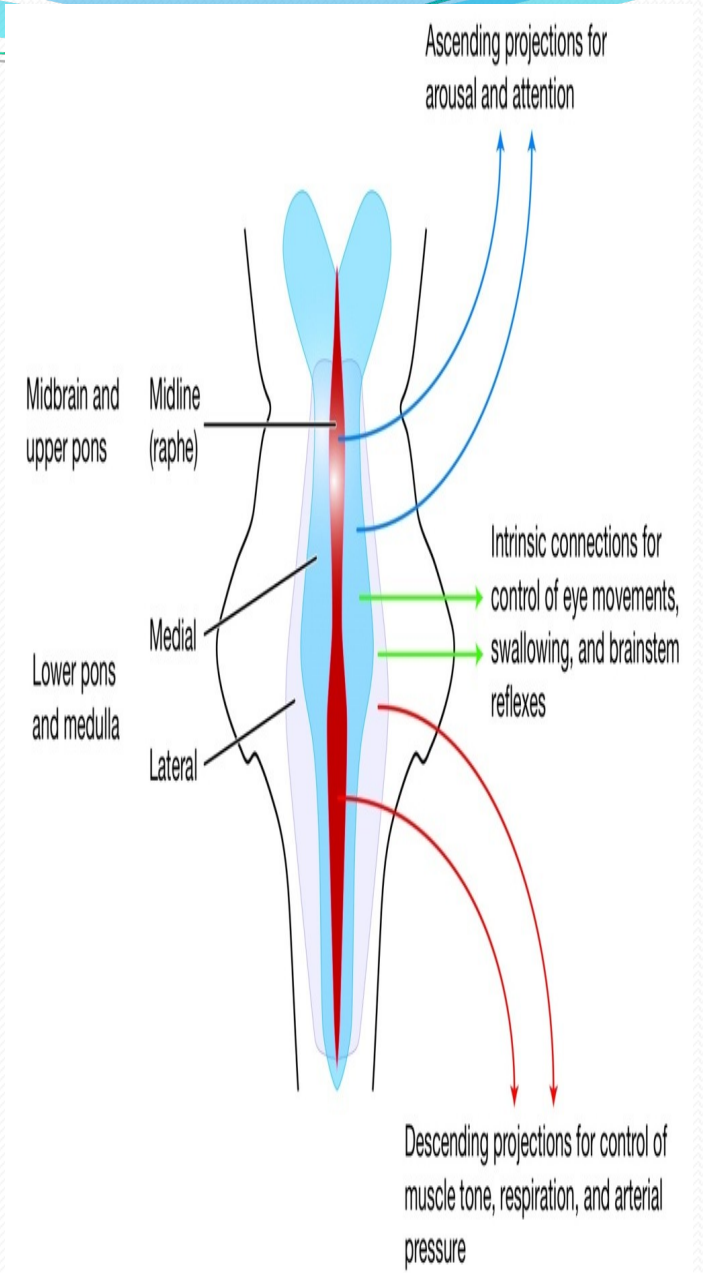
Paramedian Reticular Formation

Has large cells.

Receives signals from lateral reticular formation

Contains noradrenergic (NA) & Dopaminergic (DA) neurones, projects onto cerebral hemispheres.

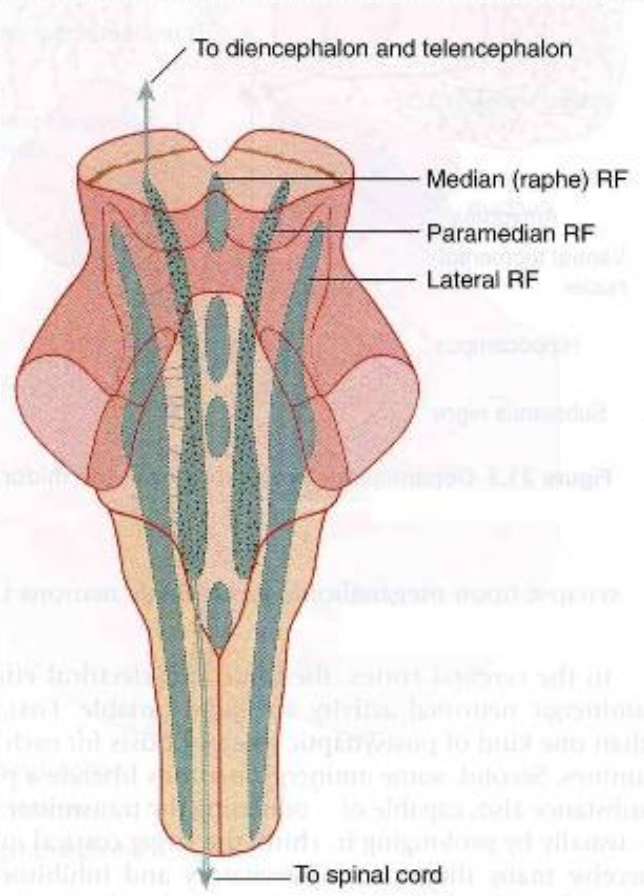
Cholinergic (Chl) neurones project onto the thalamus



Raphe nuclei (Median RF)

In the midline of the reticular formation

Contain **serotonergic projections** to the brain and spinal cord.



Functions of reticular formation:

- 1. Somatic motor control (Reticulospinal tracts)
- 2. Cardiovascular control
  - Through cardiac and vasomotor centers of the medulla oblongata
- 3. Pain modulation
- Pain signals from the lower body >> >> RF » » cerebral cortex
- RF is origin of the descending analgesic pathways
- (act on the spinal cord to block the transmission of some pain signals to the brain)

2- Thalamus:

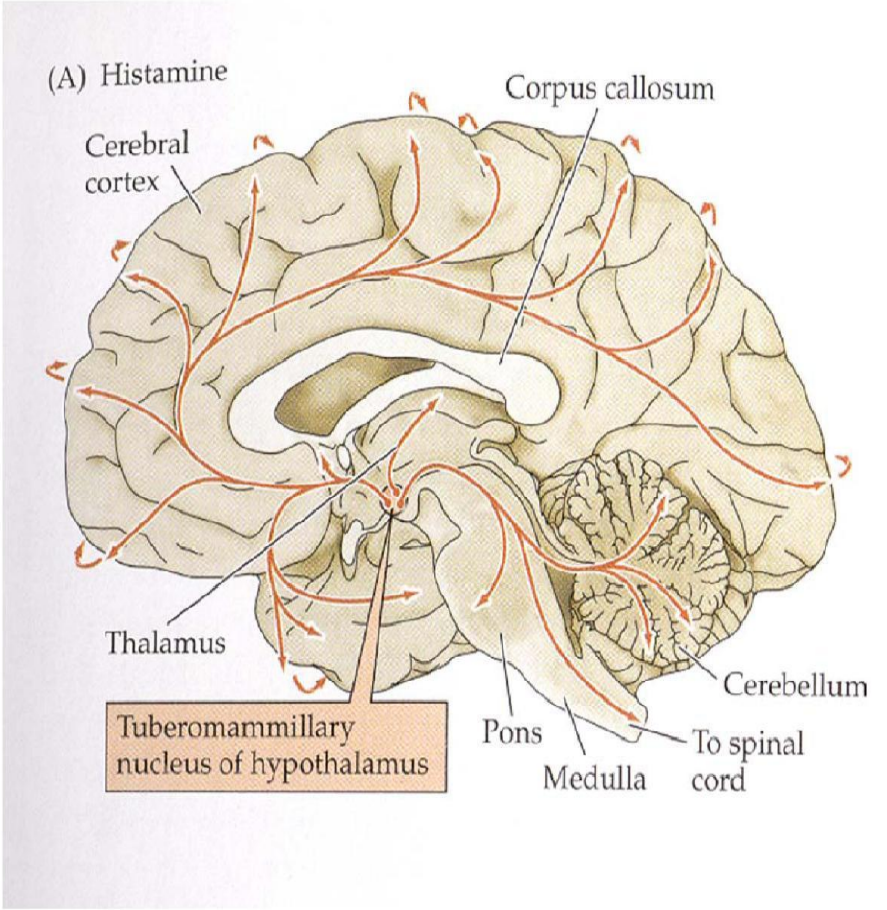
Located n the mid-part of the diencephalon

Cholinergic projections from the thalamus are responsible for:

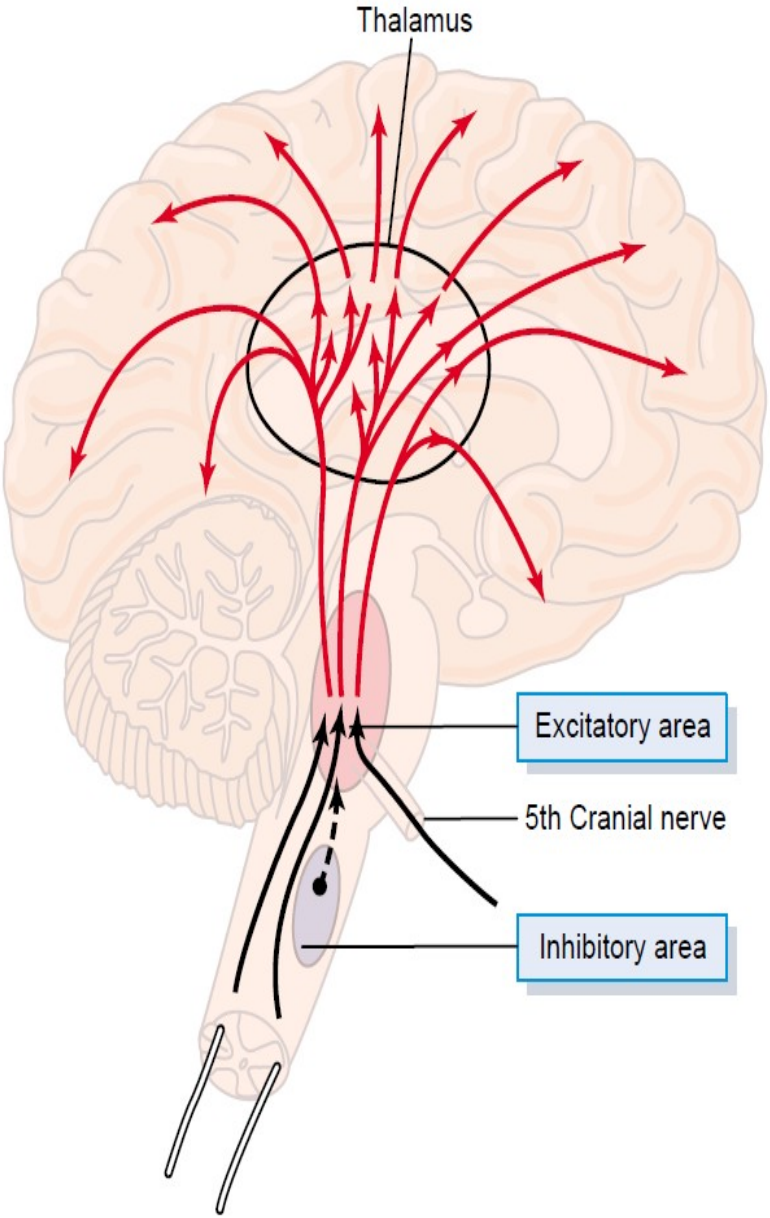
- Activation of the cerebral cortex.
- Regulation of flow of information through other thalamic nuclei to the cortex via projections into reticular nuclei.

3- Hypothalamus

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



- **Reticular Activating System (RAS):**

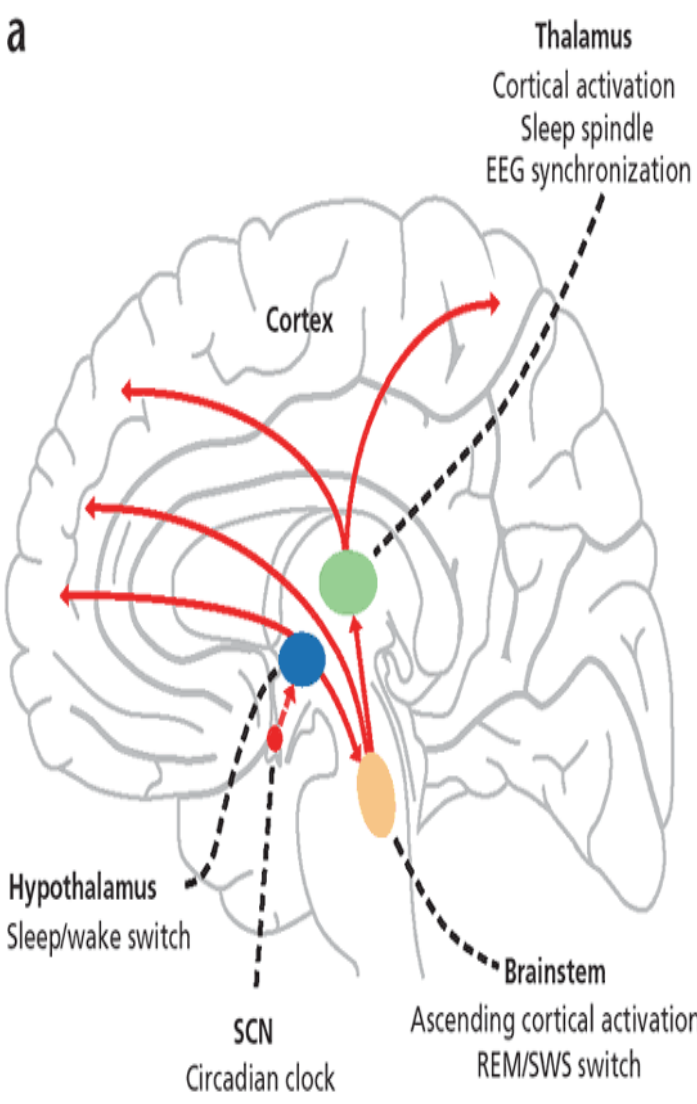


- The Bulboreticular Facilitory (Excitatory) Area + Thalamus =Reticular Activating System (RAS)
- The RAS is the system which keeps our cortex awake and conscious

- Bulboreticular Facilitory (Excitatory) = Reticular Excitatory Area of the Brain Stem
- Sends excitatory signals into Thalamus
- >>>> thalamus excites almost all areas of the cortex .

Anatomical components of RAS

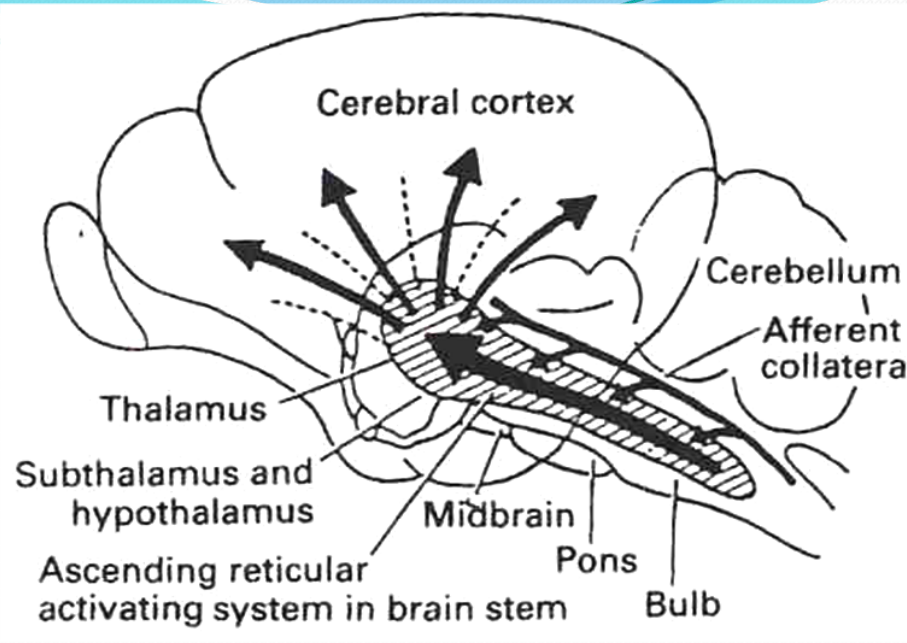
- The RAS is composed of several neuronal circuits connecting the brainstem to the cortex.
- Originate in the **upper brainstem reticular core** and project through synaptic relays in the **thalamic nuclei** to the **cerebral cortex**
- As a result, individuals with bilateral lesions of thalamic intralaminar nuclei are lethargic or drowsy

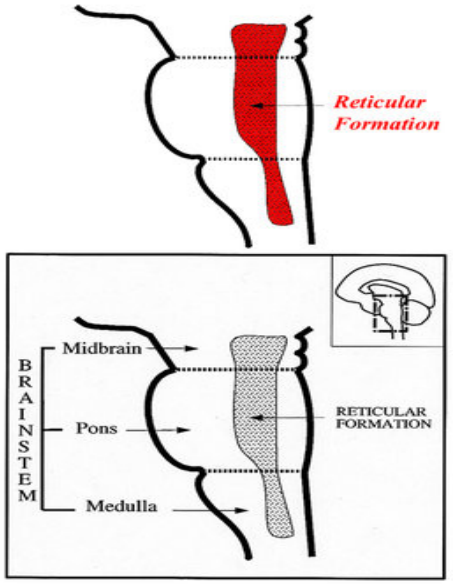


RAS

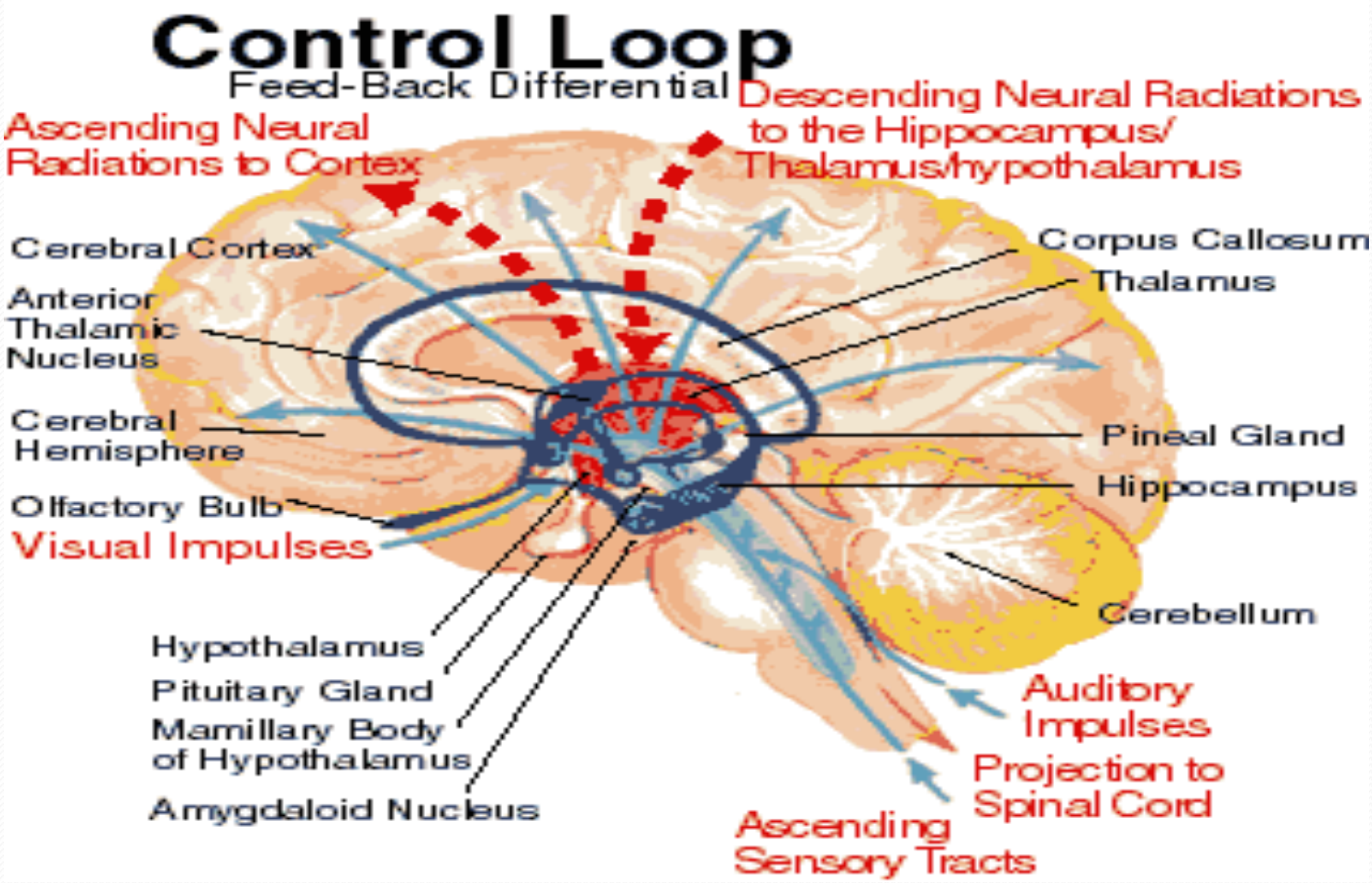
-Lesion in the mid-pons >>>>>>>unconsciousness

-Pons (uppers & middle) and midbrain are essential for wakefulness .





Sensory inputs to RAS



Functions of RAS:

1- Regulating sleep-wake transitions

If inhibitory area activity increase >>>> reduce the activity of RAS >>>>> less afferent signal to the CC >>>>> sleep

- 2-Attention:

  RAS mediate transitions from relaxed wakefulness to of high attention

- 3-RAS and learning:

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

  -Provides the neural connections for processing and learning of information,

  -Selective attention (to the correct task)

RAS dysfucntion

If RAS is depressed:

An under-aroused cortex
Difficulty in learning
Poor memory
Little self-control
lack of consciousness or even coma.

If the RAS is too excited,

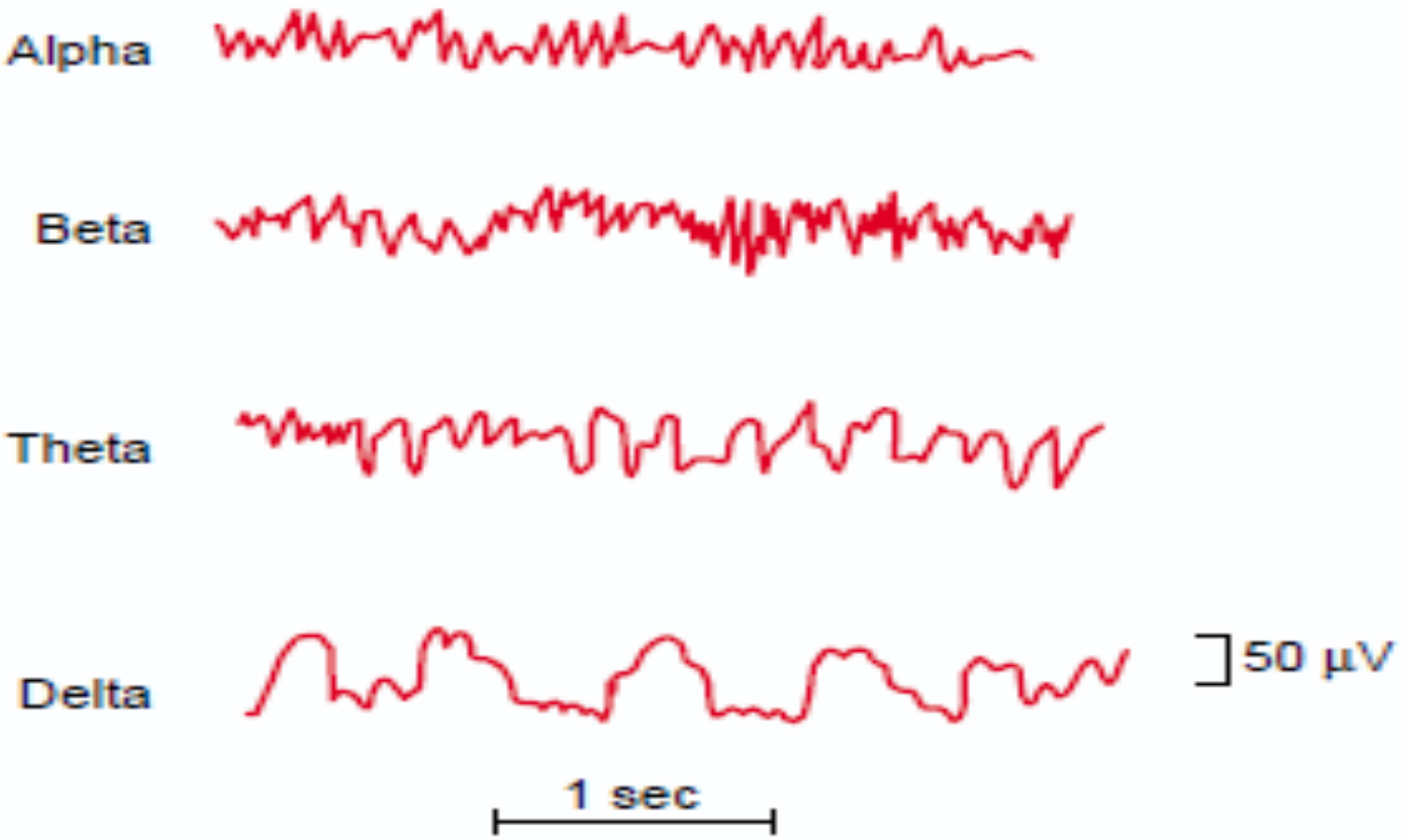
Over aroused cortex
Hyper-vigilance (sensory sensitivity)
Touching everything
Talking too much
Restless
Hyperactive

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 ?)

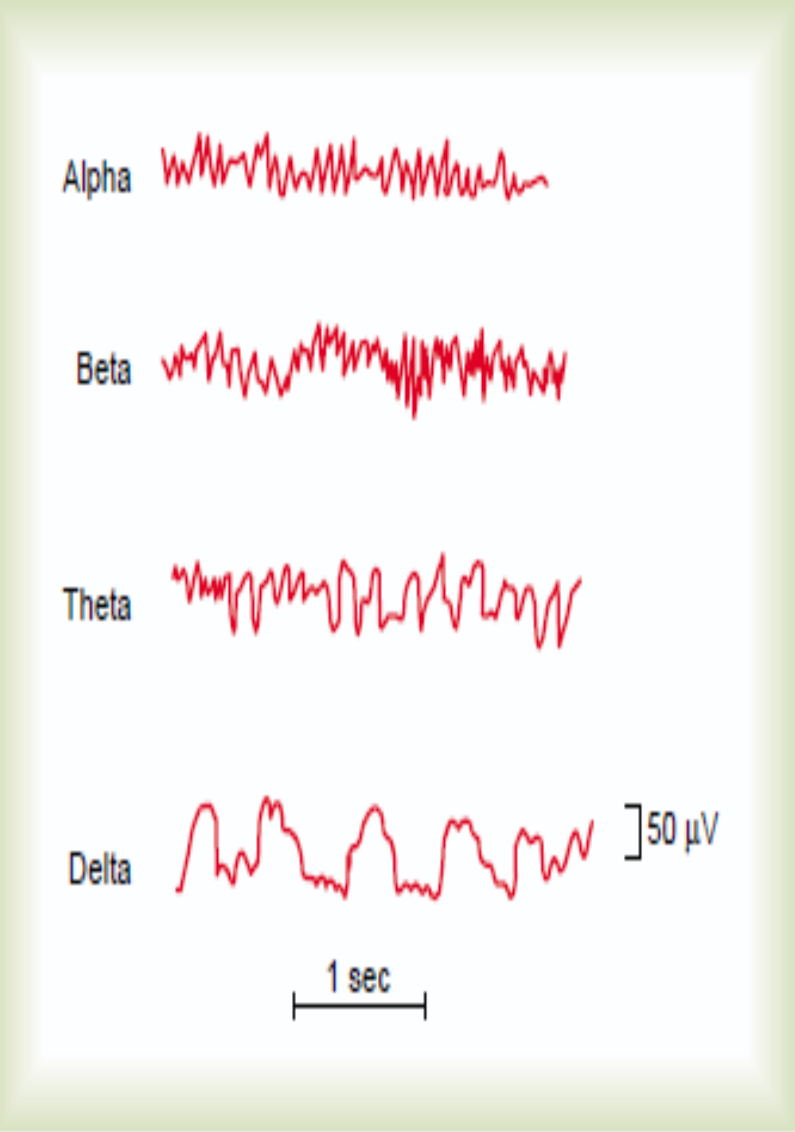
- **Vital signs** :
- Pulse , BP, respiration , pupils , reflexes , particularly brainstem reflexes , etc)
- **EEG** → Each of these states (wakefulness , sleep , coma and death) has specific EEG patterns
- **Evoked potentials** (in cases of Brain Death).

Electroencephalogram



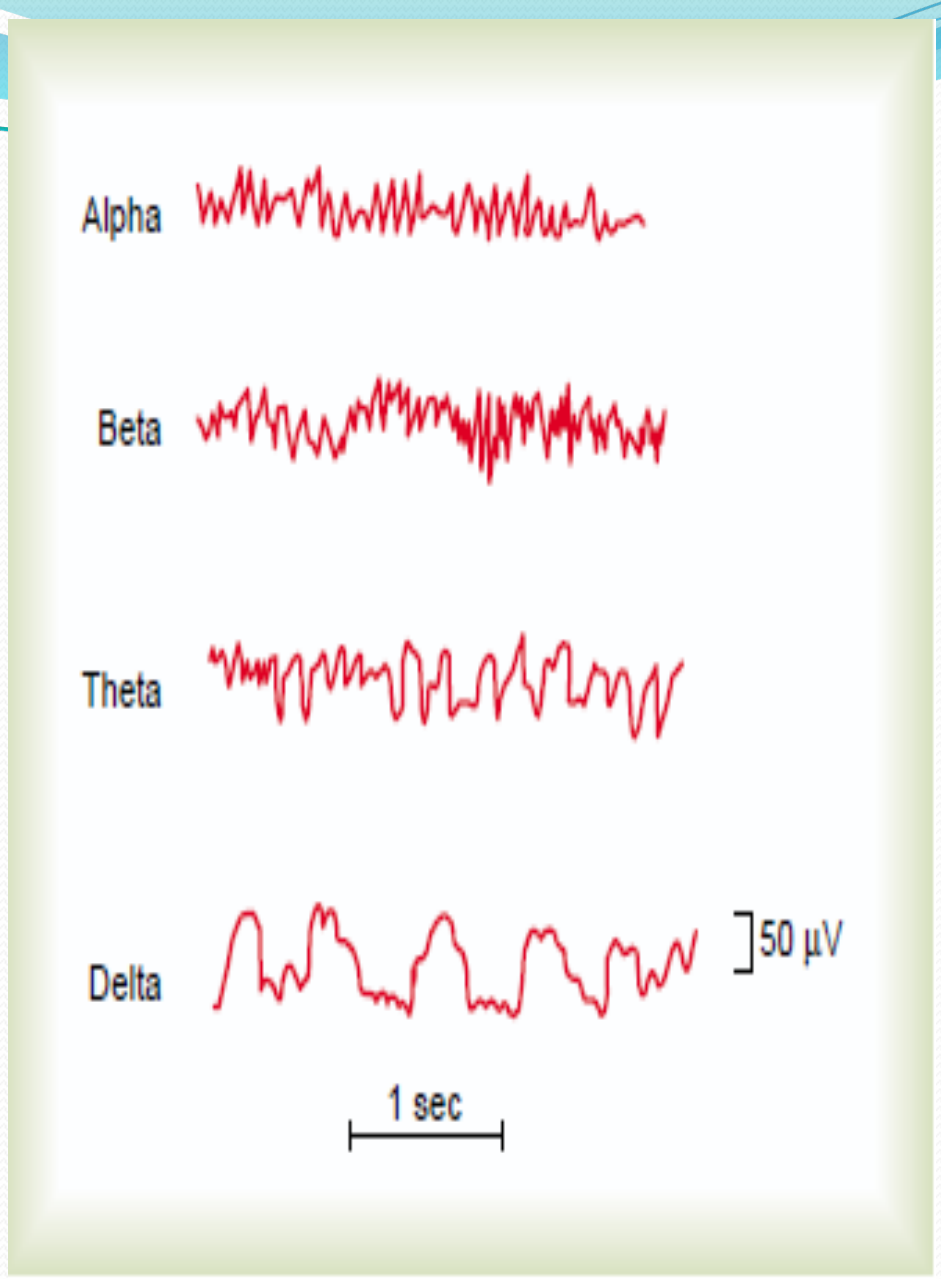
- Alpha waves:
- Recorded from the parietal &occipital regions
- Awake and relaxed+ eyes closed
- 10 to 12 cycles/second.

- Beta waves:
- Frontal lobes
- Produced by visual stimuli and mental activity
- 13 to 25 cycles per second.

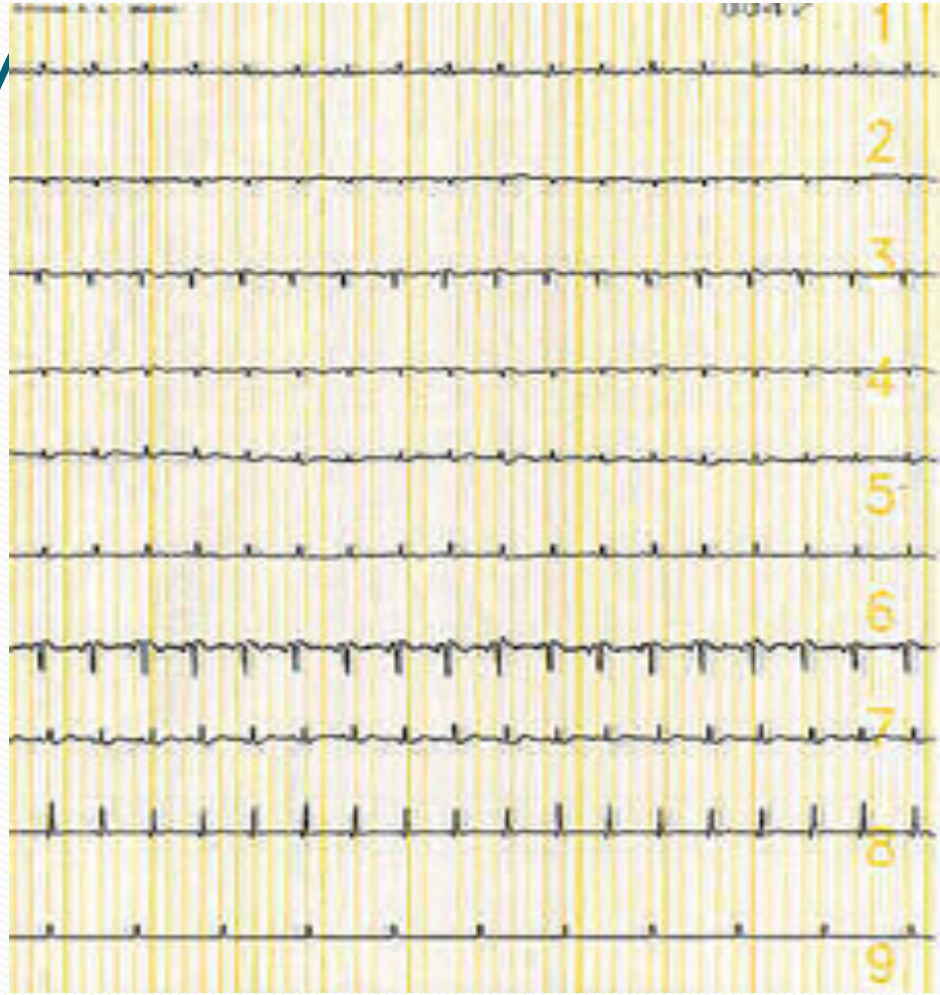


- Theta:
- Temporal and occipital
- 5 to 8 cycles/second
- Normal in newborn
- Theta waves in adults indicates severe emotional stress

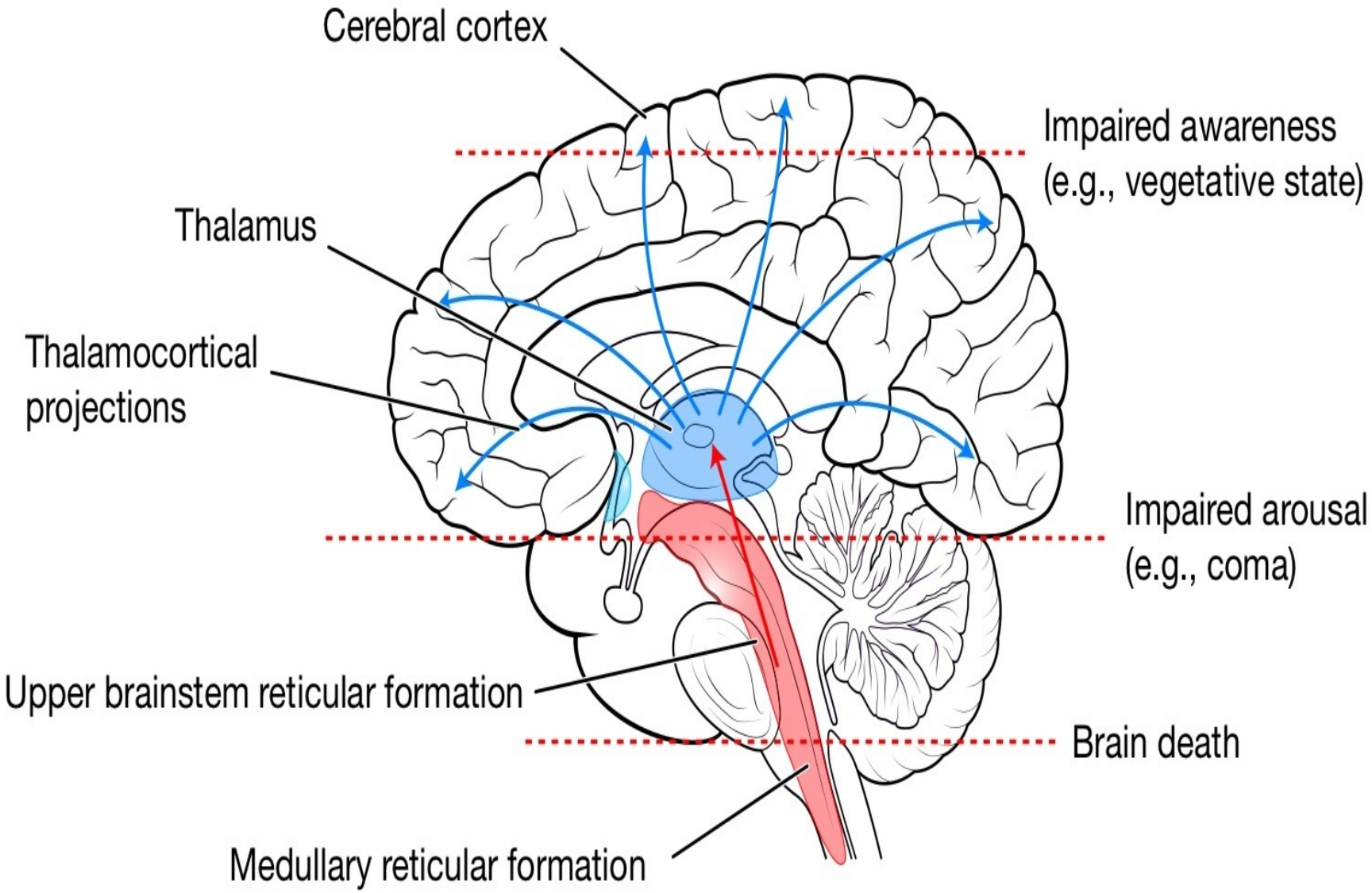
- Delta:
- From the cerebral cortex
- 1 to 5 cycles/second
- Sleep (adults) and in an awake infant
- In an awake adult indicates brain damage.



Normal EEG (at normal magnification)



Brain Death (Flat EEG ,at very high magnification)


Cerebral cortex
Impaired awareness
(e.g., vegetative state)
Thalamus
Thalamocortical
projections
Impaired arousal
(e.g., coma)
Upper brainstem reticular formation
Brain death
Medullary reticular formation

Thank you