21

Physiology of consciousness

Color Index:

- Main text
- Important
- Girls Slides
- Boys Slides
- Notes
- Extra

Editing File

Objectives

1. Define Consciousness and explain the different states of consciousness.
2. Explain what is meant by “Reticular Activating System” RAS.
3. Define the function and location of the bulboreticular Facilitatory.
4. bulboreticular Facilitatory area, Thalamus and cerebral cortex subserves & sustains consciousness.
5. Explain how a medical person can differentiate between conscious and unconscious person by means of outward behavior and physical signs
6. Describe the role of EEG and evoked potentials in differentiating between a conscious person, a sleeping person, a comatose patient and a dead patient..

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 (flat EEG = unconscious)

The four 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 (malaria or septicemia , dementia"الخرف " , 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**

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 brainstem to the CC (cerebral cortex)

Consists of 3 parts:

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

Lateral Reticular Formation	- Has small neurons - 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 - Nucleus ceruleus which located laterally and posteriorly at junction between pons and midbrain, contains noradrenergic neurons and projects onto the cerebral cortex. - Ventral tegmental nucleus contains dopaminergic neurons that project directly onto the cortex - Acetylcholine secreted by cholinergic by gigantocellular"giganto=giant"neurons project onto the thalamus -Contains **noradrenergic (NA)** & **Dopaminergic (DA)** neurons, 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:** By Reticulospinal tract

2. **Cardiovascular control:** Through cardiac and vasomotor centers of the medulla oblongata

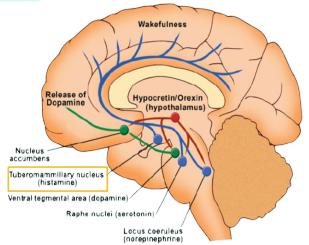
3. **Pain modulation:**
   - Pain signals from the lower body >RF > cerebral cortex
   - RF is origin of the descending analgesic pathways
   - (act on the spinal cord to block the transmission of some pain signals to the brain)

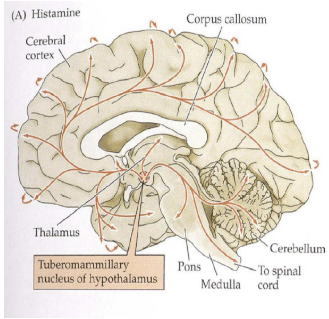
4. **Sleep and consciousness:** The reticular formation has projections to the thalamus and cerebral cortex . It plays a central role in states of consciousness like alertness and sleep. Injury to the reticular formation can result in irreversible coma.

5. **Habituation:** This is a process in which the brain learns to ignore repetitive, meaningless stimuli while remaining sensitive to others. A good 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-Hypothalamus

Tuberomammillary nucleus in the hypothalamus which consists of histaminergic neurons projects to the cortex and is involved in **maintaining the awake state.**





3-Thalamus

Located in 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.

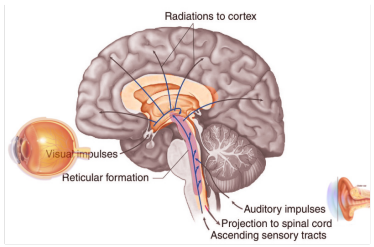
Male slides

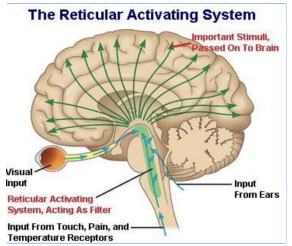
- Almost every area of the cerebral cortex connects with its own highly specific area in the th
- These functional segments are called **Thalamocortical Sectors**
- They are made of

1. Thalamo-cortical (TC) fibers.
2. Cortico-thalamic (CT) fibers.

- These neural circuits between the thalamus & cortex are essential for determining the level of consciousness

Reticular Activating System (RAS)



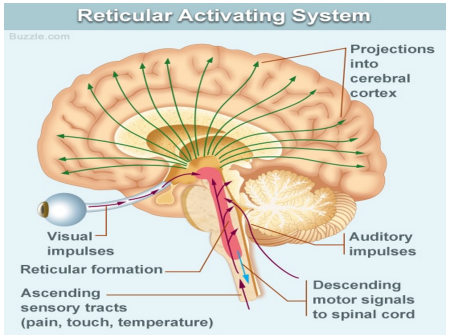


Anatomical components:

If the stimulation was in the inhibitory area in medulla, this will lead to reduction of the activity of RAS, therefore Sleeping. If the stimulation was in the Excitatory area, this will lead to maintaining the awake state.

- 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.**
- Pons (upper and middle) and the MidBrain are essential for wakefulness.
  If there is a lesion in the Mid-Pons, it will lead to unconsciousness.
- There are two main areas regarding consciousness. An Excitatory area Which is the Bulboreticular area (located in the upper ⅔ of pons + MidBrain) and an inhibitory area located in the medulla.
- If the Bulboreticular area **(Reticular excitatory area of the brain stem)** sends impulses to the thalamus, the thalamus will excite almost all of the cerebral cortex.
- As a result, individuals with bilateral lesions of thalamic intralaminar nuclei are lethargic or drowsy (نعسان).
- The Reticular Activating System is composed of the **Bulboreticular Facilitatory (excitatory) area** + **Thalamus**, both form the RAS. The RAS is the system which keeps our cortex awake and conscious.

Sensory inputs to RAS:



Attention is caused by a balance between excitatory & inhibitory signals.
For full attention: inhibitory signals decrease & excitatory signals increase in the cerebral cortex causing wakefulness
& alertness

When RAS receives impulses (from the ascending tract for example) All these impulses stimulate the thalamus and the thalamus then stimulate cerebral cortex.

Functions of RAS :

1 egulating sleep-wake transition

If the stimulation is in the inhibitory area (Which is in medulla) this will lead to reduction of the activity of RAS>> Less afferent signals to the CC>> sleeping.
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 *
- There is increased regional blood flow in the midbrain reticular formation (MRF) and thalamic intralaminar nuclei during tasks requiring increased alertness and attention *

3 Learning

-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 for processing and learning of information,
- Ability to pay / Selective attention to the correct task.

RAS Dysfunction:

If RAS is depressed	If RAS is too excited
-An under-aroused cortex -Difficulty in learning -Poor memory -Little self-control -lack of consciousness or even coma.	-Over aroused cortex -Hyper-vigilance (sensory sensitivity) -Touching everything -Talking too much -Restless -Hyperactive

All functions related to the cerebral cortex will be depressed

People with excited RAS have exaggerated cerebral cortex activities. So they will become sensitive to touch, light, sound and other stimuli. It is seen in patients with ADHD.

ADHD: Attention deficit hyperactivity disorder is a disorder that causes above normal levels of hyperactive & impulsive behaviors.

Indices of level of consciousness:

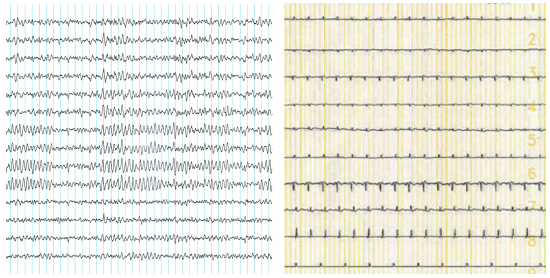
A	B	C	D
Appearance and Behavior	**Vital signs**	**EEG**	**Evoked potentials**
- Posture (sitting, standing) - Open eyes - Facial expression - Responds to stimuli (including the examiner's questions about - Name - Orientation in time & place - Other general Qs like who is the president)	- Pulse - BP - Respiration - Pupils fixed and dilated can indicate death - Reflexes (particularly **brainstem** reflexes) e.g. caloric test, gag reflex, and other spinal reflexes	Each of these states - Wakefulness - Sleep - Coma - Death has specific EEG patterns	**(in cases of brain death)** 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.

Electroencephalogram

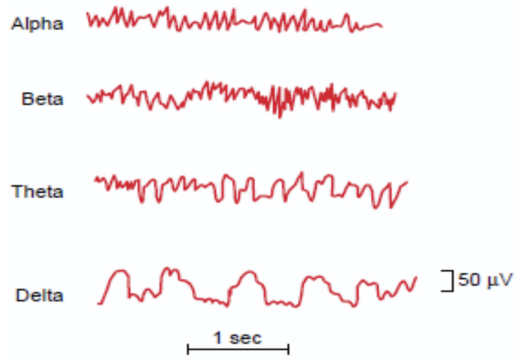
a test that detects electrical activity in your brain using small, metal discs (electrodes) attached to your scalp. Your brain cells communicate via electrical impulses and are active all the time, even when you're asleep. This activity shows up as wavy lines on an EEG recording.

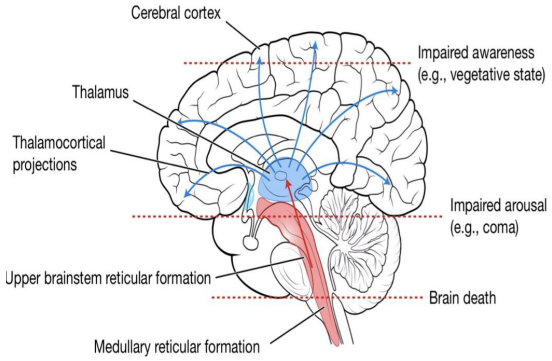
Here are 4 waves that you may find in an EEG recording:

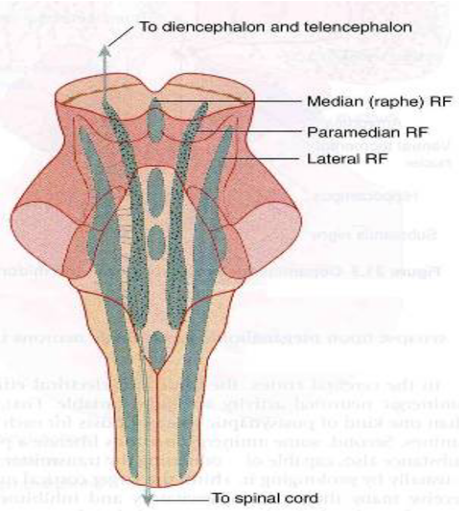
α Alpha	-Recorded from the parietal & occipital regions in adult -Awake and relaxed + eyes closed -Frequency of 10 to 12/13 Cycles/second Most common wave
θ Theta	-Temporal / Parietal and occipital lobes. -Frequency of 5 to 8 cycles/second (low). -Normal in newborn. *Theta waves in awake adults indicates severe emotional stress awake adults, can indicate neurodegenerative diseases Slower than alpha & beta waves
β Bata	-Recorded from the Frontal lobe and parietal lobe in adults -Produced by visual stimuli and mental activity. -Frequency of 13 to 25/30 Cycles/second. Wave with the highest frequency
δ Delta	-From the cerebral cortex -Frequency of 1 to 5 cycles/second (Very low). Slowest wave - **Deep sleep** in adults and awake infants. -In an awake adults indicates brain damage.

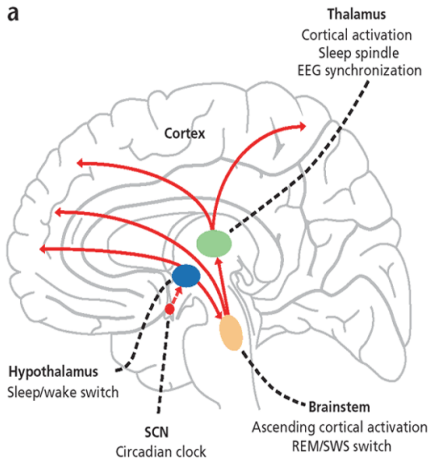


A comparison between a normal EEG (on the left: with normal magnification) and a Brain death EEG on the right. A person with a brain death will have flat EEG with very high magnification.









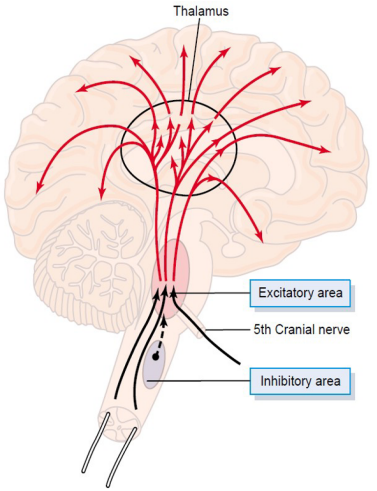
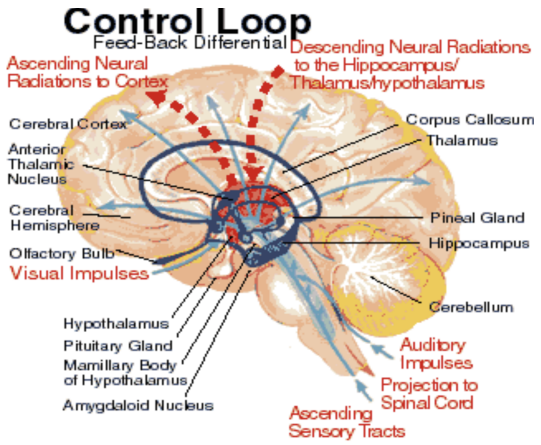
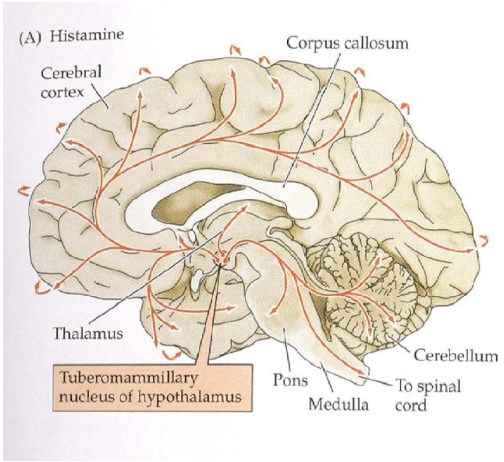
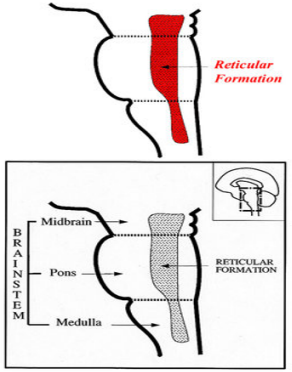


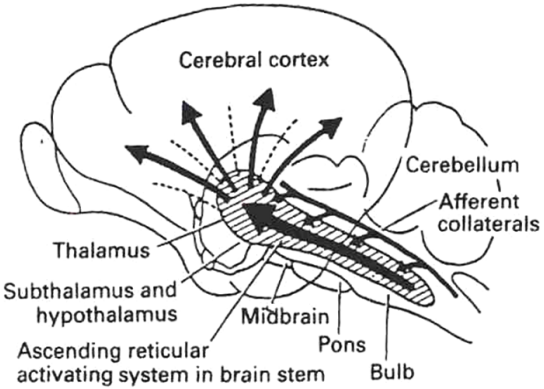
Figure 58–1

Excitatory-activating system of the brain. Also shown is an *inhibitory area* in the medulla that can inhibit or depress the activating system.









TEST YOURSELF !

1-Which system is responsible for wakefulness and alertness ?

A) Ach

B) RAS

C) Serotonin system

D) Melatonin system

2-where is the bulboreticular facilitatory (excitatory) area of the reticular formation ?

A) Cerebral cortex

B) lower pons only

C) Upper pons & midbrain

D) Thalamus

3-consciousness depends upon which of the following ?

A)Reticular formation

B)Wernicke's area

C)Broca's area

D)Angular gyrus

4-which of the following has a cholinergic projection towards the cortex to help being in arousal state ?

A)Hypothalamus

B)Thalamus

C)Raphe nuclei

D)Epithalamus

Answers : B, C, A, B.

SAQ

1- Reticular formation composed of three parts , mention them.

1-lateral reticular formation. 2-Paramedian reticular formation. 3-Raphe nuclei (median RF).

2-Mention 3 functions of reticular formation.

1-Somatic motor control. 2-Cardiovascular control. 3-pain modulation . 4-Sleep and consciousness. 5-Habituation.

3- -If RAS is too depressed , what will happen ?
-If RAS is too excited , what will happen?

Team Leaders


Aseel Alsaif


Aldanah Alghamdi


Huda bin Jadaan


Sultan Albaqami


Fahad Almughaiseeb


Hamad Alziyadi

Team Members

Bayan Alenazi
Renad alshehri
Layan Alruwaili
Norah Alhazzani
Haya Alzeer
Huda bin Jadaan
Haya Alajmi
Reena alsadoni
AlJoharah AlWohaibi
Raghad almuslih

Rahaf Alslimah
Jana Alshiban
Razan Alsoteehi
Lena Alrasheed
Layan Aldosary
Shahad Alzaid
Norah Almania
Lama Almutairi
Raghad Alhamid

Layla Alfrhan
Farah Aldawsari
Manar Aljanubi
Waad Alqahtani
Salma Alkhlassi
Shoug Alkhalifa
Sarah Alajajii
Sarah Alshahrani
Wafa Alakeel
Remaz Almahmoud
Sarah Alshahrani

Hamad Alyahya
Mishal aldakhail
Ziyad Alsalamah
Omar Alamri
sultan almishrafi
Mohammad Alzahrani
Khalid Alanezi
sami Mandoorah
Abdullah alzamil
Mohammed Alqutub
Mohammed Bin Manee

Salmam Althunayan
faisal alzuhairy
Mohammed Alarfaj
Ryan alghizzi
Mohammed Maashi
Zeyad Alotaibi
Nazmi Adel Alqutub
Faisal Alshowier
Ziad Alhabardi
Osamah almubbadel

Special Thanks to Physiology **Team441**
Team logo and design was done by **Rafan Alhazzani**
Thanks to **ALEEN ALKULYAH** for Helping with the design!

med443physioteam@gmail.com