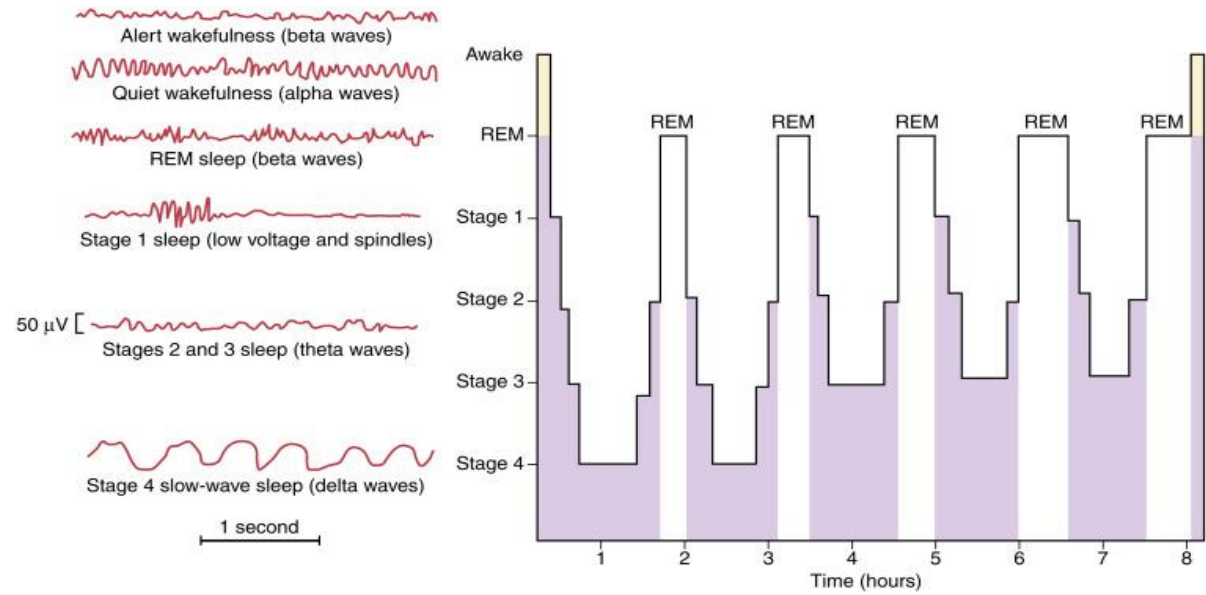




EEG

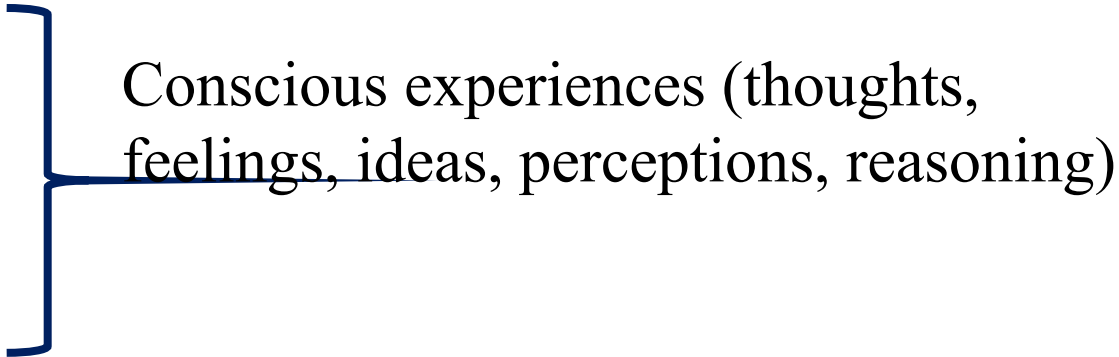
Dr Rita.M.Khadkikar
I MBBS 2.6.2020

Points of discussion

- States of consciousness (Behavioural states)
- EEG
- EEG waves
- Uses of EEG
 - Sleep and wakefulness
 - Sleep disorders
 - Epilepsy
 - Coma
 - Brain Death

States of consciousness

States of consciousness vary from

- Awake Alertness
 - Awake relaxed
 - Drowsy
 - Sleep
 - Coma
- 
- Conscious experiences (thoughts, feelings, ideas, perceptions, reasoning)

- State of consciousness is determined from the
 - behaviour and
 - EEG

- Sleep is a physiological process
- Electroencephalography is a technique

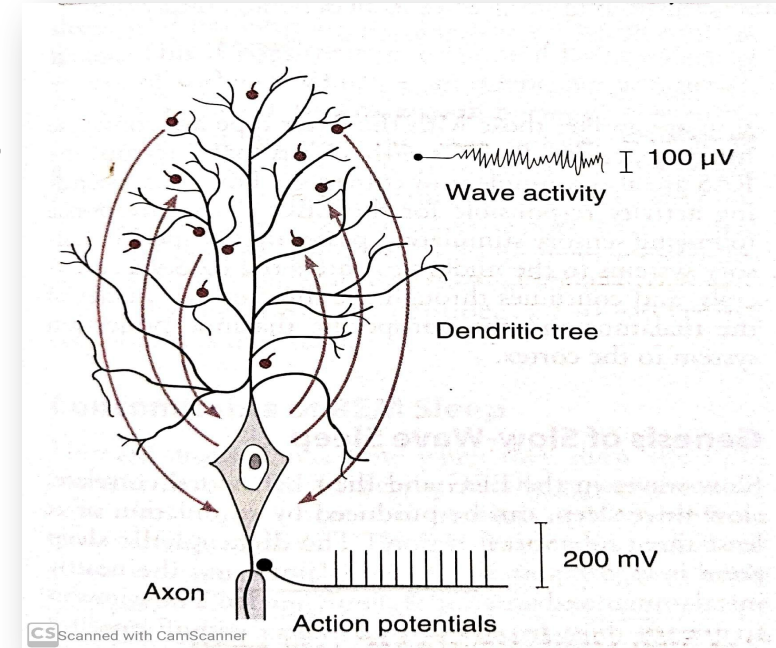
EEG

- Machine used: Electroencephalograph
- Procedure :Electroencephalography
- Record :Electroencephalogram

Electroencephalogram

Electrical potentials from the brain are either

- Graded potential like EPSP and IPSP
- Action Potential



- EEG is a record of summated postsynaptic potentials (graded potentials, EPSP+IPSP) in thousands of brain neurons underlying the electrode.
- **EEG is not a record of the action potentials**

Activity in cortical neurons

- A single neuron receives information from approximately 200000 other neurons .
- The net change in the potential is responsible for the action potential.
- Majority of signals recorded in EEG are from the pyramidal cells of the cortex (specific sensations reach layer 4 and non specific reach layers 1-4 of cortex)

Electroencephalogram and Electrocorticogram

- Electroencephalogram: record of summated postsynaptic potentials (EPSP+IPSP) of brain neurons by placing the electrodes on the scalp.
- Electrocorticogram: record of electrical activity of the brain by placing electrodes on the pial surface of the cortex

EEG recording

- Precisely defined system of electrodes are placed on various areas frontal, parietal,temporal and occipital .

Recording can be

- Unipolar or
- Bipolar

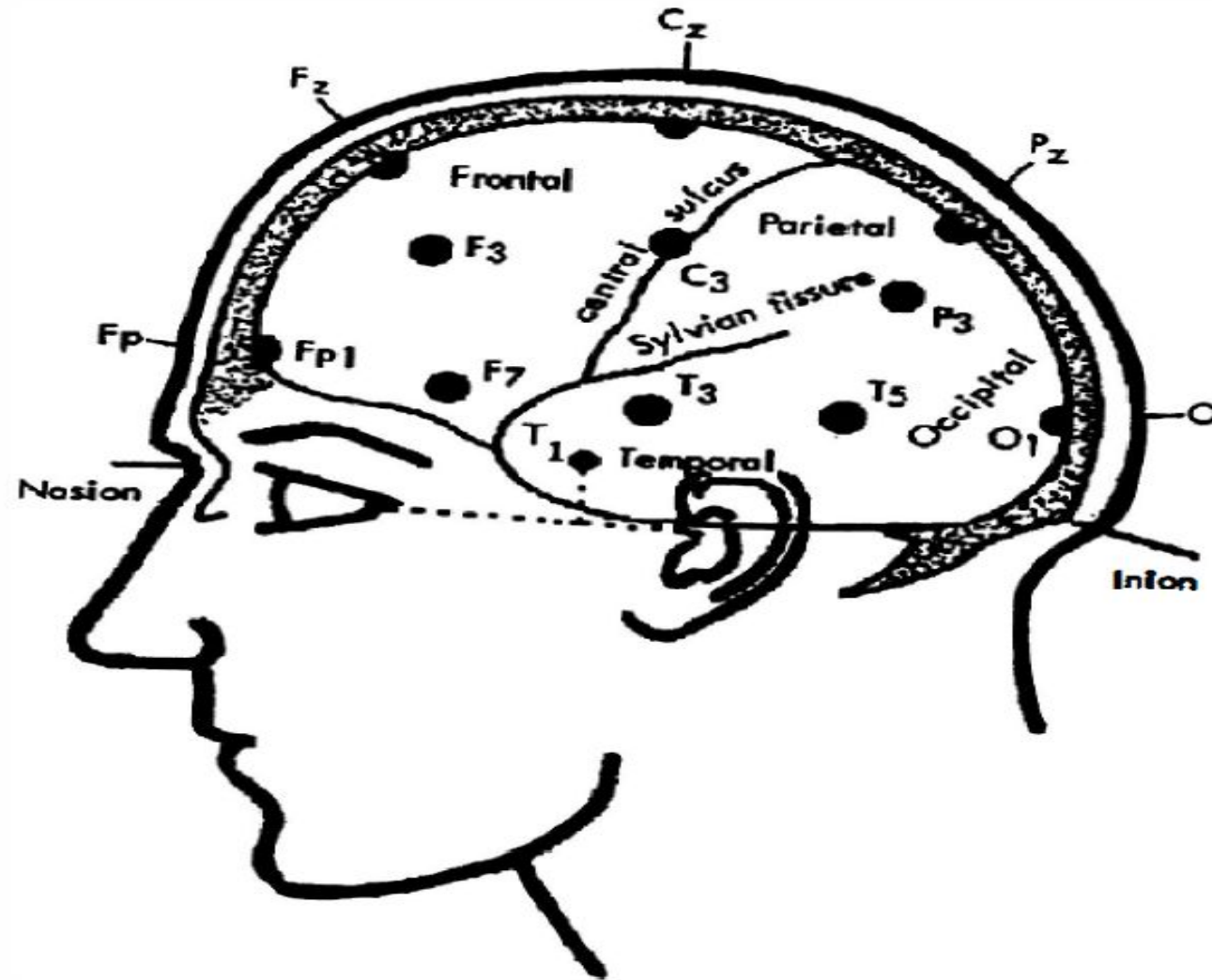
EEG recording

- Unipolar

There is one recording (active) electrode and other indifferent(inactive) electrode. The potential difference (PD) between them gives the record
Indifferent electrode is placed on the 7th cervical spine.

- Bipolar

Both electrodes are active electrodes. PD between them is recorded



EEG waves

Every EEG wave we look for

- Frequency (Hz) and
- Amplitude (μV)

EEG waves

EEG waves can be

- Synchronous : summated activity producing large waves (regular, smooth), low frequency
- Asynchronous (desynchronized): small , high frequency waves

EEG waves

α (Alpha)

β (Beta)

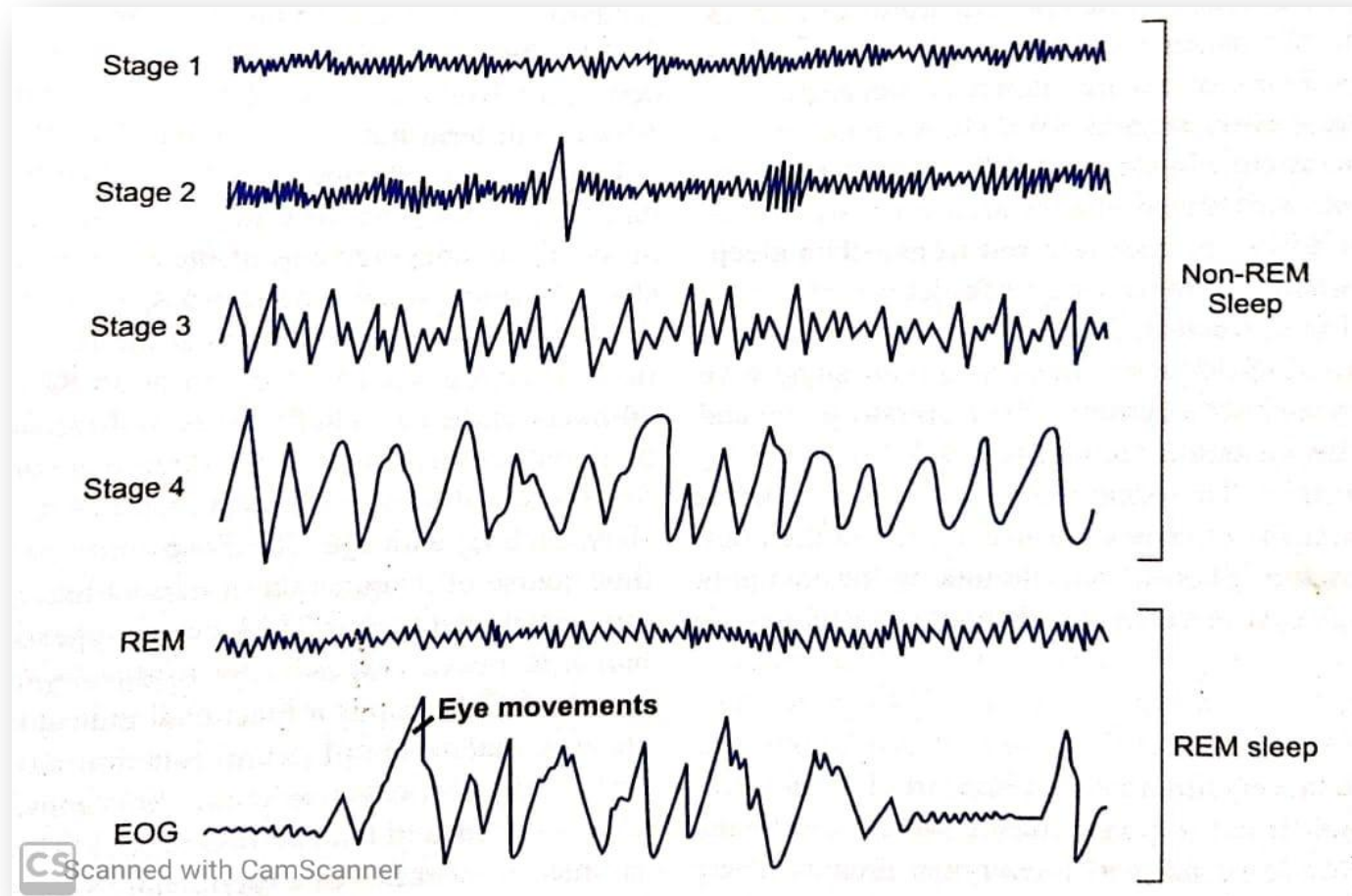
γ (Gamma)

θ (Theta)

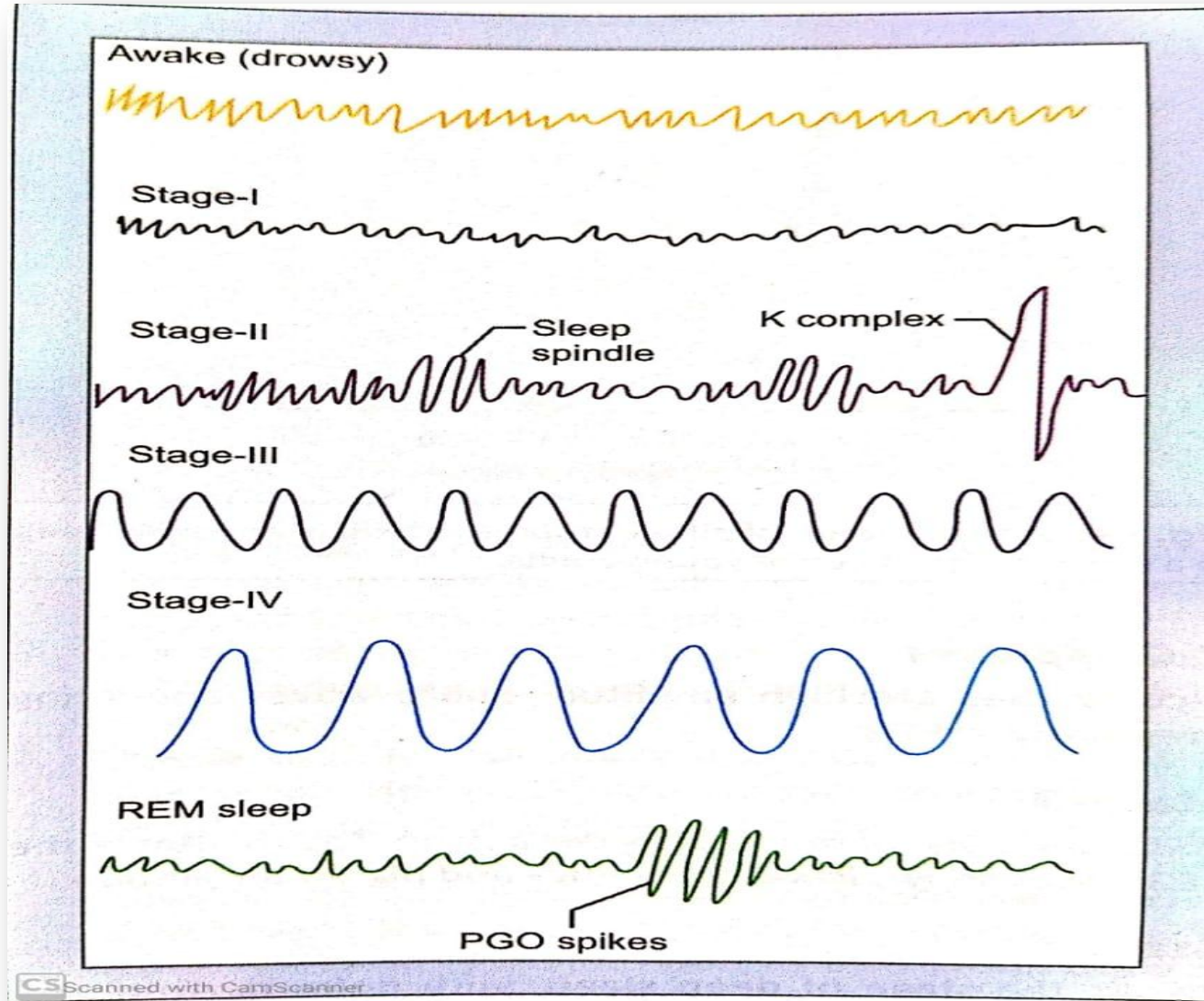
δ (Delta)

K complex

EEG changes in sleep

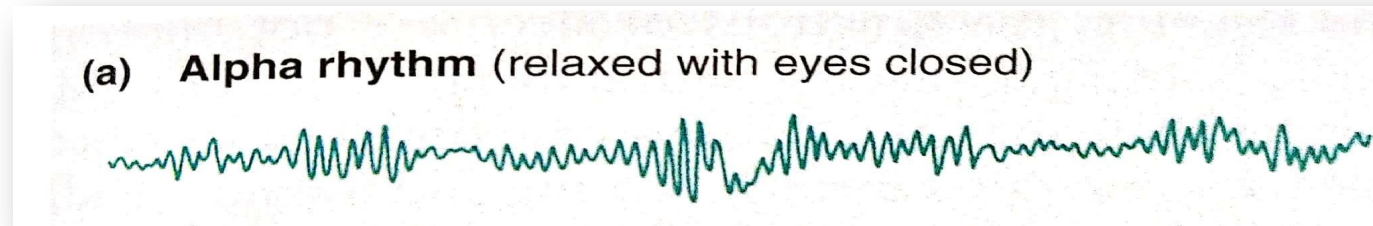


EEG changes in sleep



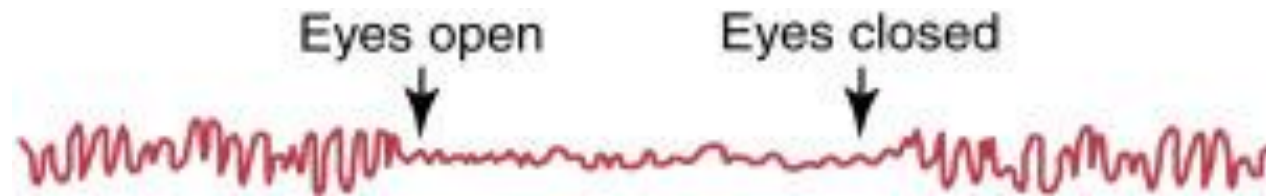
α (Alpha)

- Is seen in awake state when a person is at rest
- 8-13 Hz
- 50-100 μV
- Recorded mainly from parieto-occipital area
- Also called Bergers rhythm
- Due to spontaneous oscillations in the thalamocortical system
- Seen in Yogis (Meditation)



α (Alpha) Block

- Arousal , alerting response or desynchronization
- Here α rhythm is replaced by high frequency , low amplitude irregular waves



Seen when sudden sensory stimuli is given,
Or relaxed mind focuses or does some problem solving

α (Alpha)

- Decreases with
 - ☐ blood sugar
 - ☐ body temperature
 - ☐ Glucocorticoids
 - ☐ $p\text{CO}_2$
- Increased in the opposite conditions

α (Alpha) and β (Beta)

(a) **Alpha rhythm** (relaxed with eyes closed)



(b) **Beta rhythm** (alert)

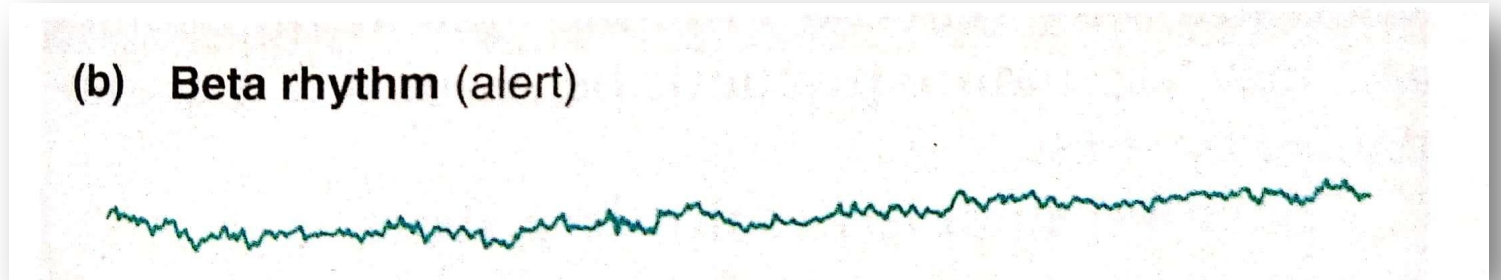


Time →

□ (Beta)

- 18-30 Hz
- Low voltage
- Recorded mainly from frontal and parietal area
- Indicated alert state (wake)
- Also seen in REM sleep (Paradoxical)

Person is asleep but EEG shows wake pattern also threshold to sensory stimuli is decreased

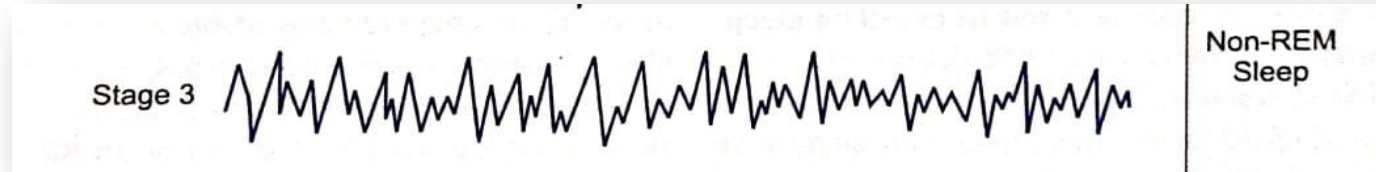


γ (Gamma)

- 30-80 Hz
- When a person is aroused and focuses intensely on something

θ (Theta)

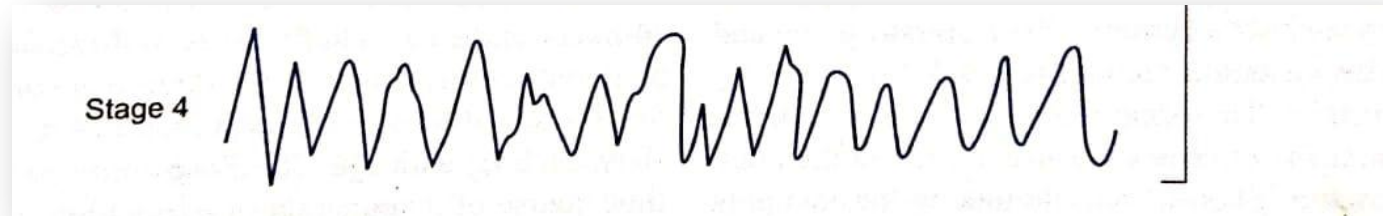
- 4-7 Hz
- 100 μ V



- Seen in Children
- Moderate sleep
- In stressful states in adults

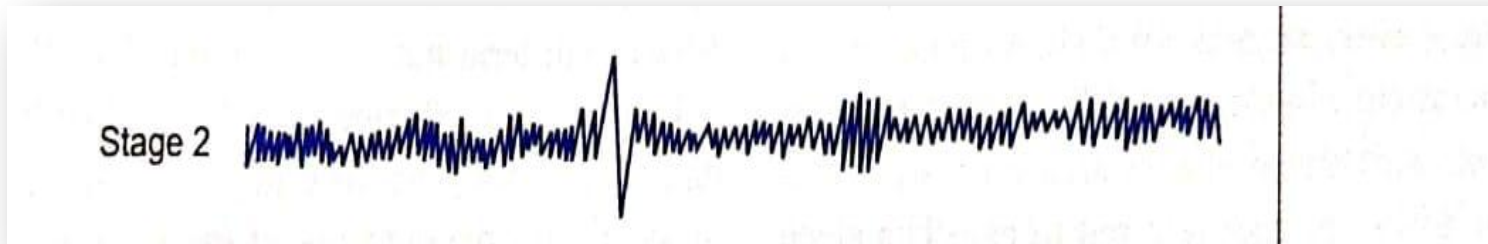
δ (Delta)

- 1-4 Hz
- 20-200 μV
- Cortex is released from thalamic and lower centres stimulation
- Seen in deep sleep and is predominant in infants.(stages 3 and 4)
- Also in organic brain diseases and coma delta waves are seen

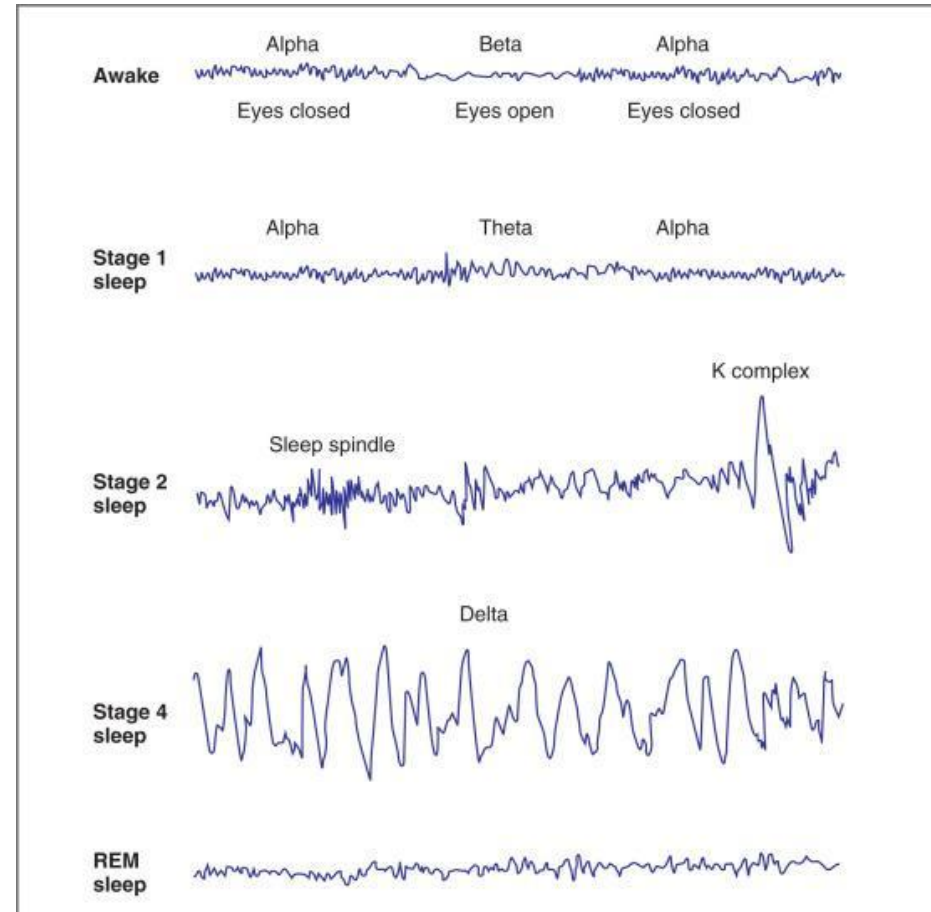


Sleep spindles and K complex

- 10-14 Hz
- 50 μV
- Similar to alpha rhythm
- With a high amplitude sharp wave the K complex
- See in Stage 2 of NREM sleep.



EEG changes in sleep



Variations with age

- δ (Delta) waves are seen upto 2 years of age
- θ (Theta) from 2-6 years
- α (Alpha) from 6 years and above

EEG recording

- It can be done in 30 minutes to diagnose conditions like Epilepsy
- Or is carried out all night to diagnose sleep disorders
- Like sleep Apnea
- Narcolepsy (□ orexin or hypocretin in hypothalamus)
- REM behavioural disorders (Locus ceruleus lesions)

Evoked potentials and EEG

- Evoked potentials: Electrical responses recorded from nervous system following sensory stimuli.
- It assess the integrity and speed of processing of the nervous system
- EEG is record on spontaneous electrical activity of the brain

Evoked potentials

Example

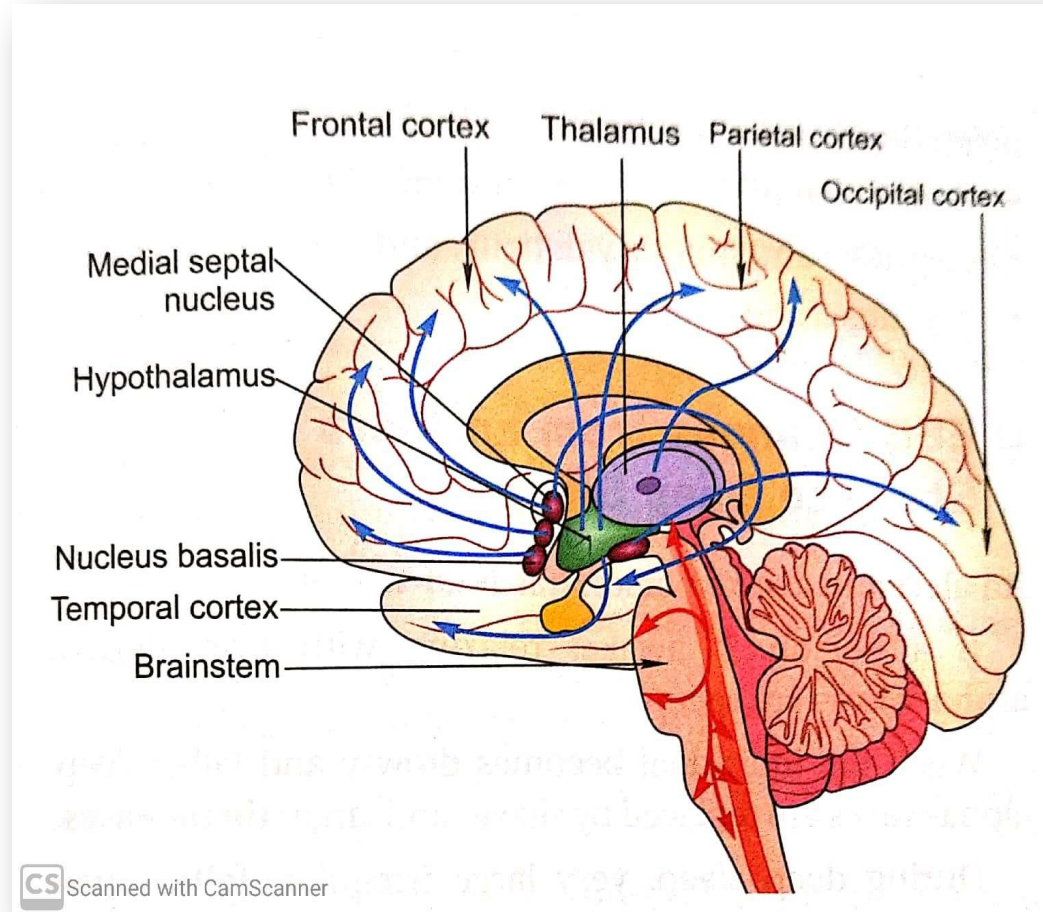
- VEP (Visual evoked potential)
- AEP (Auditory evoked potential)
- SSEP (Somatosensory evoked potential)

- MEP Stimulation of specific motor areas of exposed cortex ,record of potentials from muscles

Uses of EEG

- Sleep and wakefulness
- Sleep disorders
- Epilepsy
- Coma
- Brain Death

Thalamocortical activation through



Sleep and wakefulness

- Sleep begins with NREM
- progresses from stages 1-4 ,then
- lightens from 4-1 and
- then person enters REM sleep
- This cycle takes 90 minutes
- We have 4-6 such cycles each night

EEG changes in sleep

- Initially α (Alpha) rhythm is seen ,
- Sleep spindles with K complex is seen in stage 2
- θ (Theta) in moderate sleep ,
- δ (Delta) waves in deep sleep
- then it reverses and in
- REM sleep $\square$ (Beta) waves are seen.

Patient – For Polysomnography to diagnose sleep disorders



Epilepsy

- Affects 1% of the population : it is recurrent seizure activity
- Seizure: temporary disruption in brain activity by uncontrolled excessive neuronal activity
- EEG is abnormal ,synchronized may be upto 1000 μV
- It is characterized by involuntary muscle contraction

Epilepsy

- Causes
- Brain injury
- Infections
- Intoxication
- Sleep deprivation
- Hyperthermia
- Blood flow to brain ☐

Epilepsy

2 major types

- Partial or Focal Seizures (involving one cerebral hemisphere)
- Generalized seizures (involving both the cerebral hemispheres)

Partial or Focal Seizures

They begin in a small localized region of the cerebral cortex and brainstem. It results from ***localized reverberating circuits*** that may gradually recruit adjacent areas of the cortex.

Jacksonian march .

A progressive “march” of muscle contractions throughout the opposite side of the body, beginning in the mouth region and marching progressively downward to the legs but at other times marching in the opposite direction.

Partial or Focal Seizures

- Begins with an **aura** followed by
- **Impaired consciousness** and
- Strange repetitive movements (***automatisms***), such as chewing or lip smacking.
- No memory of the attack, except for the aura.
- ***Postictal period*** : time after the seizure prior to the return of normal neurological function

Partial or Focal Seizures

Reasons

- Scar tissue in brain (pulls on the adjacent neuronal tissue)
- Tumor that compresses an area of the brain
- Congenitally deranged local circuitry.



- Complex partial seizures

Psychomotor, temporal lobe, and limbic seizures

Generalized Seizures

- Generalized Tonic–Clonic (Grand Mal) Seizures
- Absence Seizures (Petit Mal Seizures)

Generalized Tonic–Clonic (Grand Mal) Seizures

- Activation of both hemispheres then down the spinal cord
- Causing
- Tonic contraction then
- Clonic contraction ,
- Biting of tongue,
- Dyspnoea, may result in cyanosis
- Urination and defecation

Lasts from a few seconds to 3–4 minutes

Generalized Tonic–Clonic (Grand Mal) Seizures

- Postictal period
- *Postseizure depression* of the entire nervous system;
- Person remains in stupor for 1 to many minutes.
- Severely fatigued and asleep for hours thereafter.

EEG: high-voltage, high-frequency discharges occur over the entire cortex.



Generalized Seizures

- Absence Seizures (Petit Mal Seizures)
- 15–20% of epilepsy cases in children
- 3–30 seconds of unconsciousness
- EEG -*spike and dome pattern*



50 μ V

Absence seizure

EEG changes in Epilepsy



Generalized tonic-clonic seizure



Absence seizure



Psychomotor

Epilepsy

- It is controlled by medications
- In intractable cases the focal point is surgically removed

Coma

Coma results from

- Damage to cerebral cortex, brainstem
 - Infections
 - Metabolic disorders
 - Drug intoxication
-
- Person cannot be aroused even with painful stimuli
 - Person may smile and show some primitive reflexes but cannot comprehend.

Brain Dead

- Doctors and Lawyers accept this as criterion for death
- There need to be a structural damage to brain and not disturbance in endocrine and electrolyte metabolism. Drug intoxication need to be excluded. 6 hours no brain activity-EEG flat
- No pupillary reaction
- No response to painful stimuli
- No spontaneous breathing for 10 min (off ventilator)
- Systemic circulation is feeble
- Some pure spinal reflexes may be present
- **Organs are viable and can be removed for organ donation**

Summary

- EEG good tool to assess brain function
- EEG waves
 - Normal
 - Abnormal
- Uses of EEG



THANK
YOU