

Sleep, Consciousness and the Electroencephalogram (EEG)



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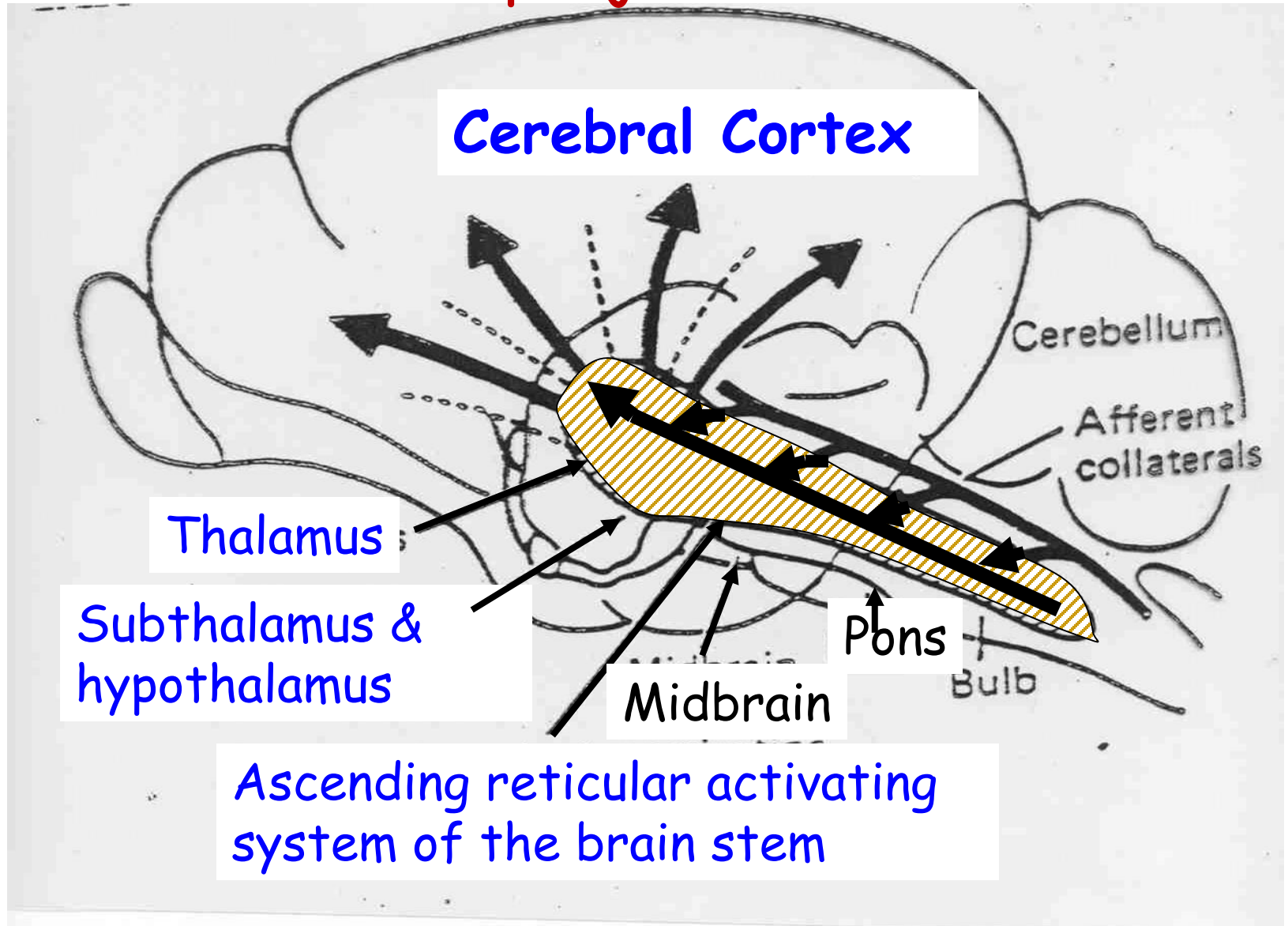
At the end of this lecture you should be able to

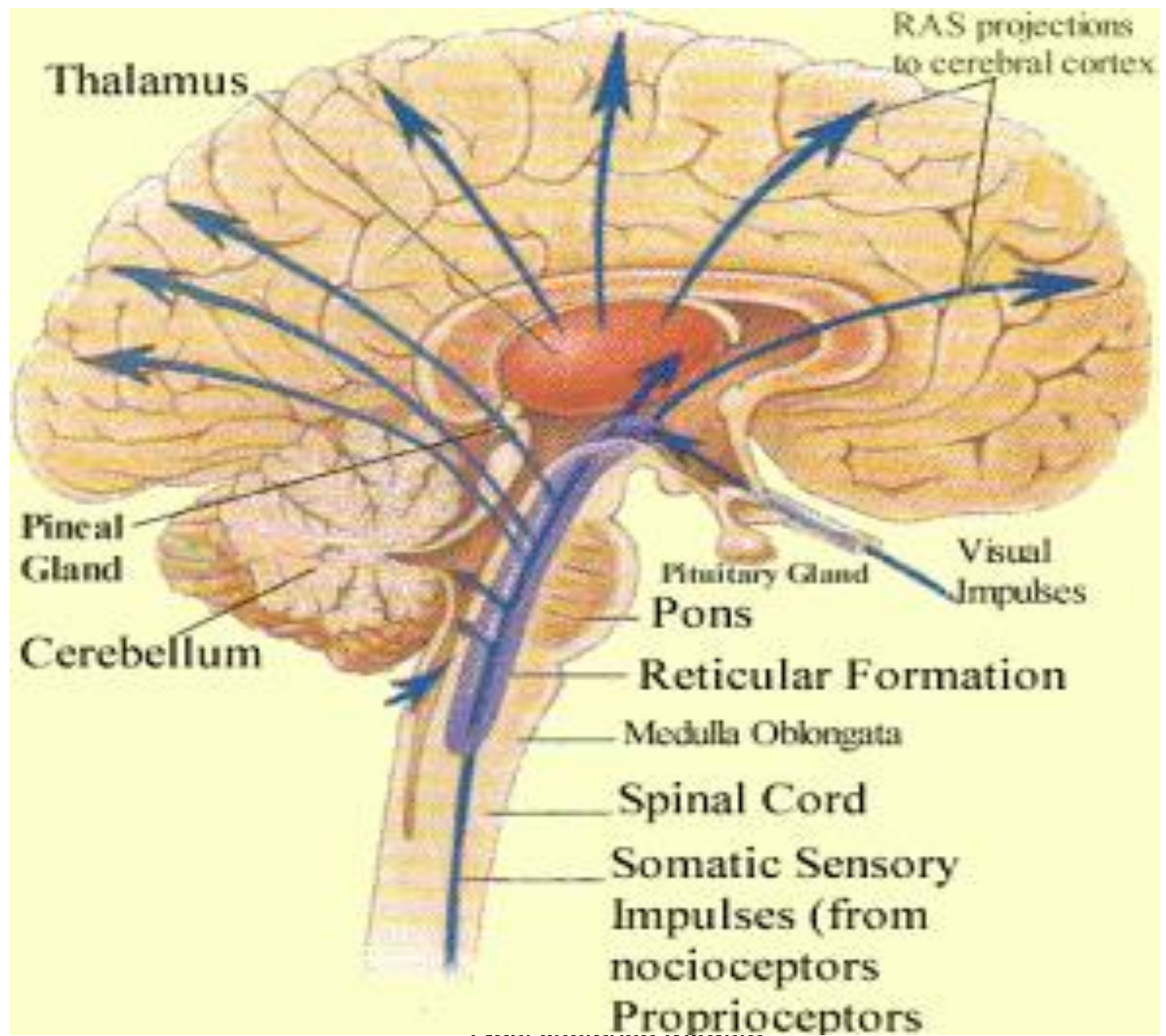
- Outline the role of the reticular activating area in maintaining cortical alertness
- The basic EEG patterns
- State the main clinical use of the EEG
- Separate sleep in to REM and non REM sleep and outline the characteristics of these

The Reticular Activating System (RAS)

- In the core of the brain stem at the midbrain, pons and medulla
- Afferents from all sensory pathways
 - Somatosensory, visual, auditory
- Efferents activate **thalamus** and via this the **whole cerebral cortex**
- Non Specific (diffuse) activation of cerebral cortex
 - Via intralaminar and reticular thalamic nuclei - **non specific nuclei**
 - (contrast with specific activation by sensory pathways)
- **Maintains the alert, conscious state**

Non specific thalamo-cortical projection





Neurotransmitters of RAS

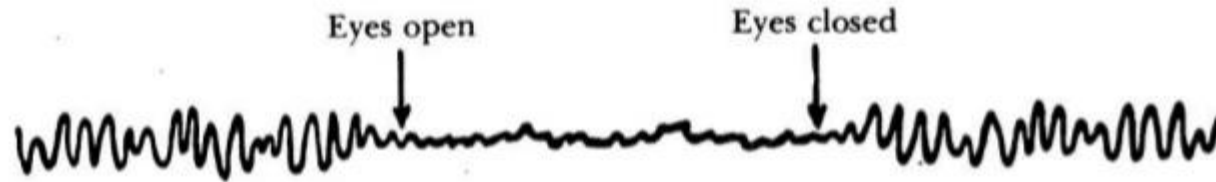
- Noradrenaline (Locus cereuleus)
- Serotonin (Raphe nucleus)
- Acetylcholine
- Inhibition of the above can give rise to sleep

Electroencephalogram [EEG]

- Recorded using scalp electrodes
- Records the dendritic post synaptic potentials of thousands of brain neurons
 - Constantly changing electrical difference between the total dendritic activity and the nerve cell body
 - Sum of dendritic activity is negative relative to the cell body, the cell is depolarised

- Predominant pattern alpha wave (8-12Hz and 50-100 μ V)
- When awake, eyes closed, mind wandering
 - Less in children (adult pattern in adolescence)
 - Reduced when \downarrow glucose, \downarrow temperature, \downarrow cortisol, \uparrow PaCO₂

Beta rhythm (alpha block)



- Occurs with mental concentration or after sensory stimulation
- High frequency, low voltage waves identified (13-30Hz)
- "Arousal" or "alerting" response
- Gamma oscillations (30-80Hz) occurs when aroused person tries to focus attention

Normal Adult Brain Waves

Awake mental
activity



Beta
14-30 Hz

Awake
resting



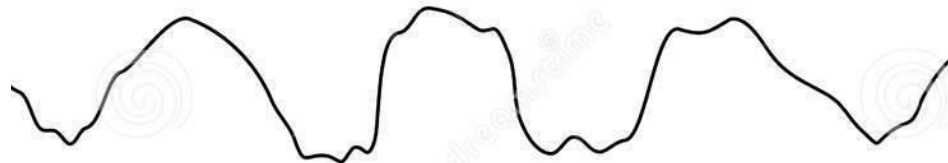
Alpha
8-13 Hz

Children
Brain diseases



Theta
4-7 Hz

Deep sleep
Infants
Brain diseases



Delta
<3.5 Hz



1 sec



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Sleep

- Unconsciousness from which a person can be roused by sensory or other stimuli
- On average around 6-8 hours /day but varies between people
- Probably needed for learning/ memory consolidation



Sleep deprivation

- Deterioration of higher brain functions
 - Learning & memory
 - Judgment
- More prolonged deprivation affects lower brain levels
 - Dysarthria
 - Tremor
 - Nystagmus
 - Increased heart rate and blood pressure

Physiological changes during sleep

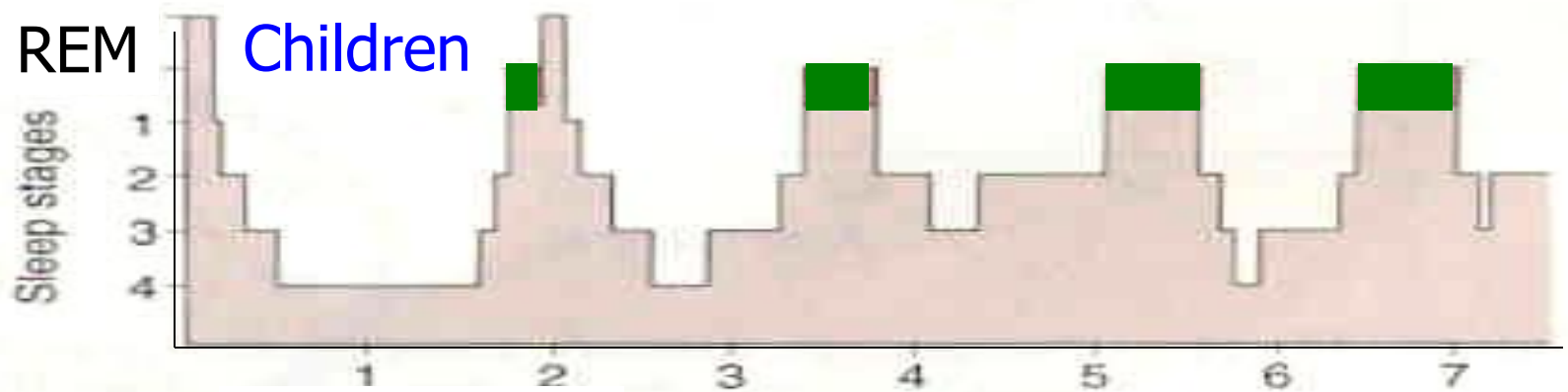
- Sleep is divided into sleep cycles which last 90 minutes
- Around 5 cycles a night

Non REM (NREM)
sleep
[70 minutes]

Rapid eye
movement
sleep
[20 minutes]

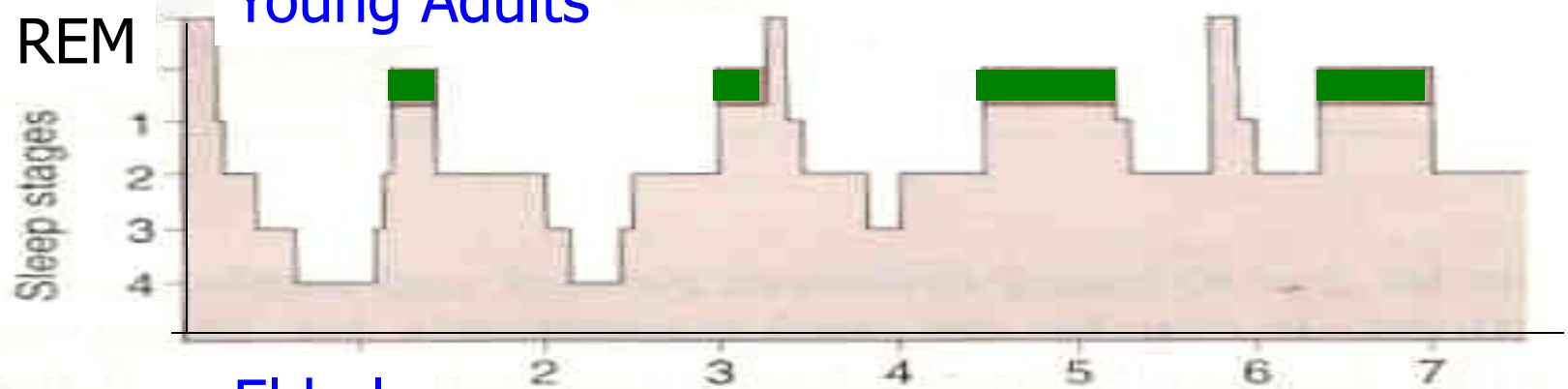
REM

Children



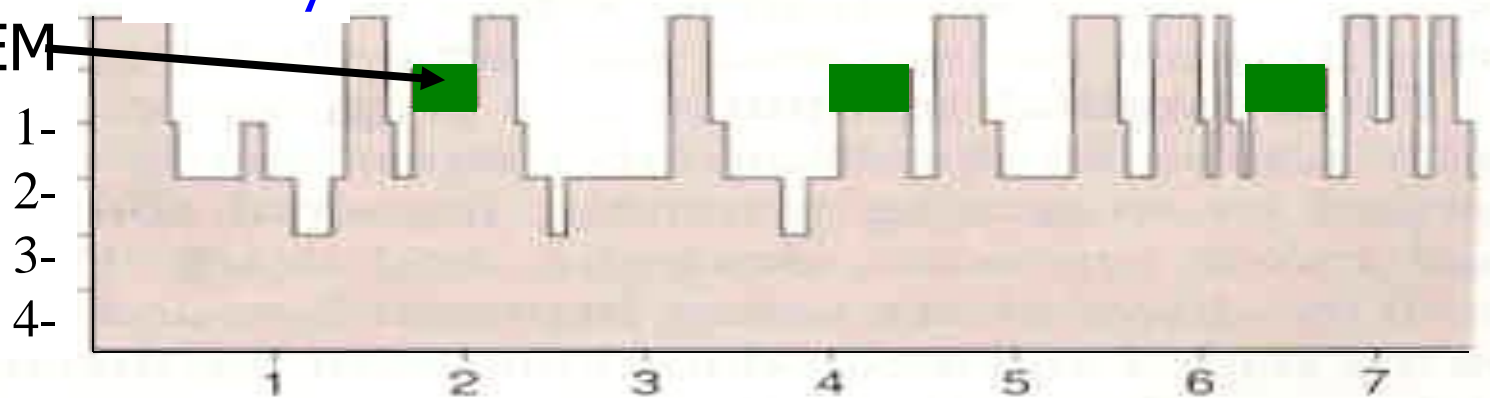
REM

Young Adults



Elderly

REM



NREM
Sleep
Stages

Hours of sleep

Non REM sleep

Sleep stages	EEG changes	Clinical
0	Alpha	Eyes closed
I	Alpha/ Theta	Dozing
II	Spindles/ K complexes	sleep
III	Delta/ theta	Deep sleep
IV	Delta	Deep sleep

Awake
Beta waves



Drowsy, Relaxed
Alpha waves



Stage 1 Sleep
Theta waves



Stage 2 Sleep
Sleep spindles,
K complexes



Stage 3/Stage 4 Sleep
Delta waves



REM Sleep
Fast, random



NREM Associations

- Reduced blood pressure
- Deep and infrequent breathing
- Reduced BMR

- *Sleep walking*
- *Night terrors*
- *Bed wetting*

REM sleep

- Mixed frequency eye movements but reduced tone of neck muscles
 - Inhibition of voluntary muscle activity
- EEG similar to alert state with eyes open
- Associated with dreaming, teeth grinding (bruxism)

Waking

- Reduced stage 3 and 4 sleep
- Increased REM

Mechanism of sleep production

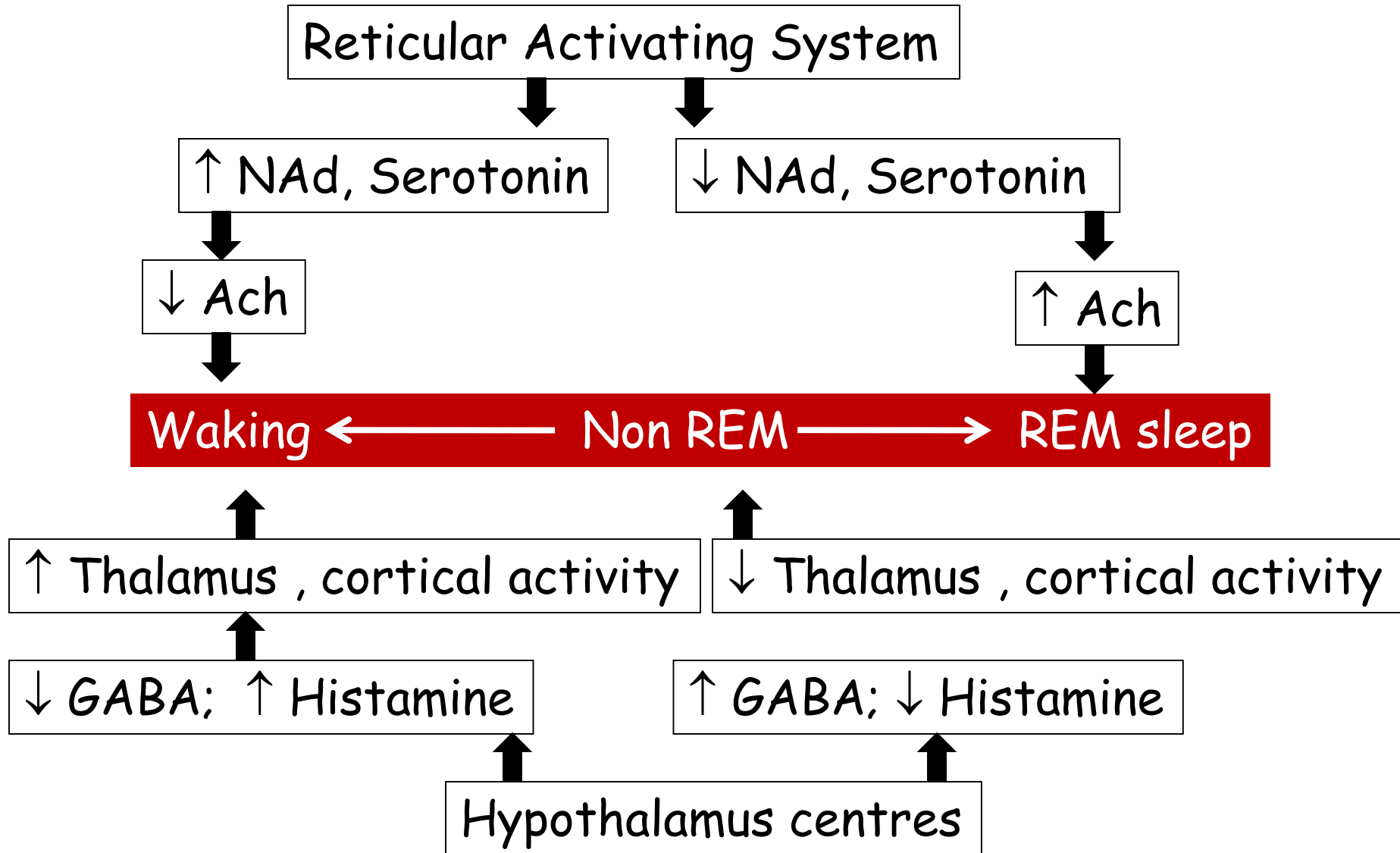
NREM

- Diencephalic sleep zone, Medullary reticular formation
- Basal forebrain sleep zone
- Others: mechanoreceptors of skin; serotonin antagonists, adenosine

REM

- Pons, limbic cortex and visual association area have increased activity
- Reduced activity of the prefrontal cortex & parietal cortex

Regulation of sleep stages





At Night
I Can't Sleep.

In The Morning
I Can't
Wake Up...



Epilepsy

- Uncontrolled, excessive activity of part or all of the brain
- **General onset:** both cerebral hemispheres activated with increased discharge
 - **Tonic clonic:** 'grand mal'- excessive stimulation of the activating area and results from a reverberating circuit
 - **Absent seizures:** 'petit mal'
- **Partial seizures:** arise from localised brain area; consciousness may be present or lost

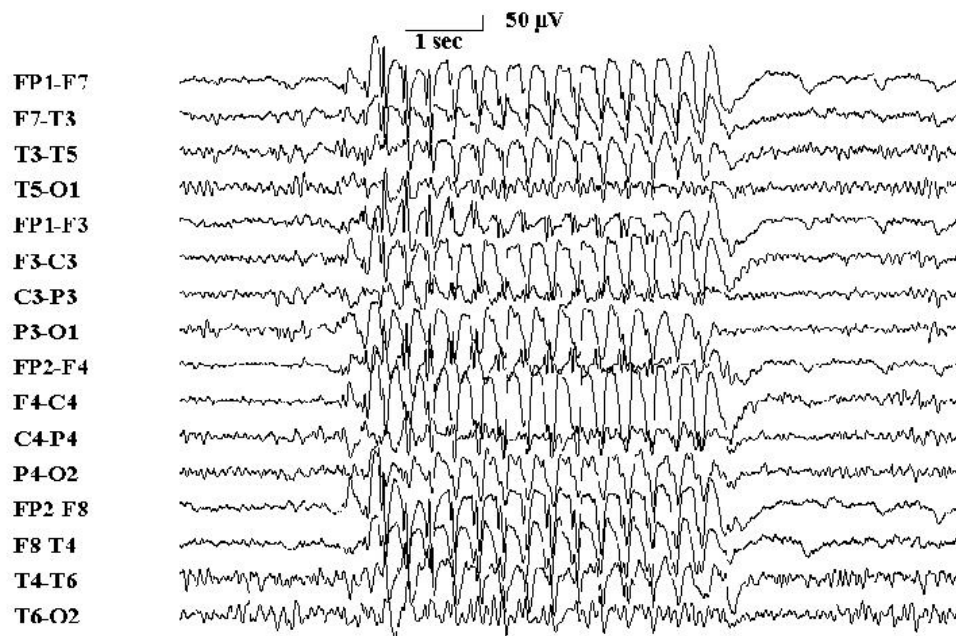
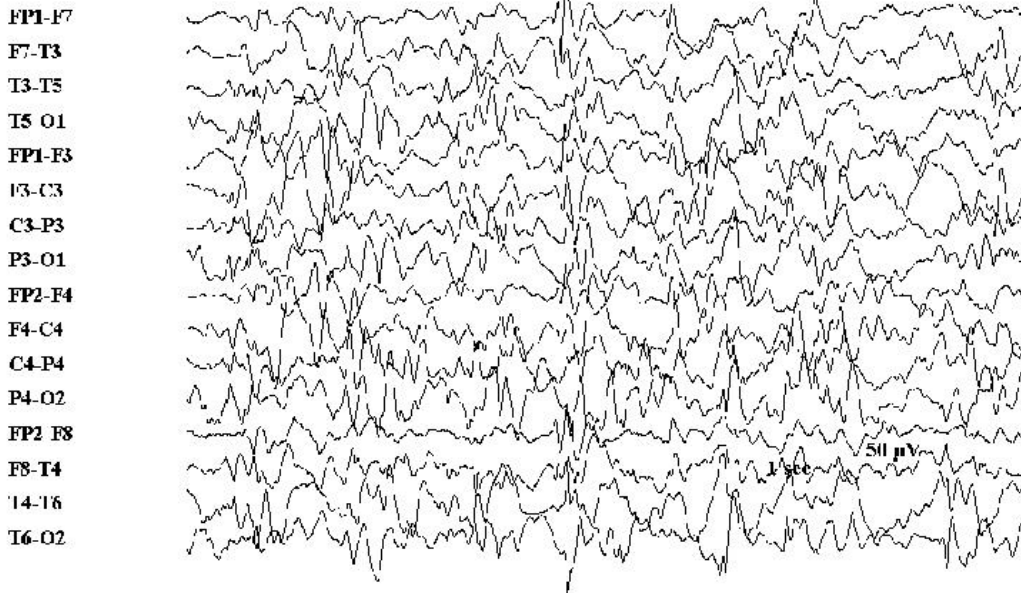
Clinical Uses of the EEG

- Generalised brain diseases e.g encephalopathy
- Diagnose and monitor Epilepsy
- *Diagnose localised brain abnormalities (e.g. Subdural fluid- but better to do neuroimaging)*

Hypsarrythmia



Absence seizure



Coma

- Loss of consciousness from which arousal is not possible
- Reduced oxygen consumption by the brain
- Block in the ascending pathway from the thalamus to the RAS

What is your brain rhythm?

