

NOTES CORRESPONDING TO BASICS :-

(Notes based on Explanation)

1.

Description of Research Work :-

→ The work deals with 'Building computational models of brain parts at a realistic scale for prediction and treatment opportunities in cases of neurological & psychiatric disorders and trauma.'

• The work basically focuses on modelling Electroencephalogram (EEG), which is an inexpensive method of diagnosing and understanding brain disorders for eg:- Epilepsy, Parkinson's disease, Alzheimer's disease.

• It is done by comparing between normal state of mind and for eg epilepsy patients. Since, it is studied very uniquely therefore, both time and frequency characteristics of EEG are studied minutely and these frequency specific behaviours are called 'rhhythms of the brain'.

→ 1st Step deals with building & modelling the 'rhhythms'.

• It has a strong influence of Control System Circuit.

EEG Simulation Model = Brain Circuitry

→ Feedforward & Feedback is build leading to closed feedback loop.

• Therefore, the work deals with EEG Biomarkers i.e., Symptoms on Alzheimer's disease, Sleep etc → which for eg. using models deal with slowing down of Alpha rhythms which means frequency reduces.

2. What is EEG?

→ EEG is the depiction of the electrical activity occurring at the surface of the brain.

This activity appears on the screen of the EEG machine as waveforms of varying frequency and amplitude measured in 'Voltage' esp microwatts.

3. Classification of EEG Waveforms :-

- EEG waveforms are classified according to their -
 - frequency
 - amplitude
 - Shape
 - Sites on the scalp at which they are recorded.

NB :- However, most familiar classification is -

EEG waveform frequency

- @ Most waves of 8 Hz and higher frequencies are normal findings in the EEG of an awake adult.

- ③ Waves with frequency of 7 Hz or less are abnormal
 - ⇒ in awake adults BUT
 - ⇒ normally seen in children or adults who are asleep.

4. FREQUENCY :-

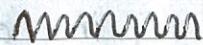
- Frequency (Hertz, Hz) is a key characteristic used to define Normal or abnormal EEG rhythms.

- The frequencies most brain waves range from are -

0.5 - 600 Hz

- Categories of frequencies which are most clinically relevant are :-

a) Alpha waves → 8-13 Hz



b) Beta waves → Greater than 13Hz



c) Theta waves → 3.5 - 7.5 Hz



d) Delta waves → 3Hz or less



← 1sec →

- a) Alpha waves :-

Alpha waves are seen in all age groups (but are most common in adults)

Alpha activity disappears normally with attention.

They occur rhythmically on both sides of the head but are often slightly higher in amplitude on non dominant side esp, in right handed individuals.

They are especially prominent with closed eyes and with relaxation.

- b) Beta waves :-

Beta waves are observed in all age groups & in deep concentration.

They tend to be small in amplitude.

They are usually symmetric and more evident anteriorly.

- c) Theta waves :-

Theta waves are observed in sleep at any age.

In awake adults, these waves are abnormal if they occur in excess.

NB:- Theta and delta waves are known collectively as SLOW WAVES.

d) Delta waves :

- # These slow waves are normally seen in deep sleep in adults as well as in infants and children.
- # Delta waves are abnormal in awake adults.
- # They have the largest amplitude of all waves.

NOTE:-

It is worth mentioning that there are some normal waveforms including K-complex, V waves, Lambda waves spindles, mu rhythms, spikes etc which are recognized by their shape and form (morphology) and secondarily by their frequency.

—X—

Reason of working on the Topic :-



It is seen in old age people are suffering from Alzheimer's disease and many other neurological diseases in different age groups.



The cause of these diseases are still not clear and so there is no specific treatment → therefore, the topic is very interesting to be studied.

⇒ Abnormal Behaviour in EEG depicts / represents neurological problems.



This project deals with knowing the reasons behind the abnormal behavior of EEG by simulation as we can't literally break the brain / head and check and thereby improve the treatment procedure & help people get cured.

NOTES BASED ON THE SLIDES :-

①

5th Oct

SLIDE 1 :-

- During different stages of the nervous system :-
such as sleep, waking & epileptic seizures
the pattern of activity generated by thalamocortical systems
changes dramatically.

- From Dr Carlton's Abstract (1887) :-

It was said that on applying electrodes one to the external surface of the brain and other to the surface of a vertical section →

- a) Vigorous currents passed through the galvanometer.
- b) Sometimes, movement in animal's body or change in its mental condition also led to fluctuations of current.

• NB :-

- Considerable deflection of needle was observed generally in deep anaesthesia → lessening gradually as the animal regained consciousness.

- When death was caused by prolonged anaesthesia

→ considerable deflection occurred &
slowly after death → needle fell to zero.

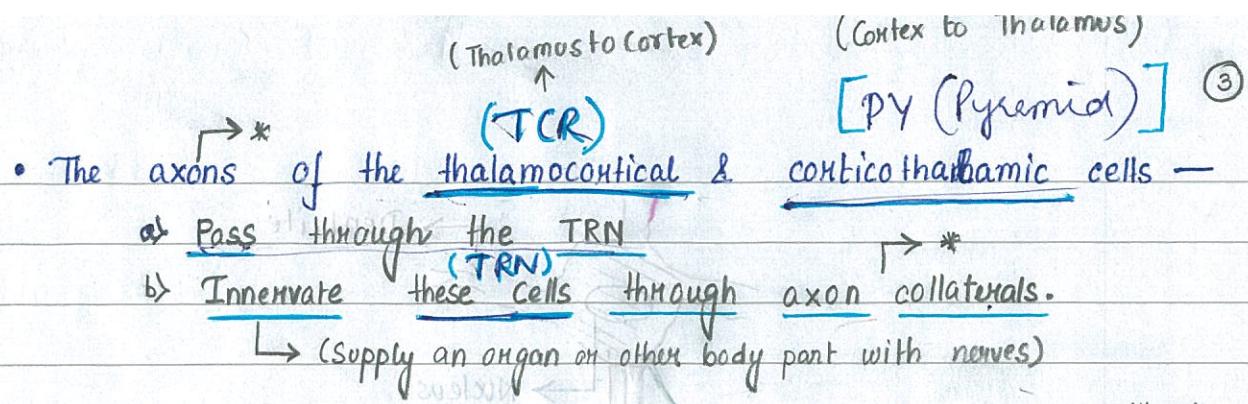
In the activity of EEG, the state dependent changes in the activity of thalamocortical systems are very well demonstrated.

SLIDE 2 :-

- Waking State :- EEG is characterized by low Voltage & Higher frequencies ($> 30\text{Hz}$)
- Deeper Sleep :-
 - slow waves become prominent.
 - \rightarrow 2 particularly prominent slow waves are delta waves and spindle waves.
 - $[0.5 - 4\text{Hz} \text{ oscillations}]$ prominent in deep sleep (stages 3 & 4)
 - $[6-15\text{ Hz oscillations.}]$ They are 1-3 sec duration periods of 'waxing' & 'waning.'
- Occurrence of ^(both) delta & spindle waves are indicative of {synchronized oscillations} in thalamocortical systems.
 - it means when a huge collection of neurons work together

SLIDE 3 :-

- Coronal Section through Human Thalamus :-
 - \rightarrow [Coronal plane is any vertical plane that divides the body into ventral and dorsal sections.]
 - (Front/belly) (Back)
- Thalamus consists of \rightarrow 2 imp. structures :-
 Thalamic Reticular Nucleus
 Thalamocortical Relay nuclei
- The Thalamic Reticular Nucleus is a collection of GABAergic neurons that form a shell surrounding the dorsal & lateral aspects of the Thalamus.
 - (back) (side of the body or body part that is further from center of the body)



NOTE (Explanation) :-

- a) Neuron → Neuron also known as nerve cell is an electrically excitable cell that processes and transmits information through electrical and chemical signals.
- b) Neurotransmitter → Neurotransmitters are chemical messengers, that transmit signals across a chemical synapse from one neuron to another target neuron.
- c) Projections of Neuron → A typical neuron consists of -
 - Cell body (soma)
 - Dendrites
 - Axon.

Most neurons have multiple projections that sprout from the cell body called 'neurites'.

The term 'neurite' is used to describe either a 'dendrite' or an 'axon'.

'Dendrites' are thin structures that arise from cell body, often extending for hundreds of micrometers & branching multiple times giving rise to complex dendrite tree.

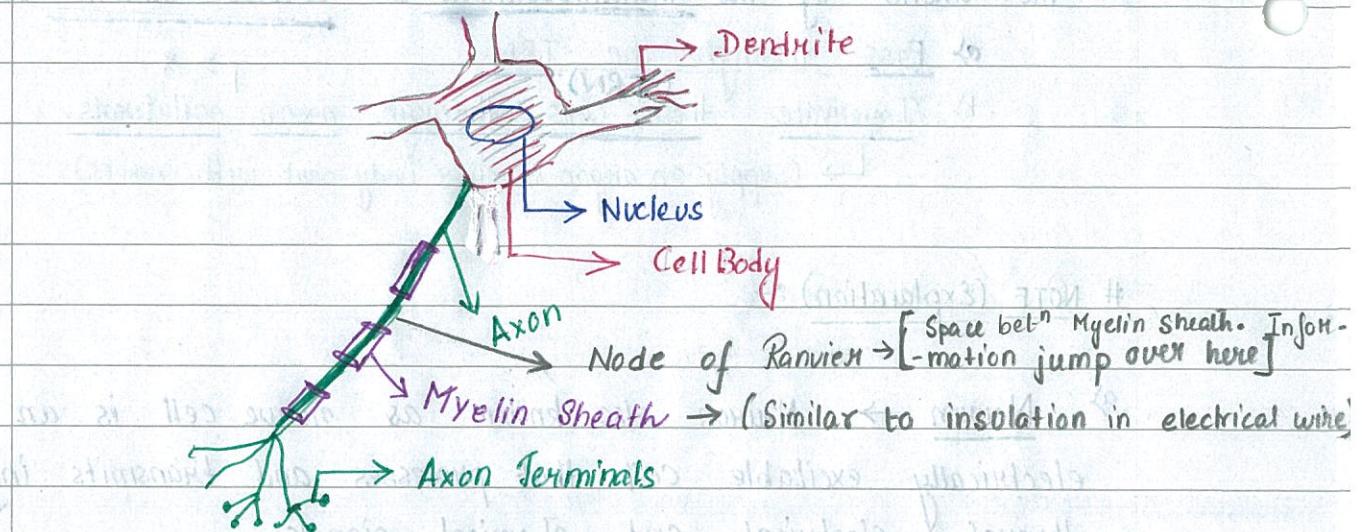
'Axons' are special cellular extensions that arise from cell body at a site called 'axon hillock' & travels for a distance as far as 1 meter in humans & even more in other species.

(is a specialized part of cell body of neuron that connects to axon)

[Chimp] V9]

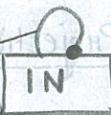
(GDT)

— all is simulation in HOD & Jonathan's book with 10 axons left.



d) Axon Collaterals → It is often associated with feedback mechanisms.

Axons that can send a branch back towards its own cell's body are referred to as axon collaterals.



This also means