

ELECTROENCEPHALOGRAM (EEG)

EEG is an instrument used for recording the electrical activity of the brain by suitably placing surface electrodes on the scalp. The biological name of brain is Encephalon.

On the surface of the brain, the voltage about 10 mv. Due to the propagation through skull bone, they are attenuated from 1 to 100 μ v which are picked by EEG electrodes. The frequency ranges from 0.5 to 3000Hz and the resistance range from few 1000 Ω to nearly 100 Ω depending on electrode used.

Placement of Electrodes:

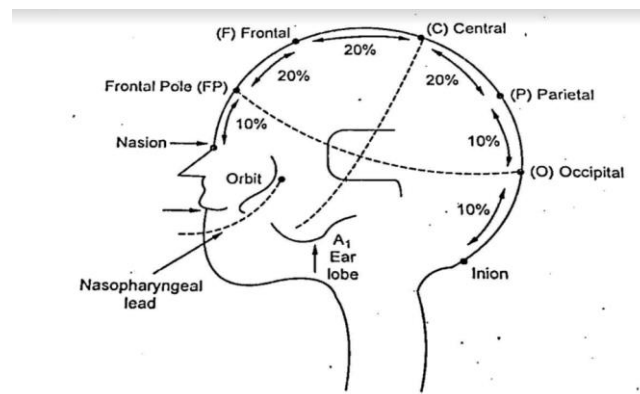


Fig: Electrode placement system

The brain waves are the summation of neural depolarisation in the brain due to stimuli from the five senses. They are Frontal, parietal, temporal. Frontal pole and occipital lobes of the brain. The above figure shows the electrode placement system of five senses with distance.

Electrodes:

Several types of electrodes can be used to record EEG. These include peel and stick electrodes, silver plated cup electrodes and needle electrodes. EEG electrodes are smaller in size than ECG electrodes.

Recording Type:

- **Monopolar Recording:** EEG may be recorded by picking up the voltage difference between an active electrode on the scalp with respect to reference electrode on the ear lobe or any other part of body.
- **Bi-polar Recording:** Bi-polar recording is more popular, the voltage difference between two scalp electrodes is recorded.

EEG Recorder Unit:

The block diagram of EEG recorder is shown below. It consists of four units.

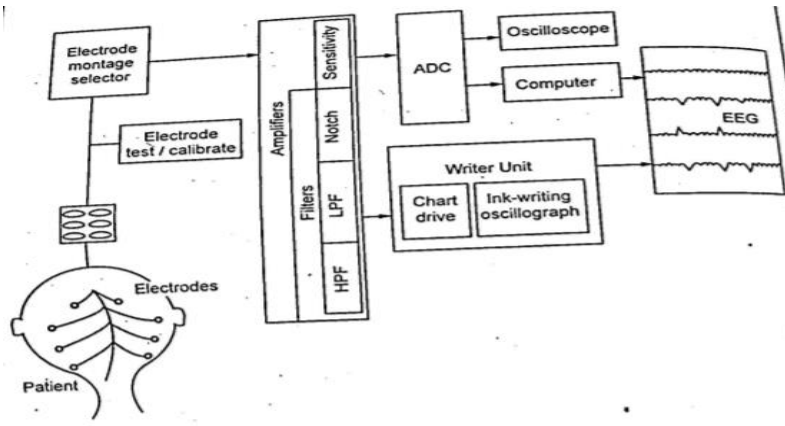


Fig: Schematic diagram of an EEG machines

Electrode selector and calibrate unit:

- Montage
- Electrode Montage selector
- Calibrate

Amplifier unit:

- Filter
- Sensitivity

Output Recorder:

- Chart drive
- Ink – writing oscillograph

Display unit:

- Computer
- Oscilloscope

Montages:

A pattern of electrodes on the head on the channels are connected together is called Montage. Montage is always symmetrical. EEG electrodes are arranged on the scalp according to a standard known as 10/20 system adopted by American EEG society. But these are 21 electrode locations, in 10/20 system.

Electro Montage selector:

EEG signals are transmitted from the electrodes to the head box and then to the montage selector. Montages are either Bipolar or Referential.

Bipolar montage is made by the subtraction of signals is from the adjacent electrode pairs. Referential montage is made by subtracting the potential of a common reference electrode from each electrode on the head.

Preamplifier:

The preamplifier must have high gain and low noise characteristics because the EEG potentials are small in amplitude. The amplifier must have very high CMMR to minimize stray interference signals from power lines and other electrical equipment.

Sensitivity Control:

The overall sensitivity of an EEG machine is the gain of the amplifier multiplied by the sensitivity of the writer. The writer sensitivity is 1cm/v, therefore the amplifier must have an overall gain of 20,000 for a 50 μ v signal.

EEG machine has two types of gain, one is continuously variable, used to equalize the sensitivities of all channels. The other control operates in steps, it is used to increase or reduce sensitivity of a channel by known amount. This control is usually calibrated in decibels.

Filters:

An EEG contains muscle artifacts to contraction of the scalp and neck muscles which over lie the brain and skull. The upper cut-off frequency can be controlled by using high frequency filters. Some EEG have a notch filter sharply turned to 50Hz to eliminate mains frequency interference.

Writer Unit:

The writer unit of an EEG is usually of the ink type direct writing recorder. The best types of pen motors used in EEG have a frequency response of about 90Hz. For some special applications, the frequency response is about 1000Hz. Modern PC based machine give a printout from a laser printer

Paper drive:

In direct writing recorders, the paper drive provided by a synchronous motor. An accurate and stable paper drive mechanism is necessary in normal practice, several paper speeds are available for selection. Speeds of 15, 30 and 60mm/s are essential.

Channels:

The electrodes are connected to separate amplifiers and writing system commercial EEG machines have up to 32 channels, although 8 or 16 channels are more common.

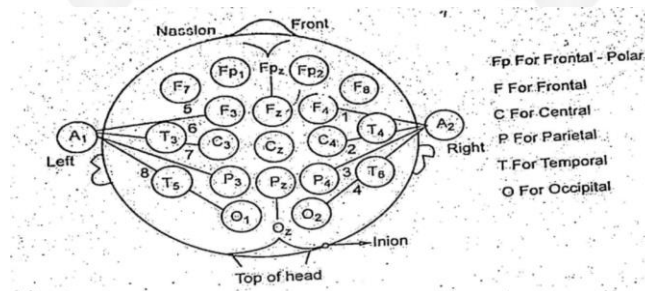
Output Unit:

Microprocessors are now employed in most of the commercially available EEG's permit customer programming montage selection. These EEG's also include a video monitor screen to display the selected pattern as well as position of scalp sites with electrode to skin contact.

Modern EEG's are mostly PC based with a Pentium processor. The system can store up to 40 hours of EEG and displayed on 43cm color monitor. The user interface is through an ASCII keyboard and the output is available in the hard copy form through laser printers.

Arrangements of 10-20 Lead System:

In EEG, electrodes are placed in standard positions on the skull in an arrangement called 10-20 lead system. It is devised by international federation of societies of EEG. The following figure shows the 10-20 lead system, placement of electrodes on the scalp for EEG recording.



Electrodes are identified according to their position on the head. Odd numbers represent left side electrodes, even numbers represent right side electrodes, Z denotes midline electrodes.


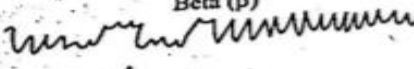
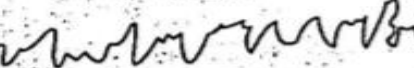

A new montage convention has been introduced in which electrodes are spaced at 5% distances along the cranium. These electrodes are called closely spaced electrodes.

EEG Wave Analysis:

EEG wave analysis helps physicians to diagnose the level of consciousness, sleep disorders, brain tumours, epilepsy and multiple sclerosis. The waves on the surface of the brain may be as large amplitude as 10mv.

- But waves recorded from the scalp have a smaller amplitude of approximately 100µv.
- The frequencies of brain waves range from 0.5 to 100Hz.
- The character of brain wave is highly dependent on the degree of activity of cerebral cortex.

The following waveform shows different types of EEG and its functions.

Different types of Normal EEG waves:	
Waves	Functions
 <p>Alpha (α)</p>	<ul style="list-style-type: none"> ❖ Alpha waves are rhythmic waves occurring at frequency between 8 & 13 KHz Found in normal person EEG when they awake in quiet, resting state of celebration. ❖ Voltage approximately 20-200 µv ❖ If patient is asleep, alpha waves disappear completely.
 <p>Beta (β)</p>	<ul style="list-style-type: none"> ❖ Beta waves occur at frequency range of 14 to 30 Hz, during intense mental activity it has high as 50 Hz. ❖ Most frequently recorded from the parietal and frontal regions of scalp. ❖ It appears during intense activation of CNS (Central Nervous system) and during tension.
 <p>Theta (θ)</p>	<ul style="list-style-type: none"> ❖ Theta waves have frequencies between 4 to 7 Hz. ❖ Occur mainly in parietal and temporal regions in children, also occur emotional stress in adults, particularly during periods of disappointment and frustration.
 <p>Delta (δ)</p>	<ul style="list-style-type: none"> ❖ Delta waves frequency below 35 Hz. ❖ Occurs in deep sleep and in series organic brain disease.

The following waveform shows the different level of consciousness

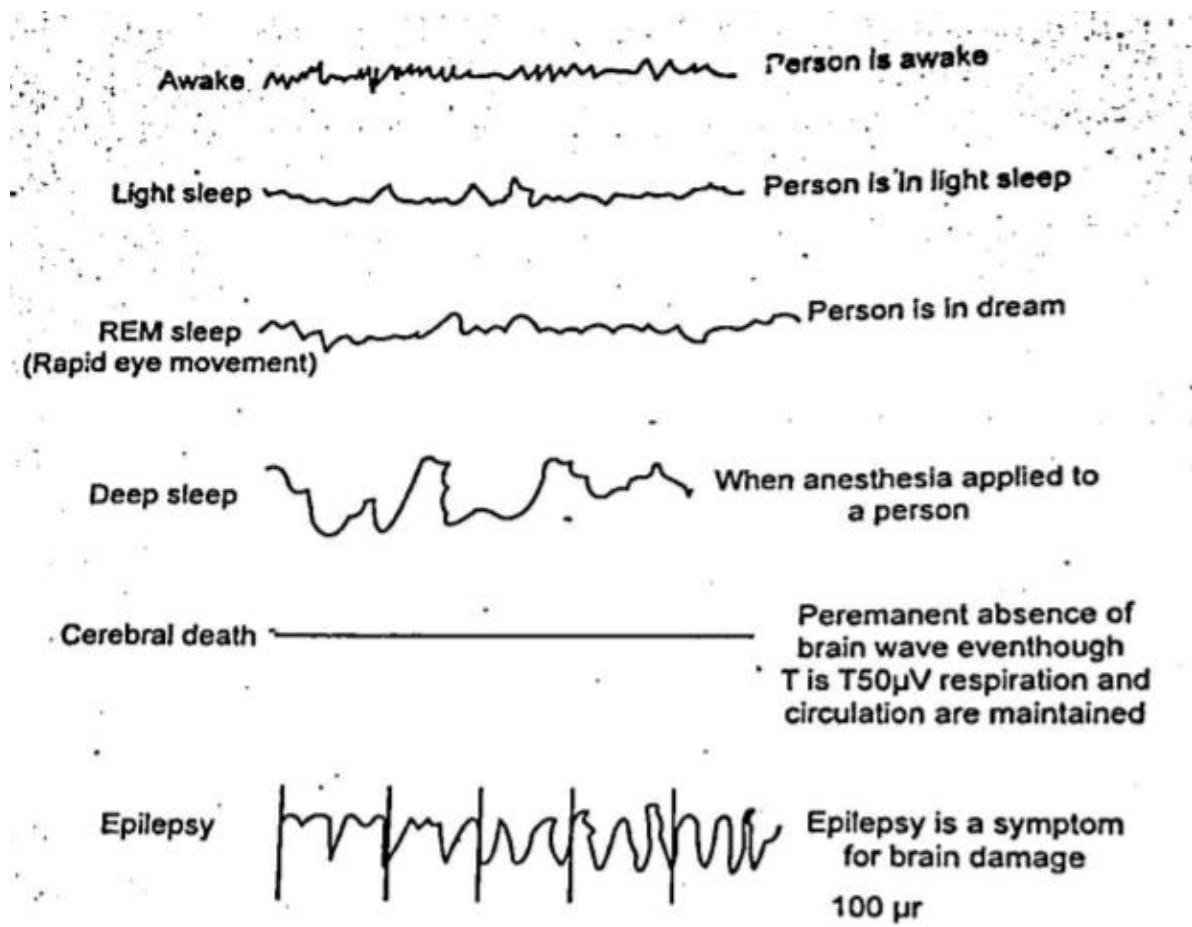


Fig: EEG waves for different level of consciousness

