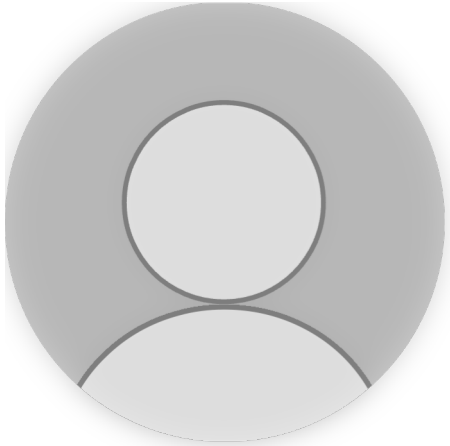


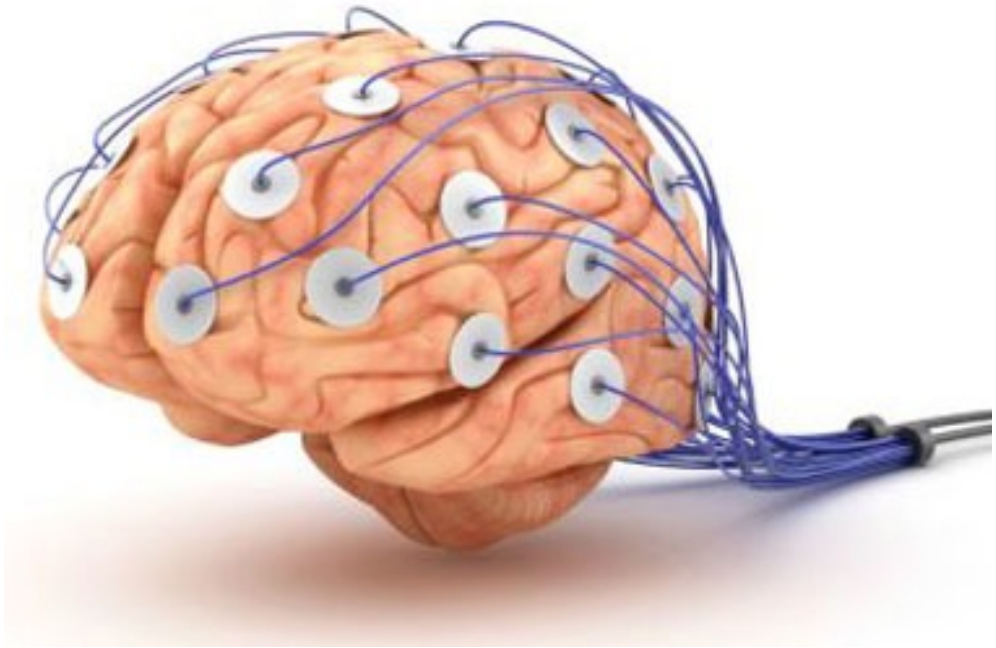
มหาวิทยาลัยมหิดล
คณะแพทยศาสตร์
ศิริราชพยาบาล

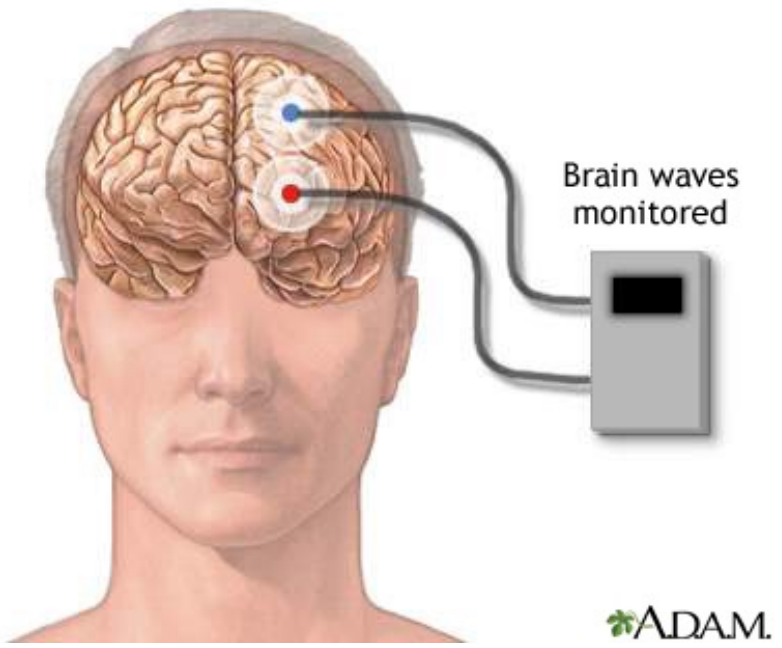
Basic EEG for neurology residents “Normal Awake EEG”

Mahidol University
Faculty of Medicine
Siriraj Hospital

What is EEG?

- Electrical activity of the brain that is recorded from electrodes placed on the scalp

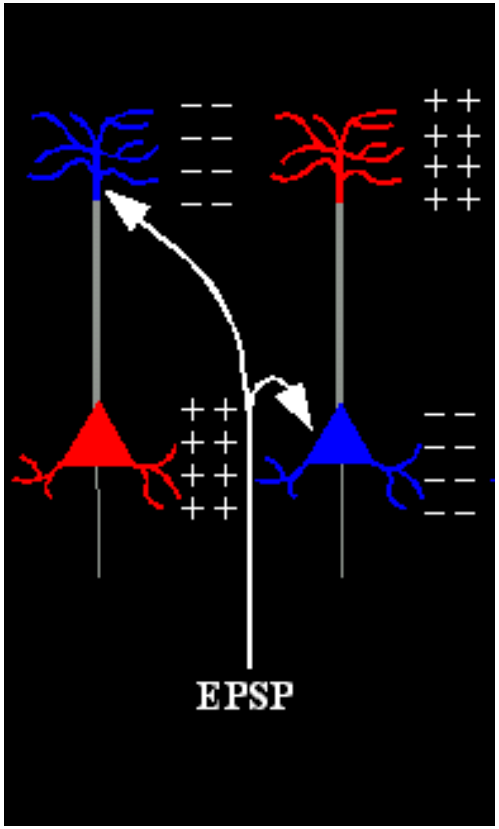


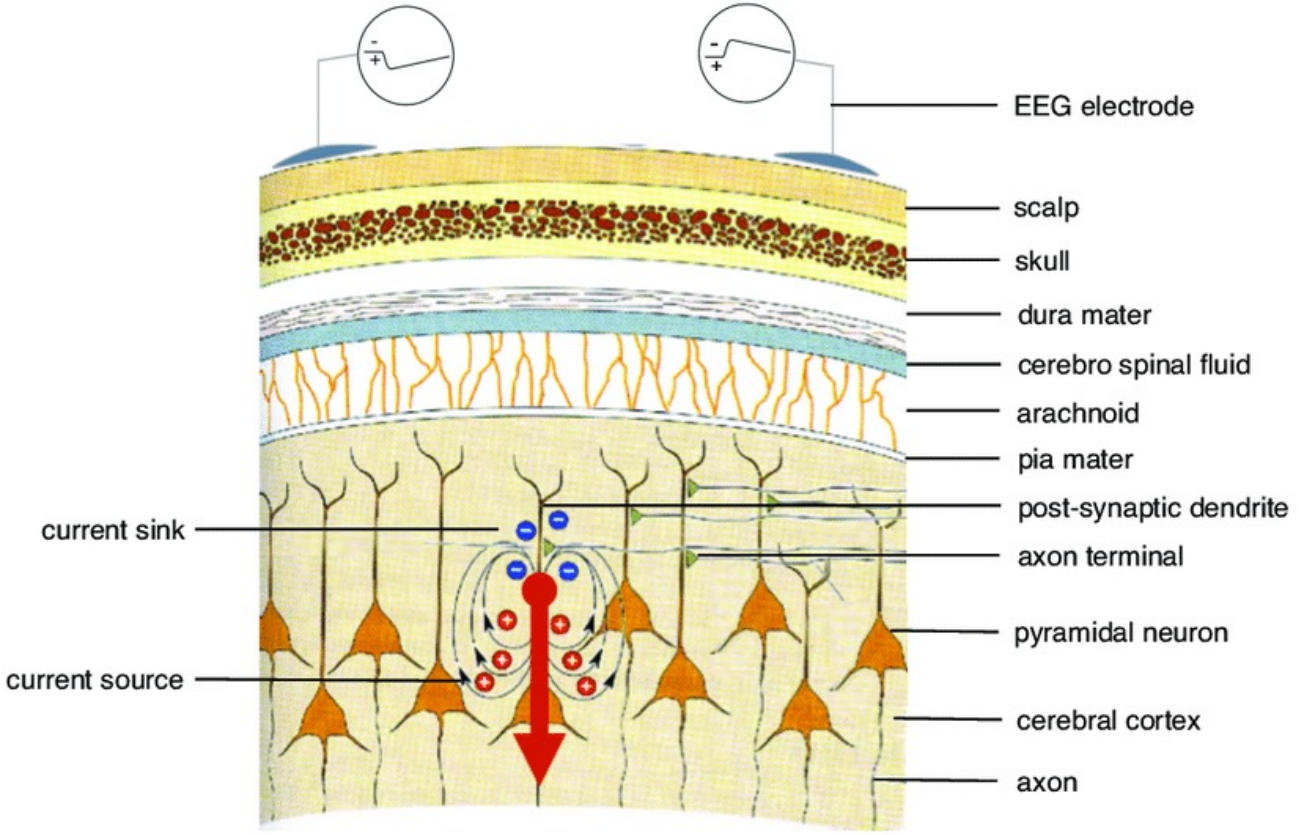


Origin of EEG

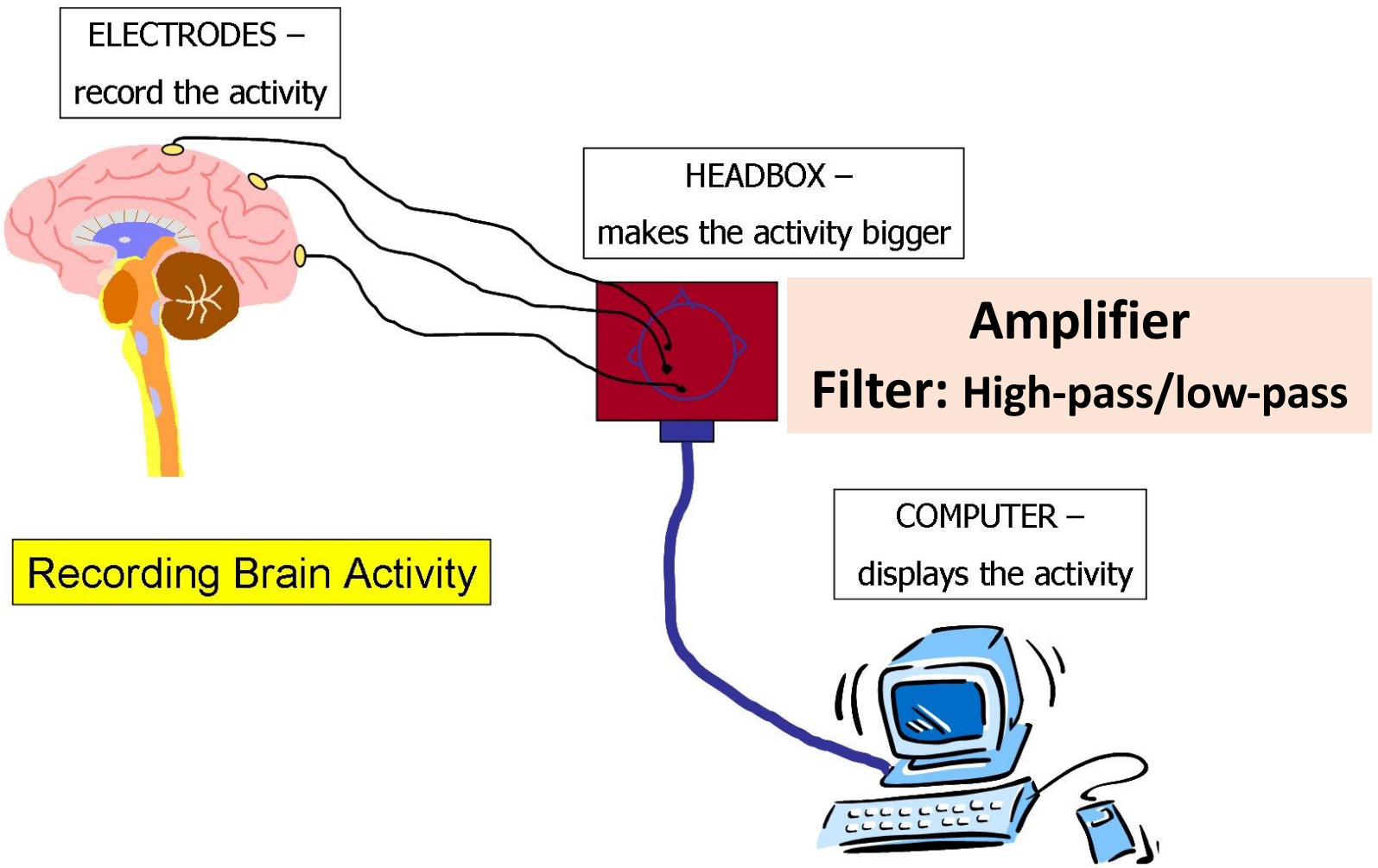
- Summation of inhibitory postsynaptic potentials (IPSPs) and excitatory postsynaptic potentials (EPSPs) from pyramidal neurons
- More than 100,000 neurons
- Not action potential

Recording EEG

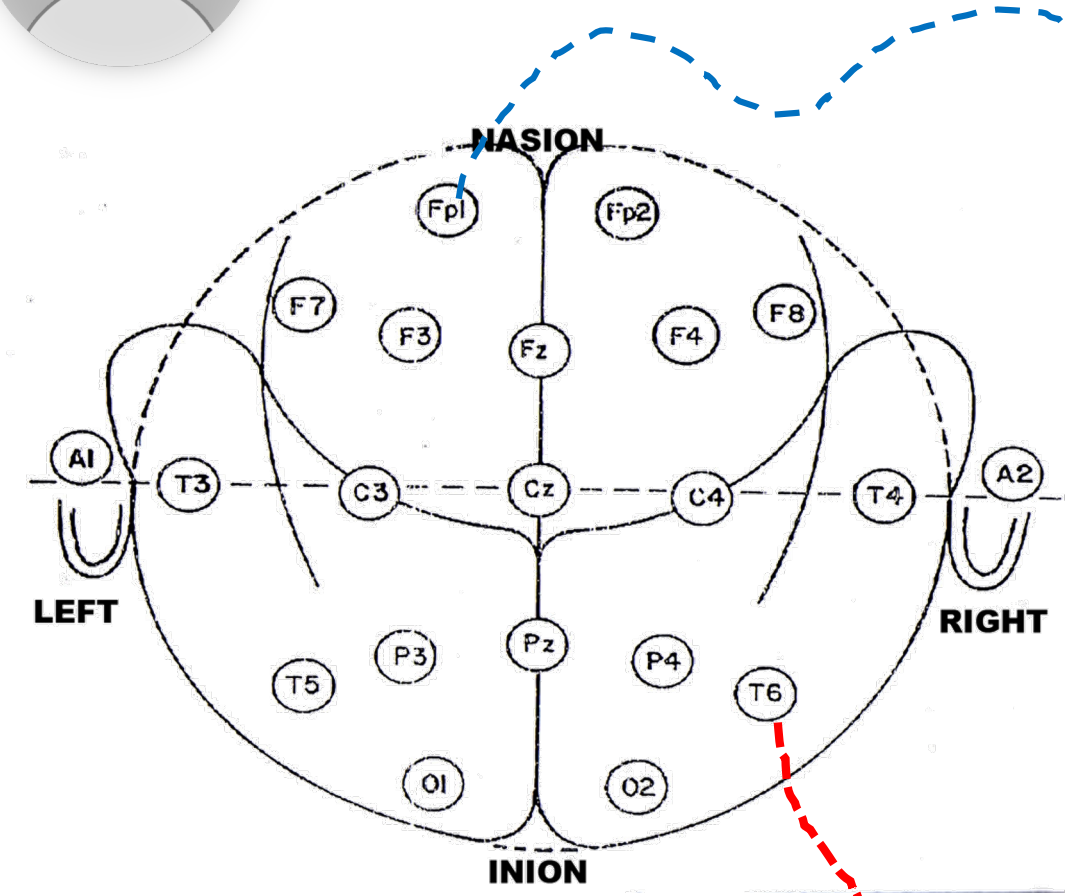


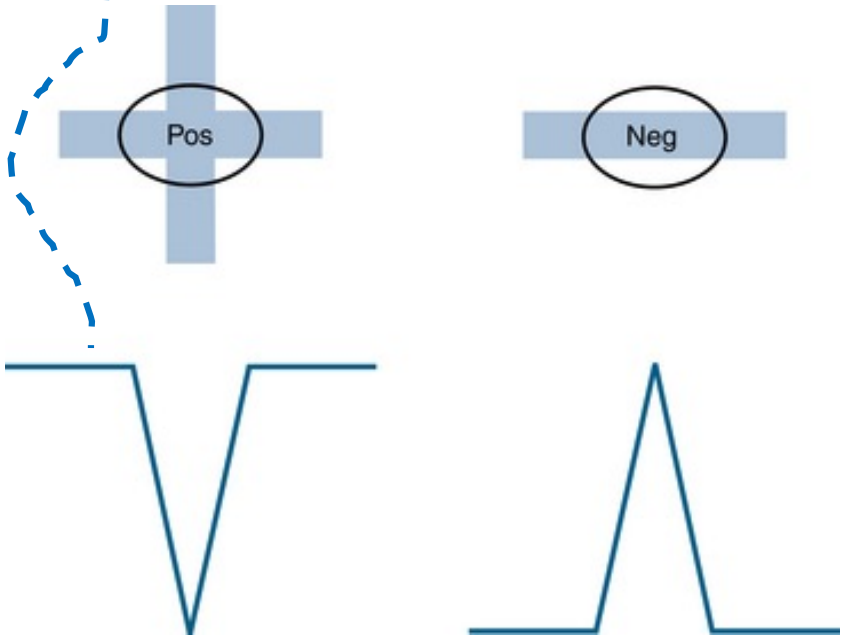


Recording EEG



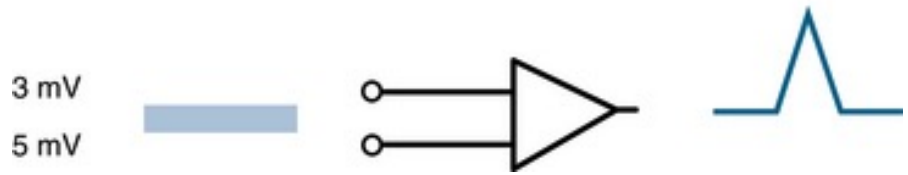
Recording EEG



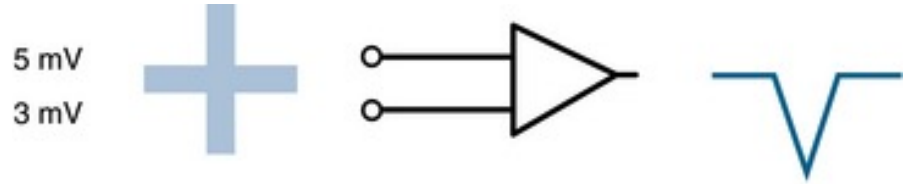


Output from amplifier

- Difference between input1 and input 2
- If input 1 is more negative than input 2 → the pen will deflect up

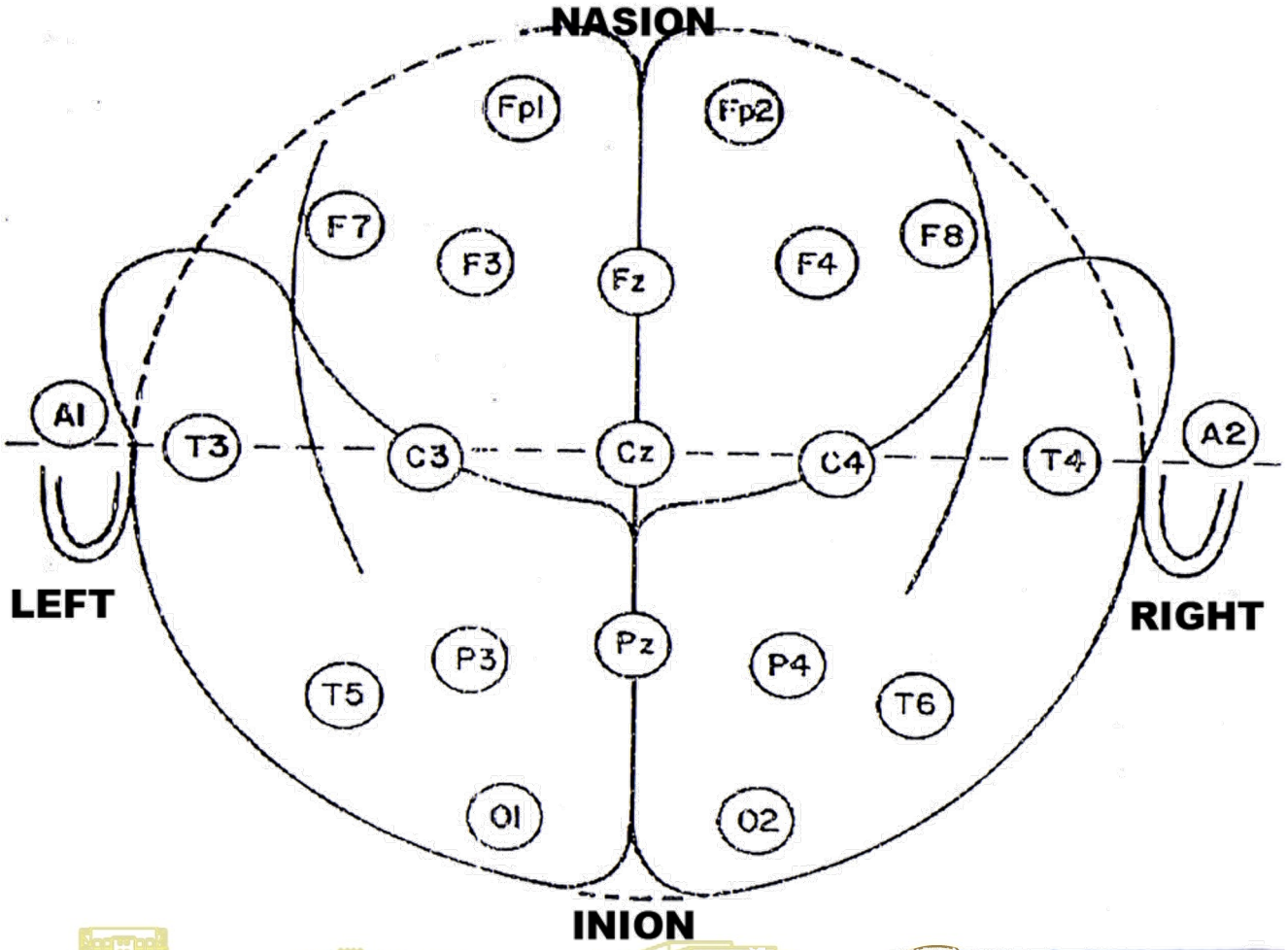


- If input 1 is more positive than input 2 → the pen will deflect down



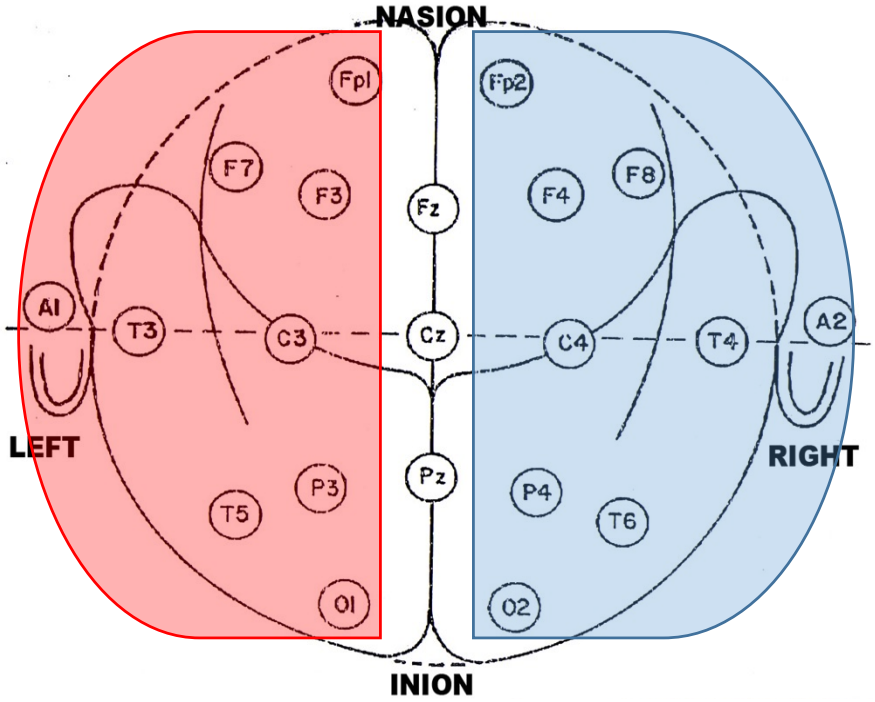
Electrode placement

International 10-20 system



Electrode placement

International 10-20 system



- Minimum 21 electrodes
- **Odd-numbered: LEFT side**
- **Even-numbered: RIGHT side**
- Specific letters designate the anatomical area; for example “F” means frontal

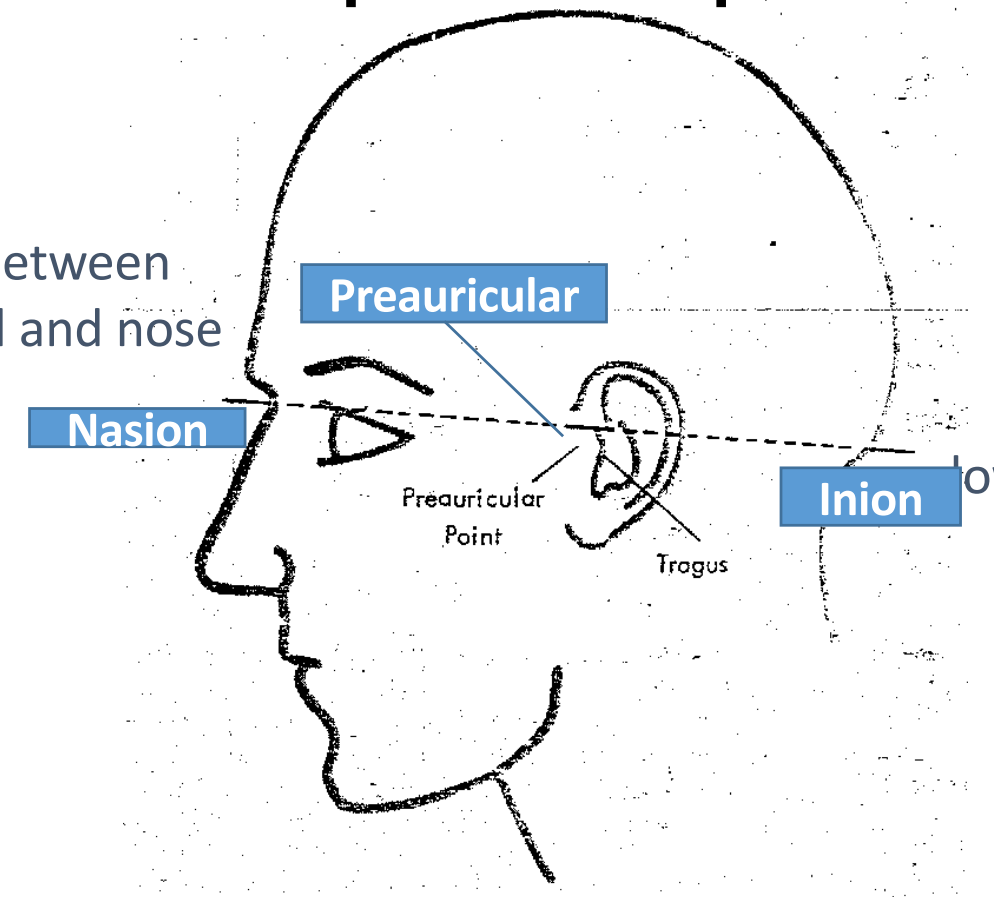
International 10 -20 system

4 landmarks are used

nasion & **inion**

& 2 **pre auricular points**

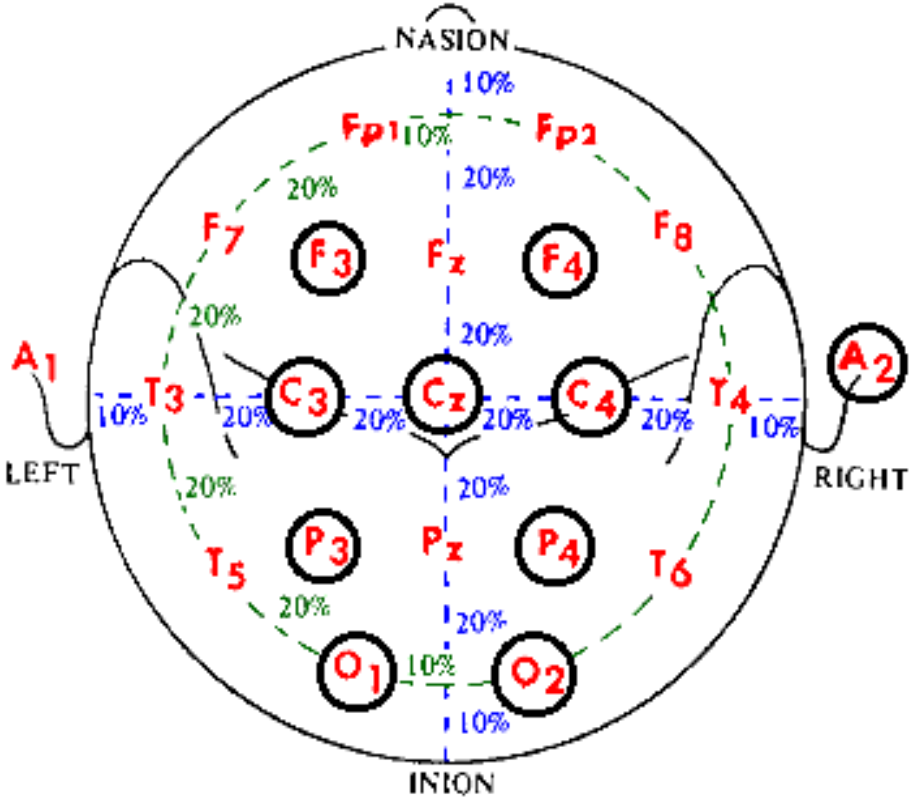
point between forehead and nose

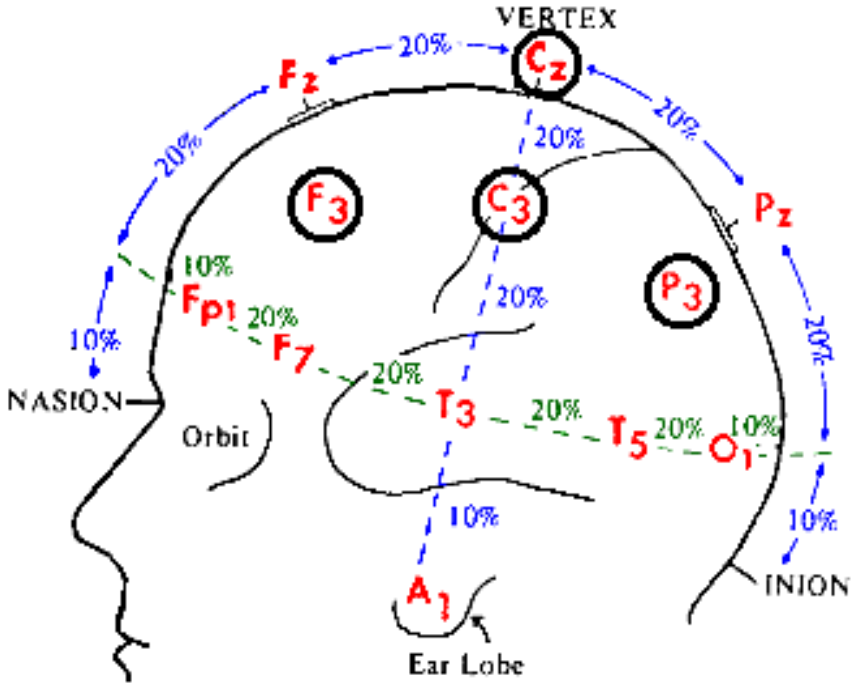


Bump lowest point of skull at back of head

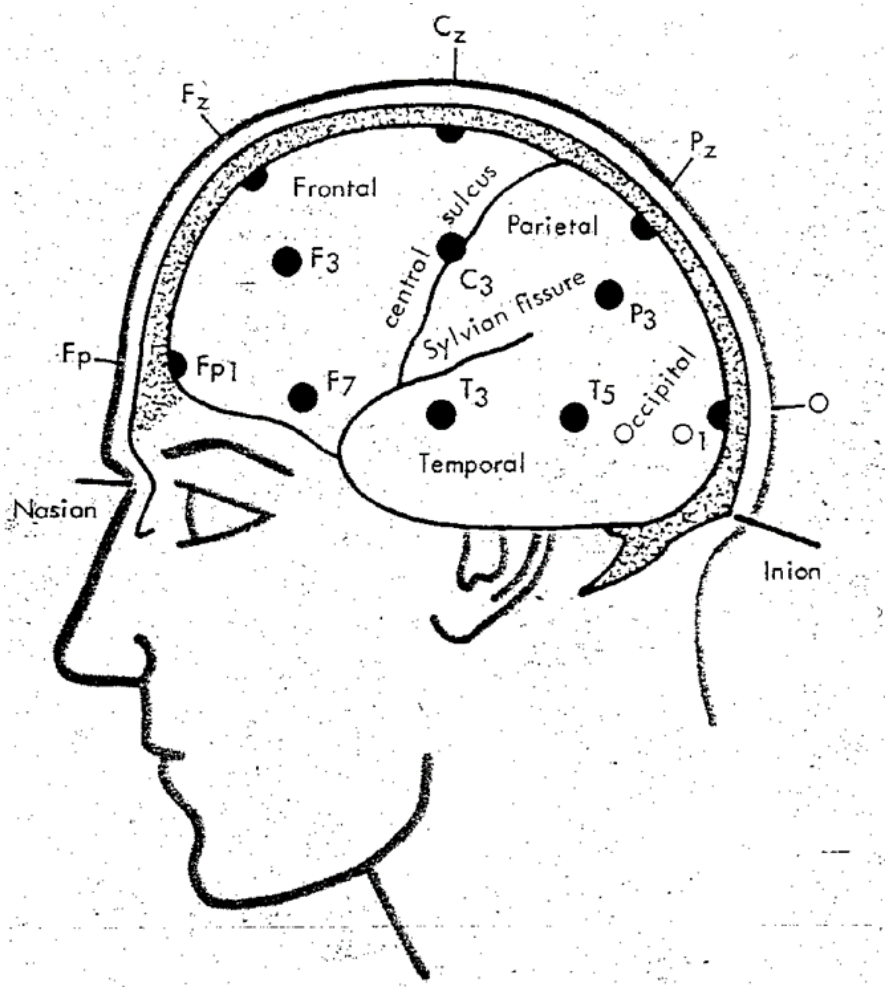
LEFT LATERAL VIEW OF SKULL LANDMARKS.

International 10-20 system



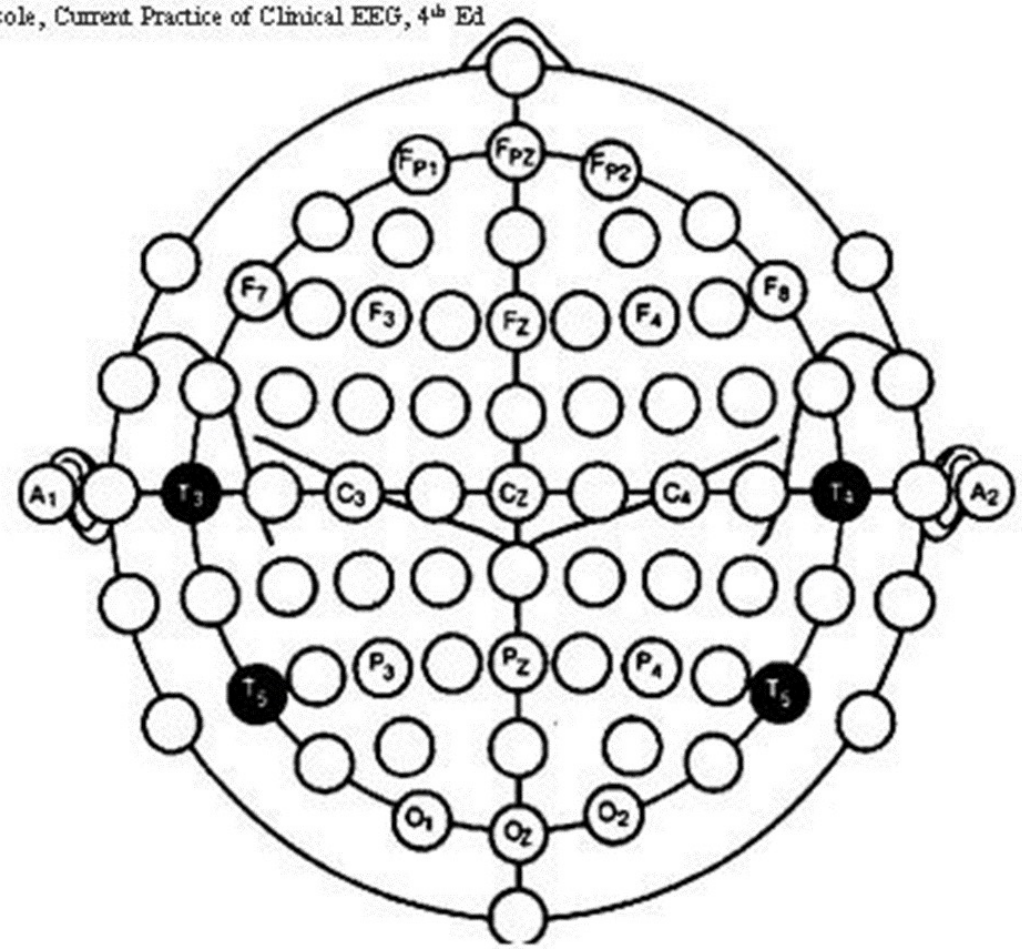


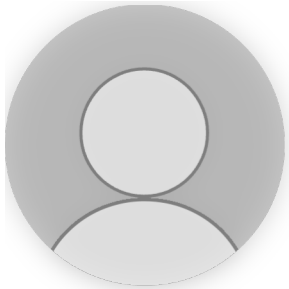
Anatomical regions represented by EEG letters



Electrode placement: 10-20 system

From Pedley and Ebersole, Current Practice of Clinical EEG, 4th Ed



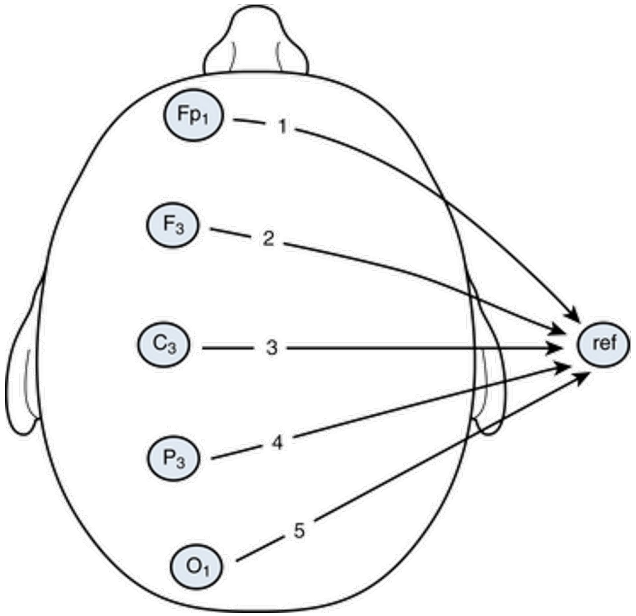


Montage

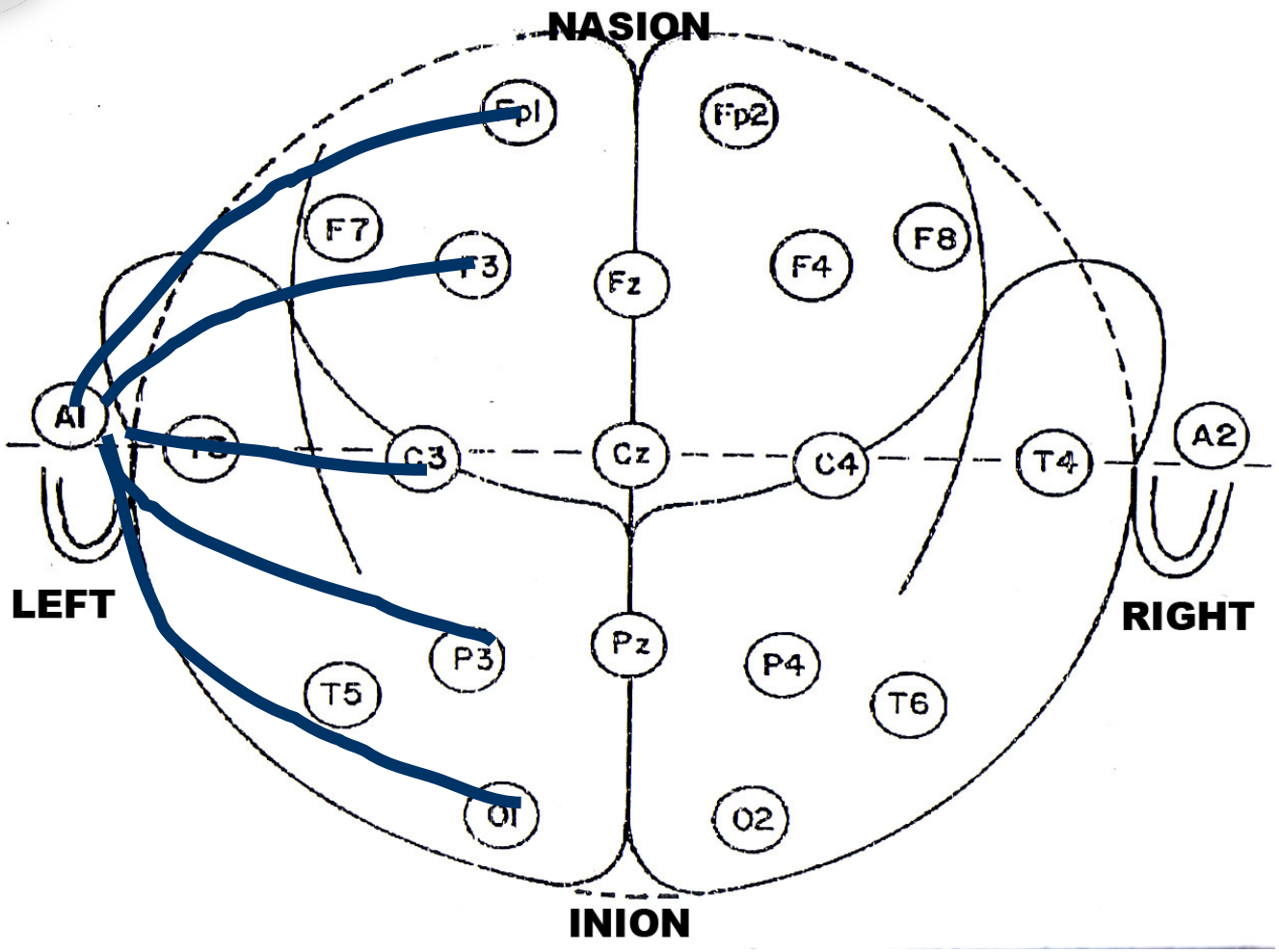
- Referential montages
- Bipolar (Differential) montages

Referential montages

- Common reference electrode connected to input2
- Reference electrode need to be carefully chosen



Referential montages

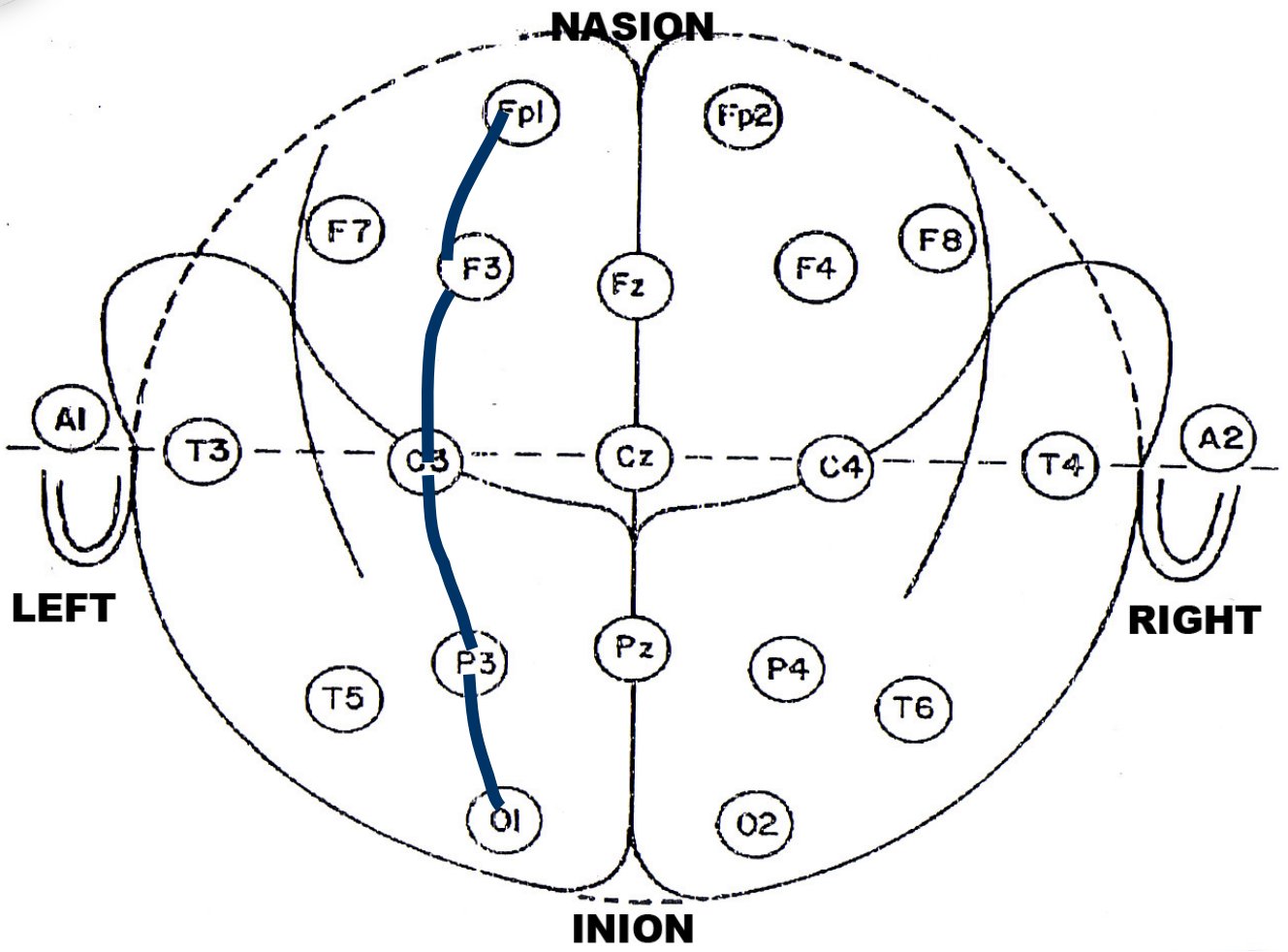


Fp1	-A1
F3	-A1
C3	-A1
P3	-A1
O1	-A1

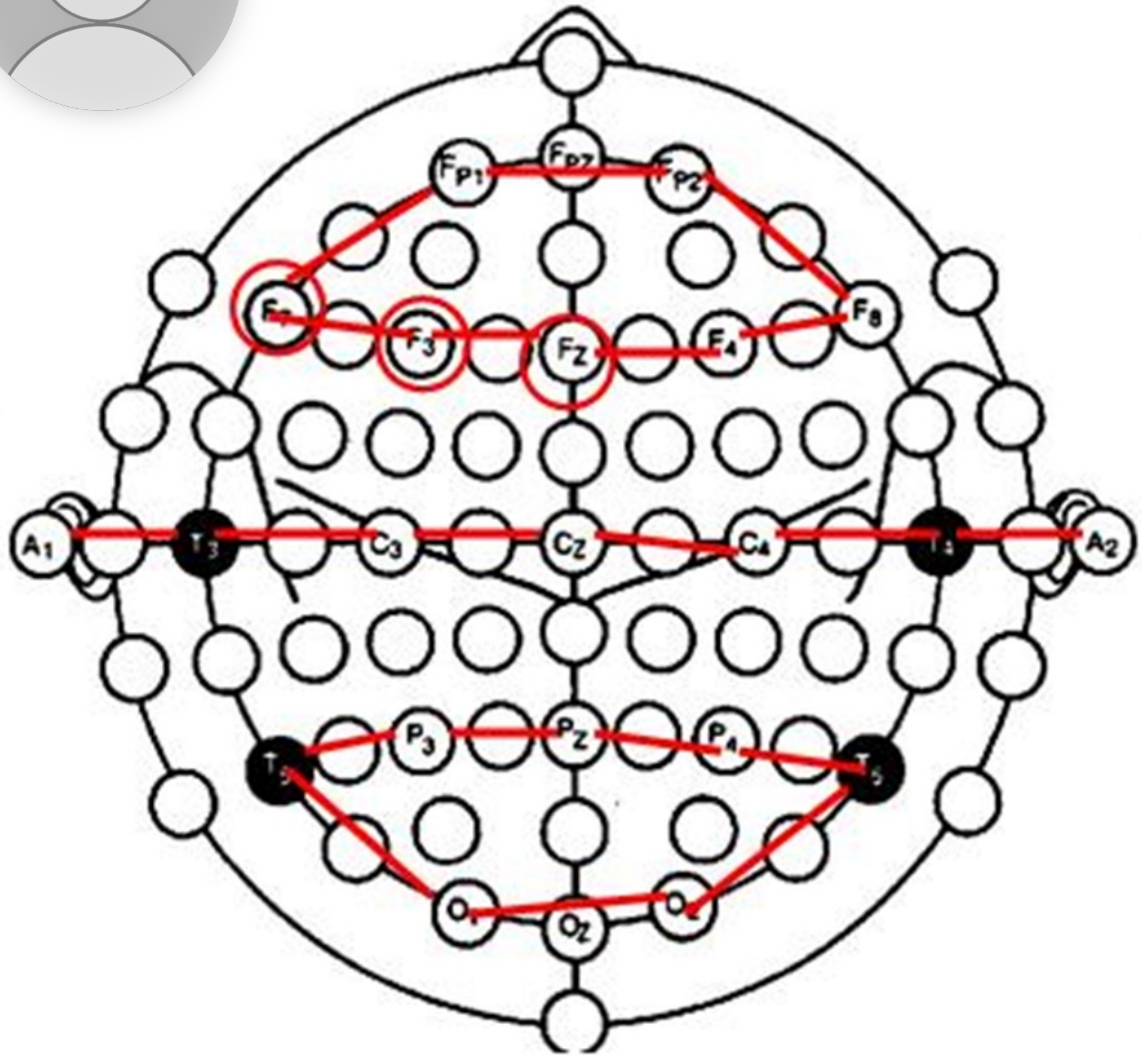
Bipolar montages

- Input 1 and 2 both connect to active electrodes
- Links serial pairs of electrodes in straight longitudinal or coronal lines

Bipolar montages



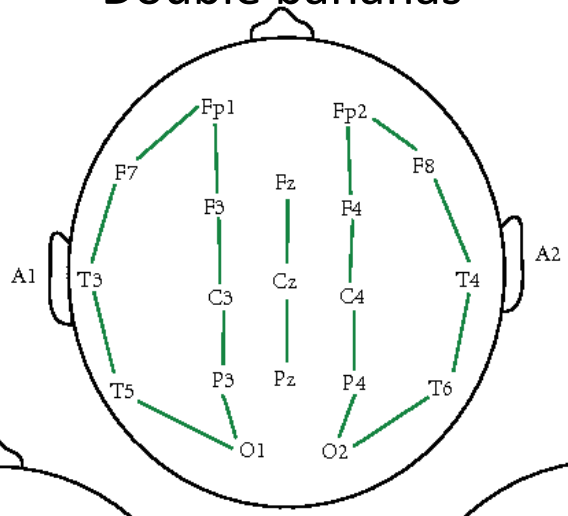
Fp1	-F3
F3	-C3
C3	-P3
P3	-O1



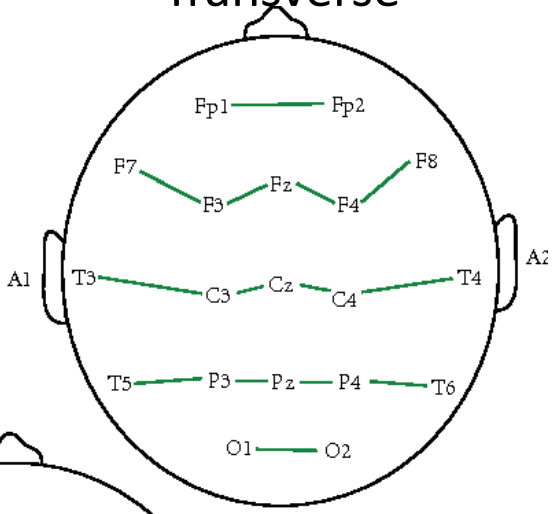
Coronal / transverse bipolar montage:

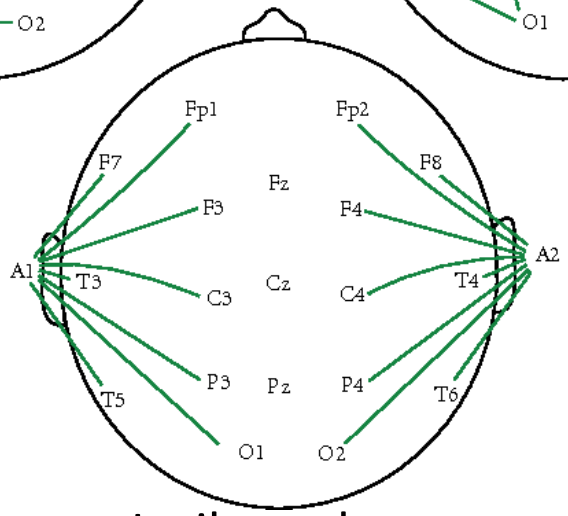
Common EEG montages

Double bananas

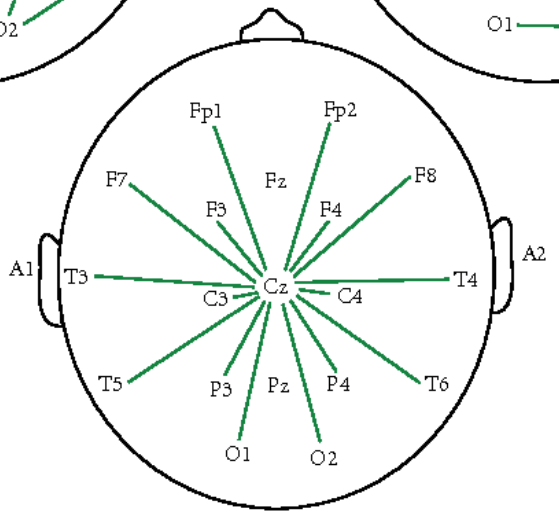


Transverse





Ipsilateral ear



Cz ref

Bipolar montages

Advantage

- Eliminating the problem from contaminated reference
- Less artifacts

Disadvantage

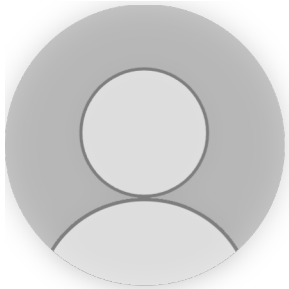
- Possibility of signal cancellation

Routine EEG

- Note state of consciousness
- Mental activation
- Photic stimulation
- Hyperventilation
- Other stimulation: Tactile, pain, noise, etc. if indicated

Information needed for EEG interpretation

- Age
- State of consciousness



Description & terminology of EEG activities

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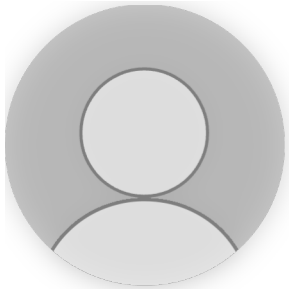

What are on EEG records?

Normal physiologic rhythm

Abnormal physiologic rhythm

- Epileptiform discharges (ED)
- Nonepileptiform discharges

Artifacts

- Physiologic artifacts
- Nonphysiologic artifacts

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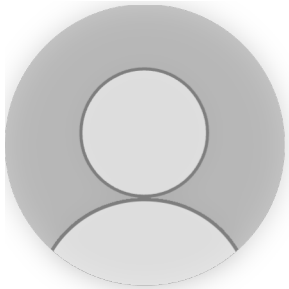
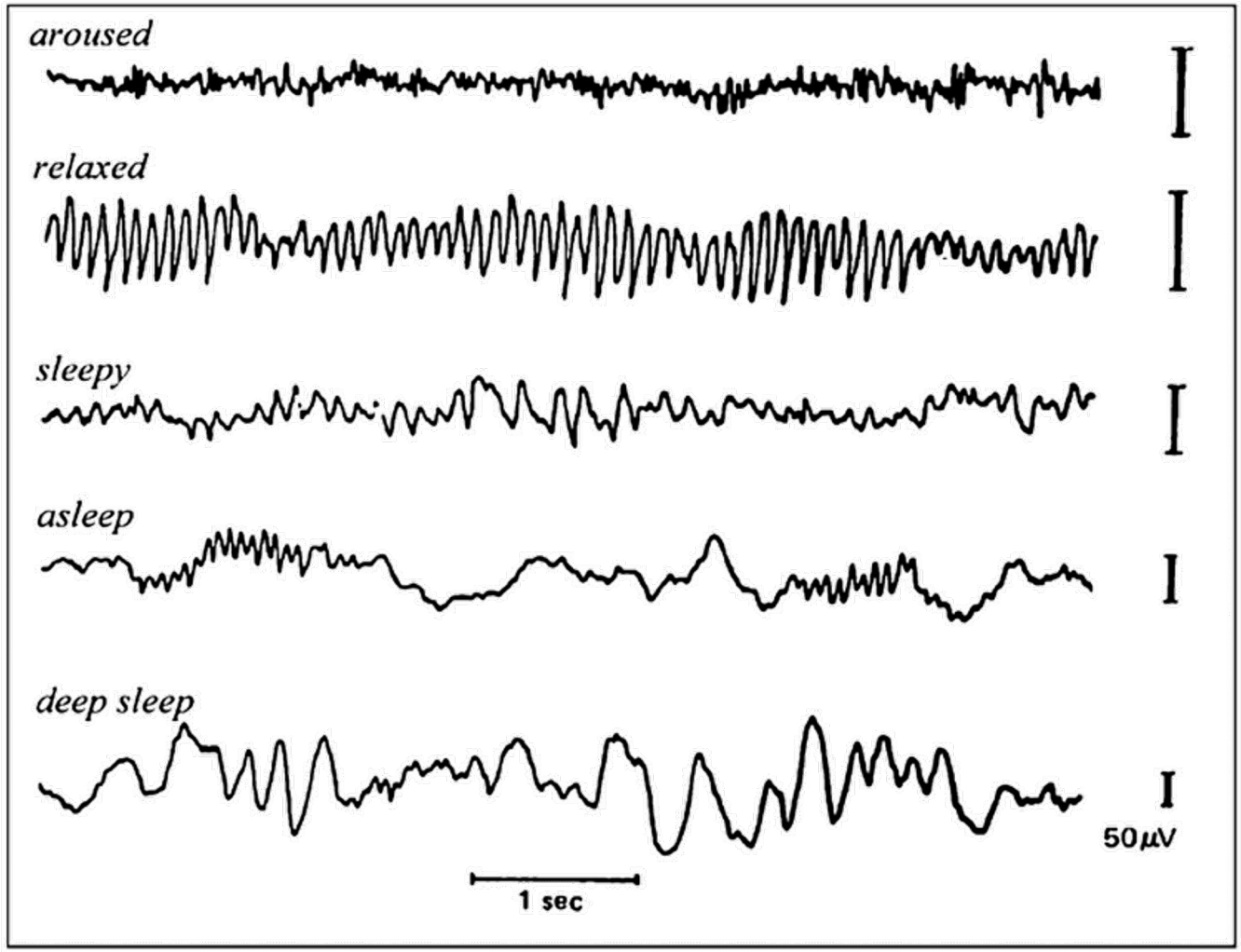


Description & terminology

- Wave form
- Interhemispheric coherence: symmetry, synchrony
- Repetition
- Frequency
- Amplitude
- Symmetry
- Distribution/location
- Occurrence
- Reactivity

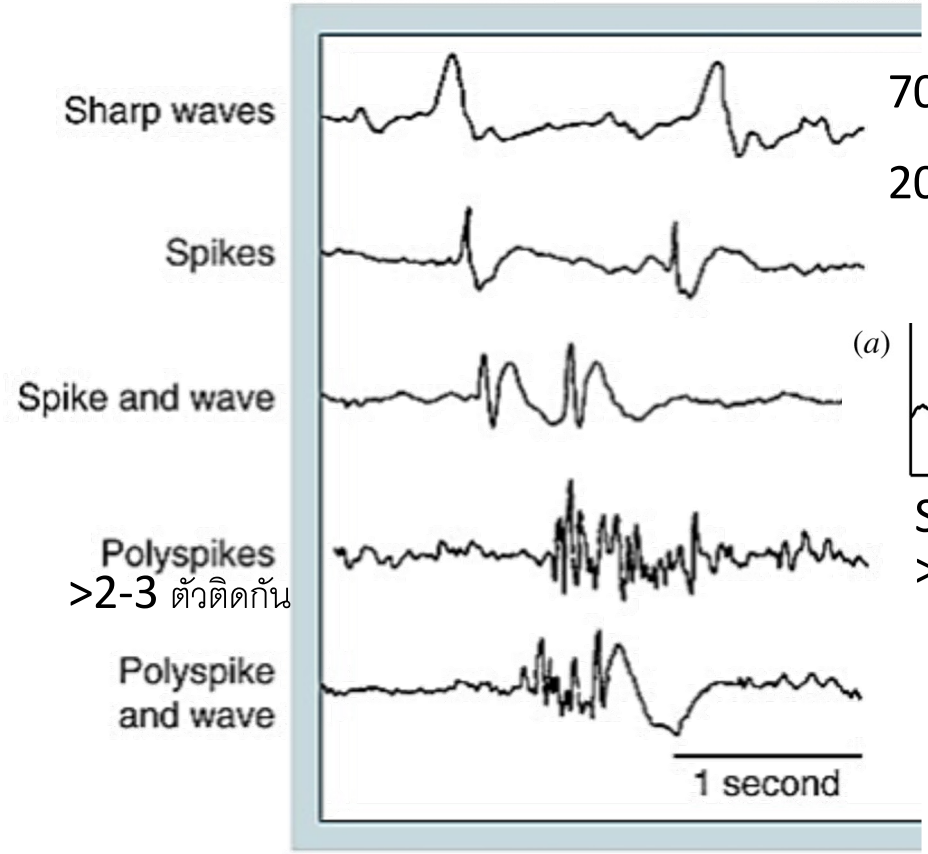
Wave form

- Non-ED
  - Regular
  - Sinusoidal



Wave form

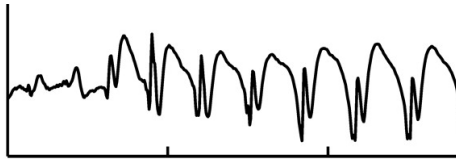
- Epileptiform



70-200 msec

20-70 msec

(a)



Spike and wave complexes
>3 ตัวติดกัน

>2-3 ตัวติดกัน

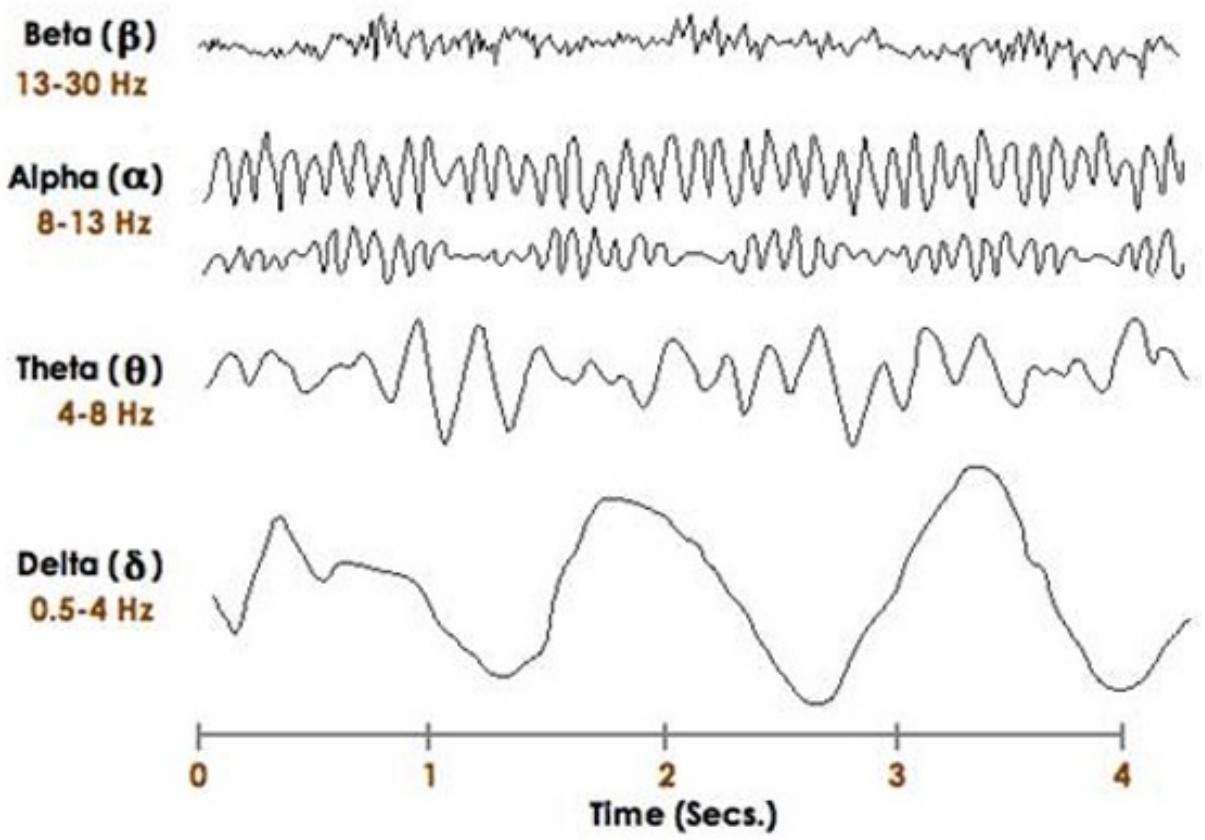
Repetition

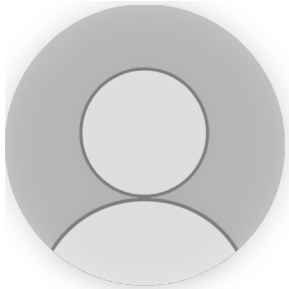
- Rhythmic (regular): sinusoidal
- Non-rhythmic (irregular): polymorphic

Frequency

- Delta: <4 Hz
- Theta: 4-<8 Hz
- **Alpha: 8-<13 Hz**
- Beta: >13 Hz

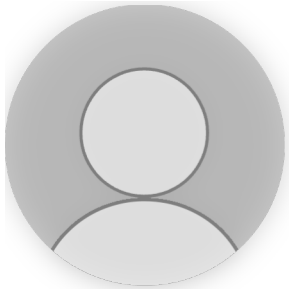
- Slow → <8Hz
- Fast → >13 Hz





Amplitude

- Low: <20 uV
- Medium or moderate: 20-50 uV
- High: >50 uV

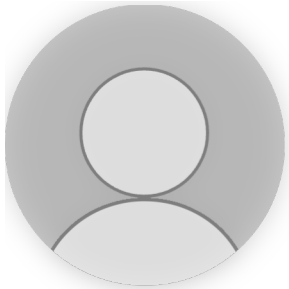


Distribution

- Widespread, diffuse or generalized
- Lateralized (hemisphere)
- Focal (lobe)

Occurrence

- Intermittent or occasionally
  - <70-80%
- Continuous or persistence
  - >80%



Normal awake EEG

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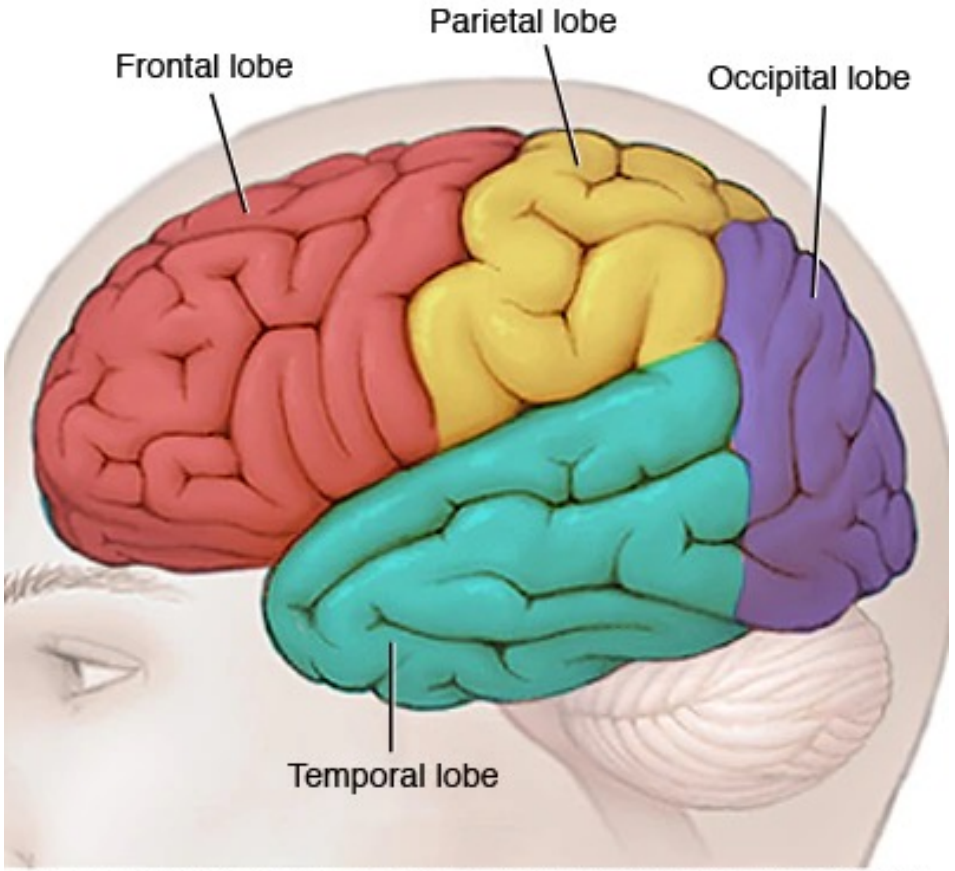
Normal awake EEG

State of consciousness

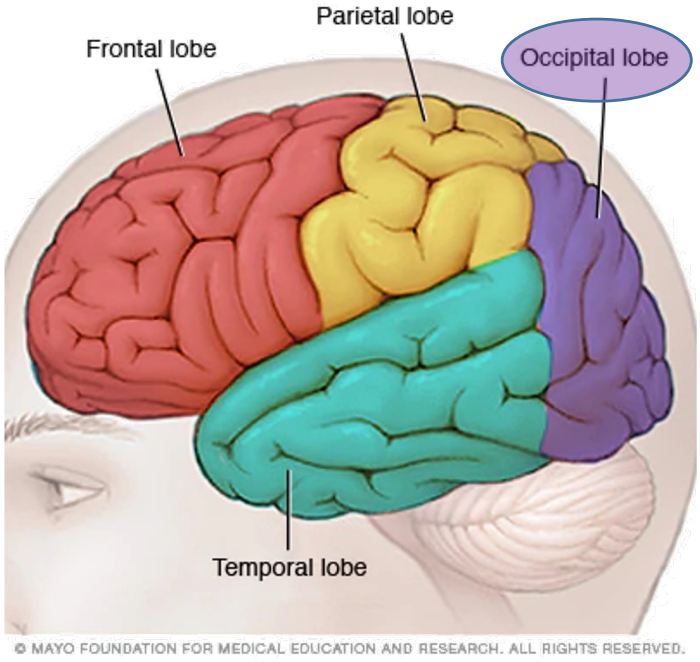
- Awake EEG
- Sleep EEG

Location

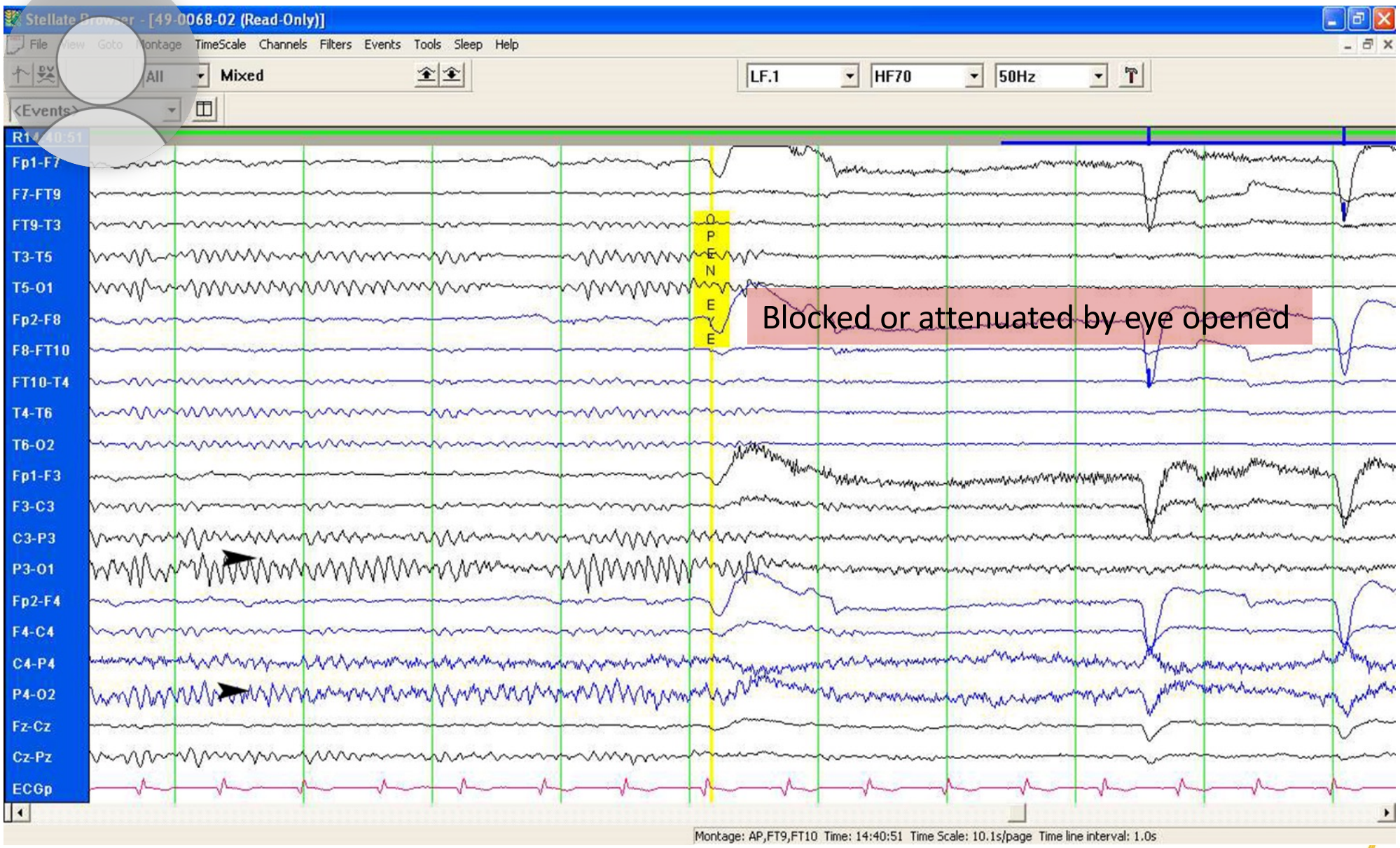
- Different rhythm



Posterior dominant background (alpha rhythm)



- Frequency: 8-13 Hz,
  - 3-4 Hz in newborn, up to 8 Hz by 3-6 yo
- Voltage: depends on age, higher voltage in children
- Waveform: regular, waxing and waning in amplitude
- Occurrence: continuous during awake
- Location: occipital, parietal, posterior temporal, symmetric
- Reactivity: reduced with eye opening

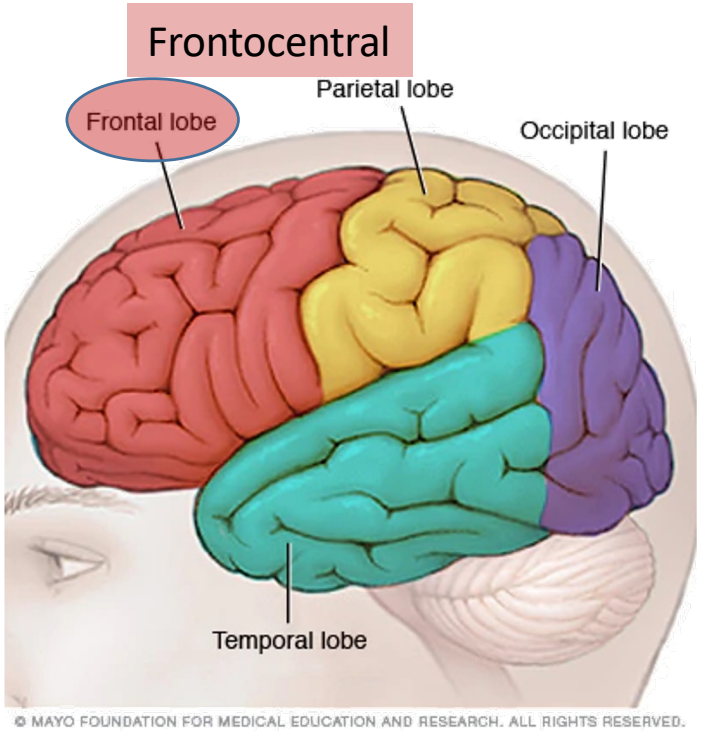

Stellate Browser - [49-0068-02 (Read-Only)]
File View Goto Montage TimeScale Channels Filters Events Tools Sleep Help
All
Mixed
LF.1
HF70
50Hz
<Events>
Fp1-F7
F7-FT9
FT9-T3
T3-T5
T5-O1
Fp2-F8
F8-FT10
FT10-T4
T4-T6
T6-O2
Fp1-F3
F3-C3
C3-P3
P3-O1
Fp2-F4
F4-C4
C4-P4
P4-O2
Fz-Cz
Cz-Pz
ECGp
OPEN EYE
Blocked or attenuated by eye opened
Montage: AP,FT9,FT10 Time: 14:40:51 Time Scale: 10.1s/page Time line interval: 1.0s

Posterior dominant rhythm: Age dependent

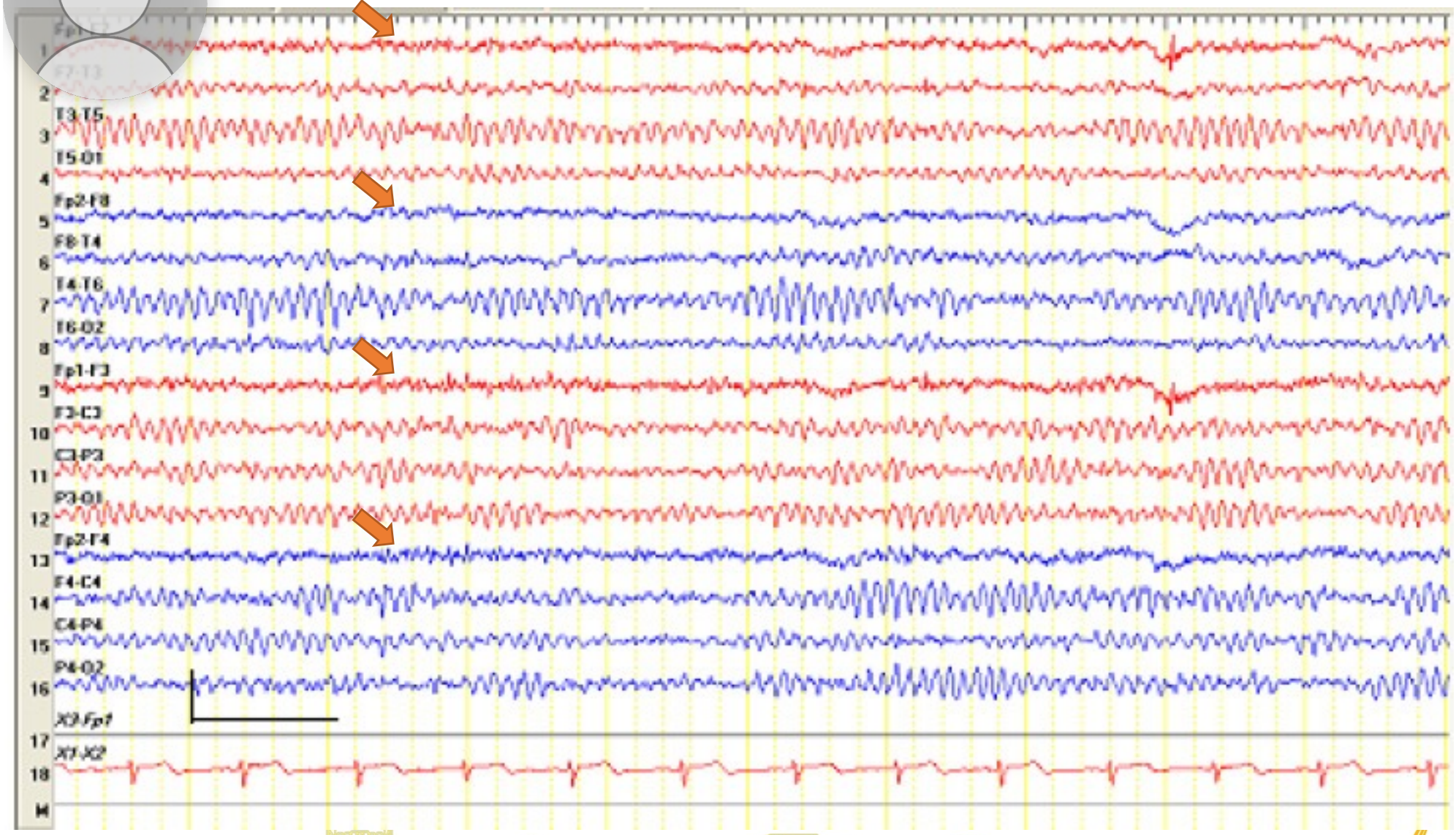
- 4 months — 4 Hz
- 5 months to 1 year — 5-6 Hz
- 3 years — 8 Hz (>80% of age group)
- 9 years — 9 Hz
- 15 years — 10 Hz

- about 1 Hz different between Rt./Lt. hemisphere
- ¼ of normal, alpha rhythm is poorly visualized
- Amplitude: Rt > Lt

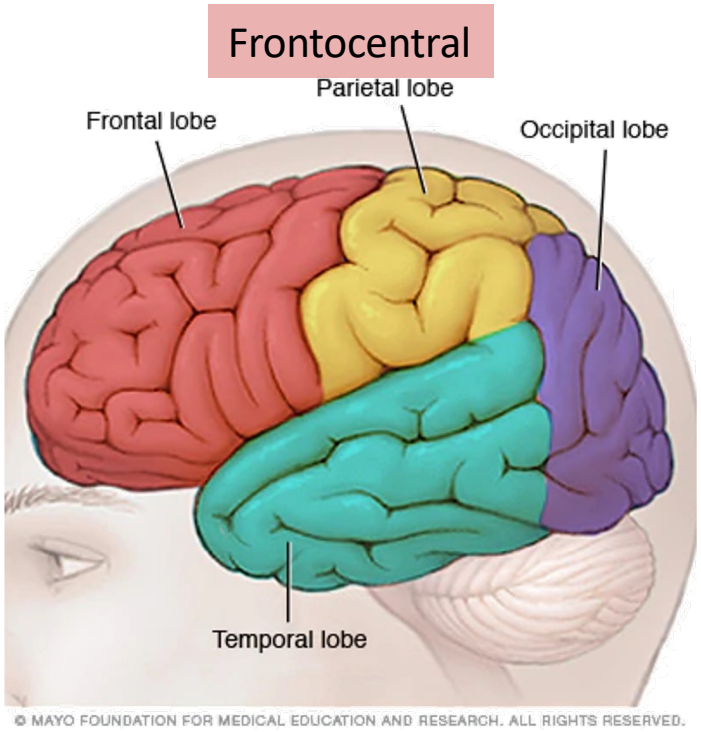
Frontal Beta rhythm



- Frequency: >13 Hz (common 18-25 Hz)
- Voltage: low voltage, usually < 20 uV
- Occurrence: irregular but continuous during awake, may be more prominent with drowsiness
- Location: Frontocentral region, symmetric

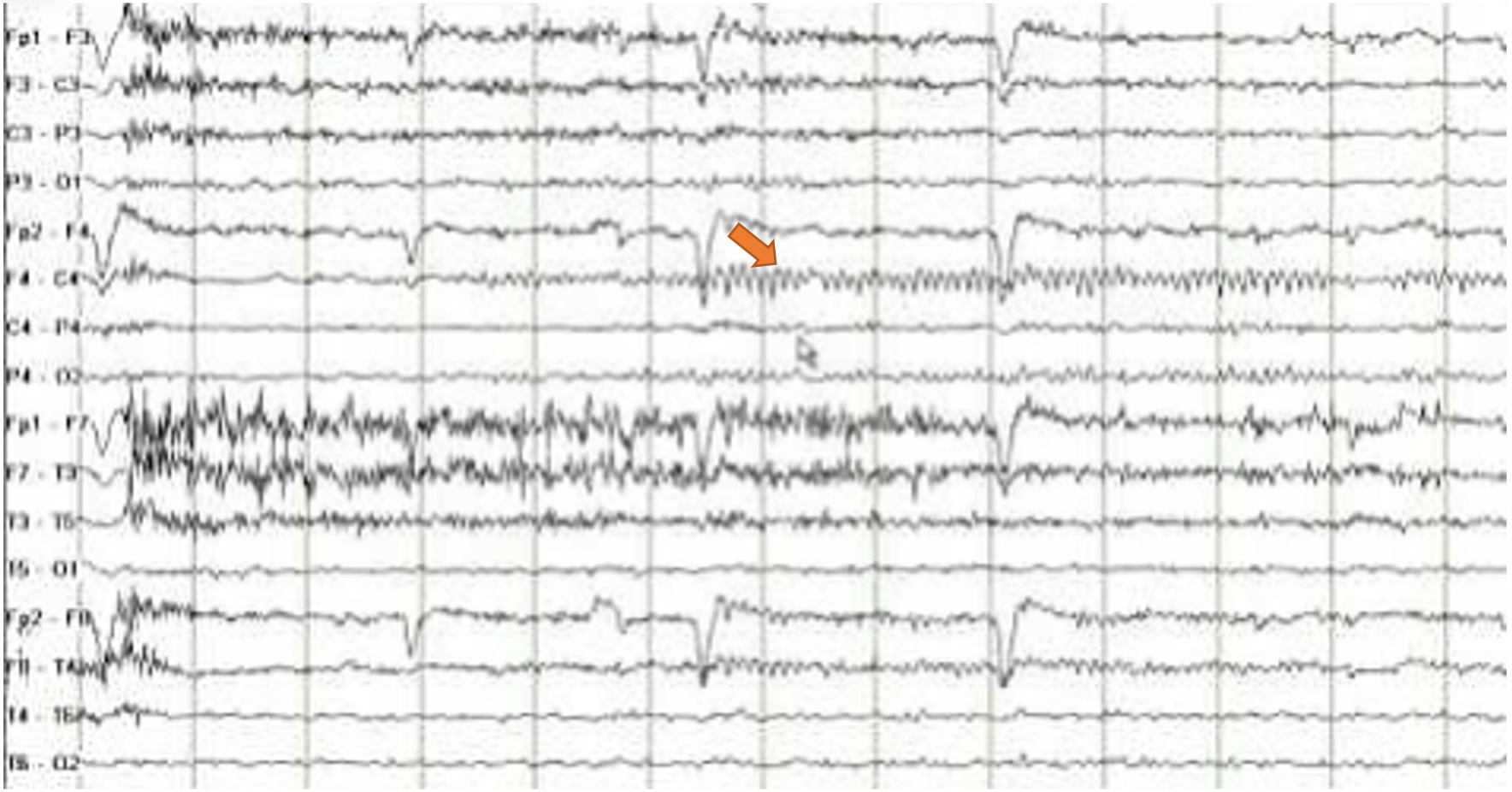

T3-T5
T5-O1
Fp2-F8
F8-T4
T4-T6
T6-O2
Fp1-F3
F3-C3
C3-P3
P3-O1
Fp2-F4
F4-C4
C4-P4
P4-O2
X2-Fp1
X1-X2

Mu rhythm

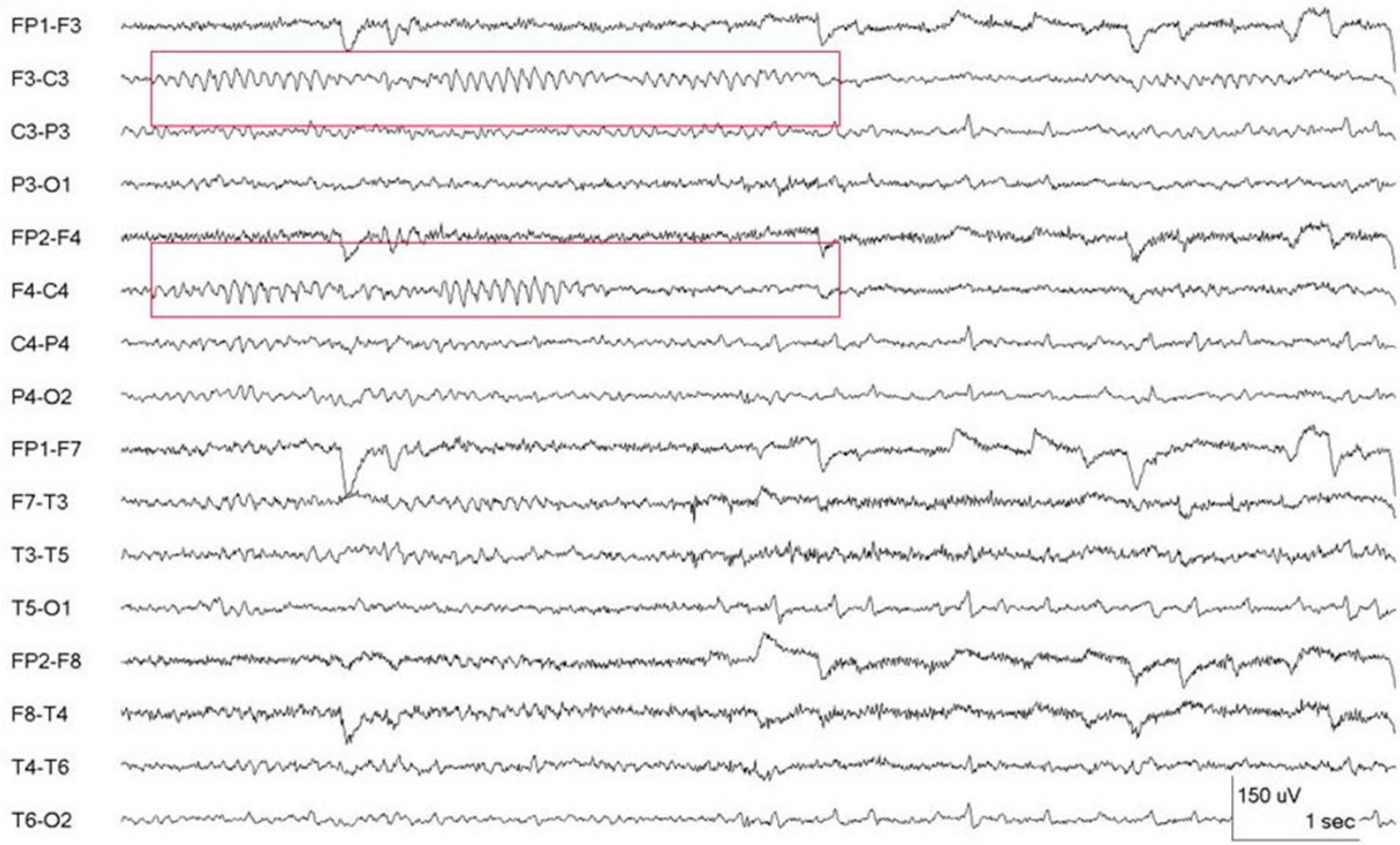


- Resting state of motor neuron
- Frequency: 8-10 Hz
- Voltage: **similar to alpha rhythm**
- Waveform: arch like
- Occurrence: intermittent, 17-19% in young adult, less in elderly or children
- Location: central region
- Reactivity: blocks with movement of contralateral extremity
- Can be unilateral/ asymmetric

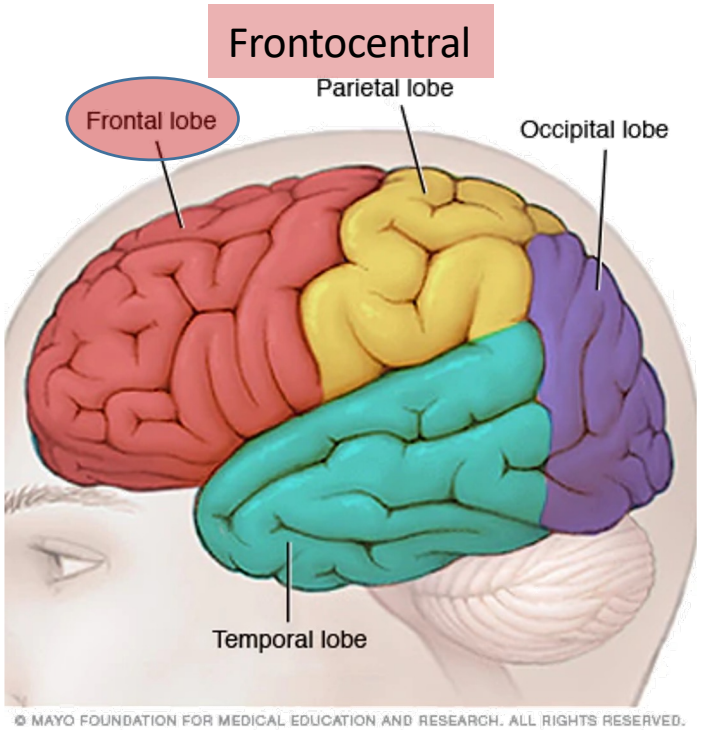
Mu rhythm


Fp1 - F3
F3 - C3
C3 - P3
P3 - O1
Fp2 - F4
F4 - C4
C4 - P4
P4 - O2
Fp1 - F7
F7 - T3
T3 - T5
T5 - O1
Fp2 - F8
F8 - T4
T4 - T6
T6 - O2

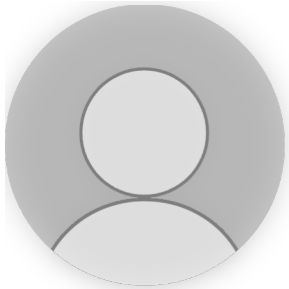
Mu rhythm


FP1-F3
F3-C3
C3-P3
P3-O1
FP2-F4
F4-C4
C4-P4
P4-O2
FP1-F7
F7-T3
T3-T5
T5-O1
FP2-F8
F8-T4
T4-T6
T6-O2
150 uV
1 sec

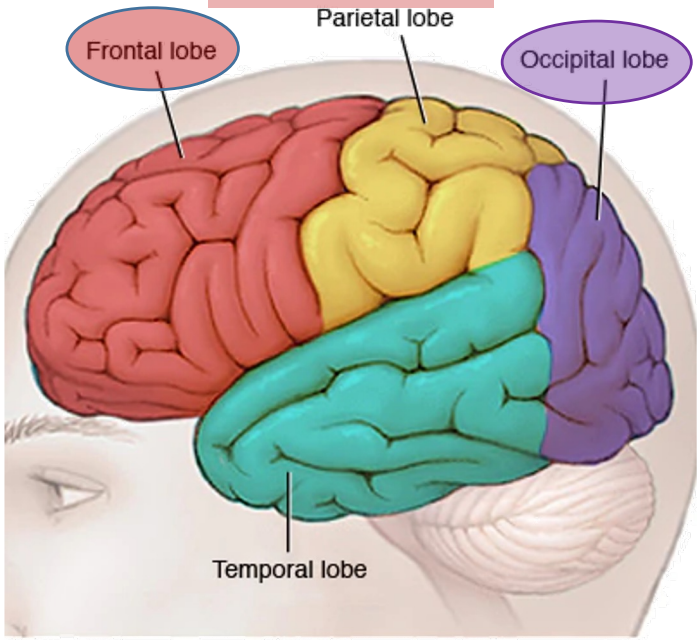
Theta rhythm

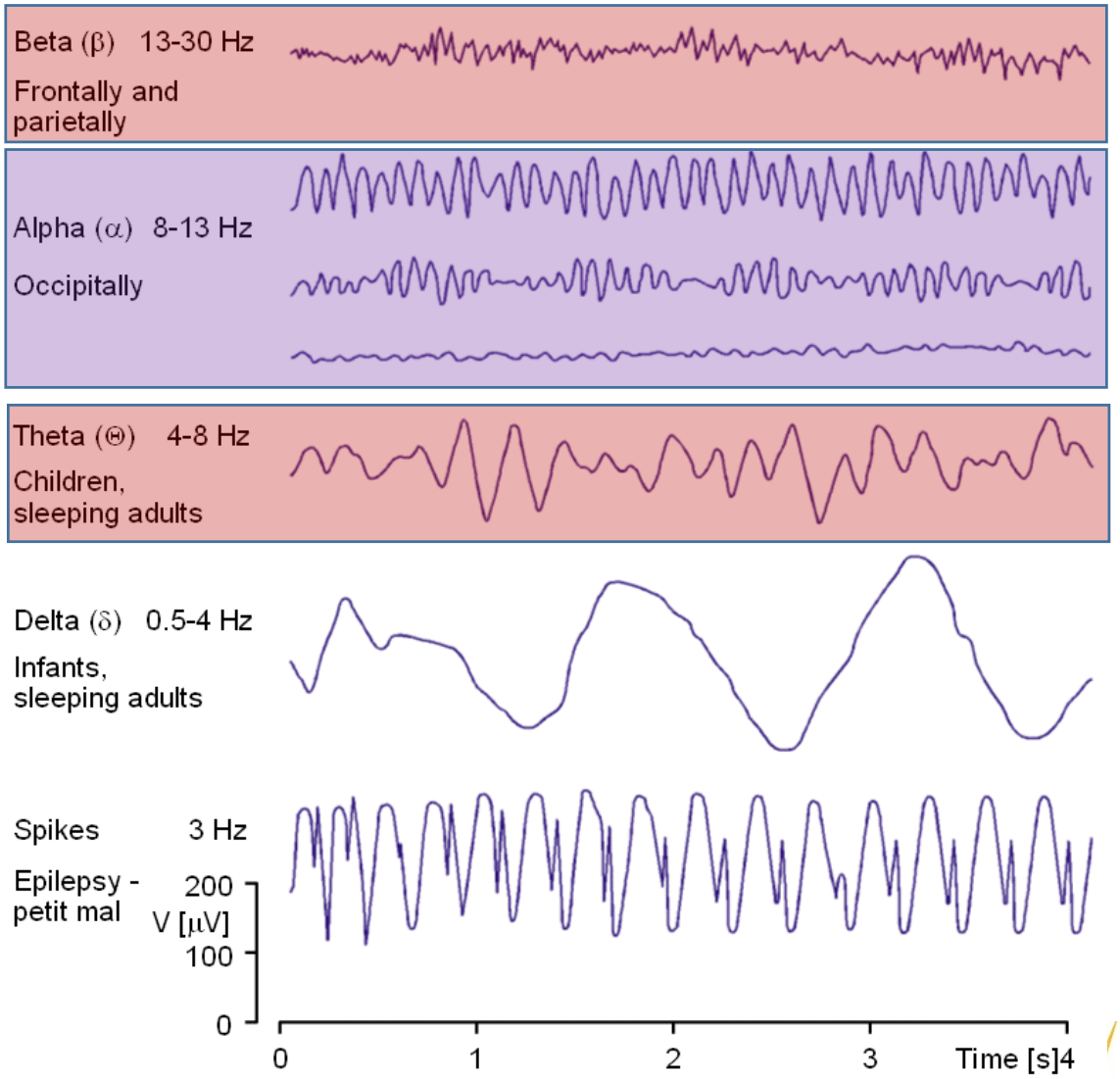


- Frequency: 4-7 Hz (most commonly 6-7 Hz)
- Voltage: similar to alpha rhythm
- Occurrence: irregular
- Enhance with drowsiness/ light sleep
- Location: Frontal, frontocentral region, symmetric



Frontocentral





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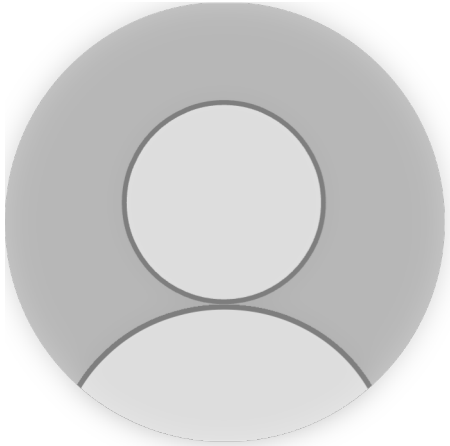

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ศิริราชพยาบาล

Basic EEG for neurology residents “Normal Awake EEG”

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