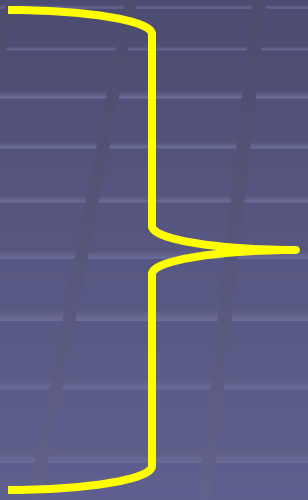
Sleep stages

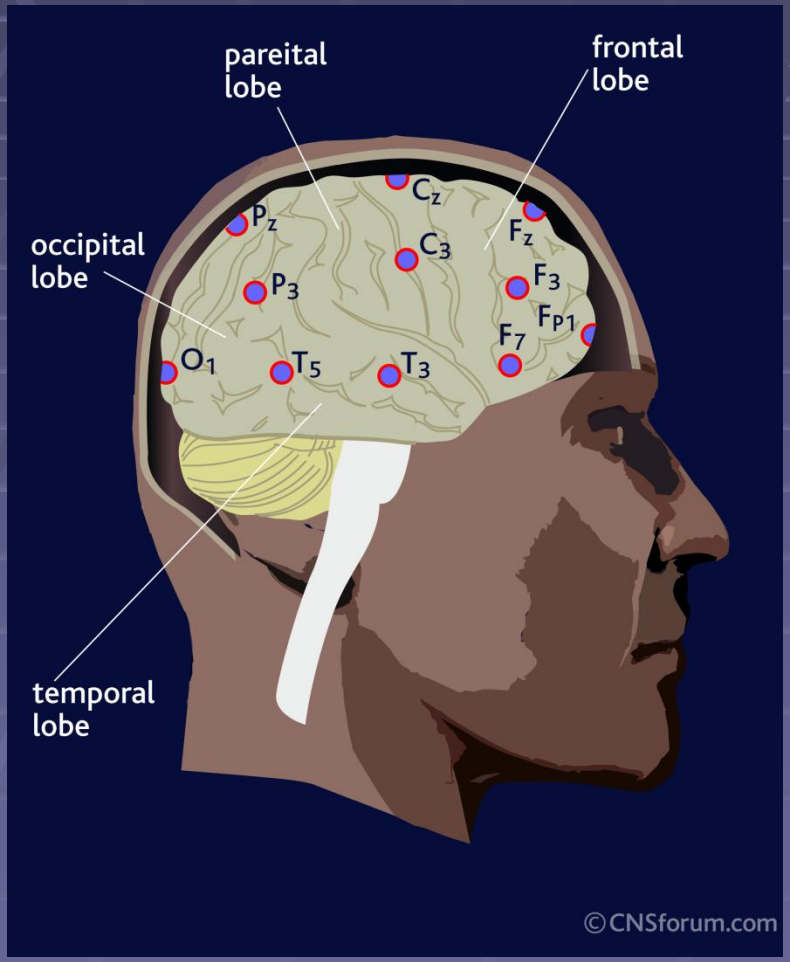
- **Awake**
- ***Stage 1***
- ***Stage 2***
- ***Stage 3***
- ***Stage 4***
- **Rapid eye movement sleep (REM)**

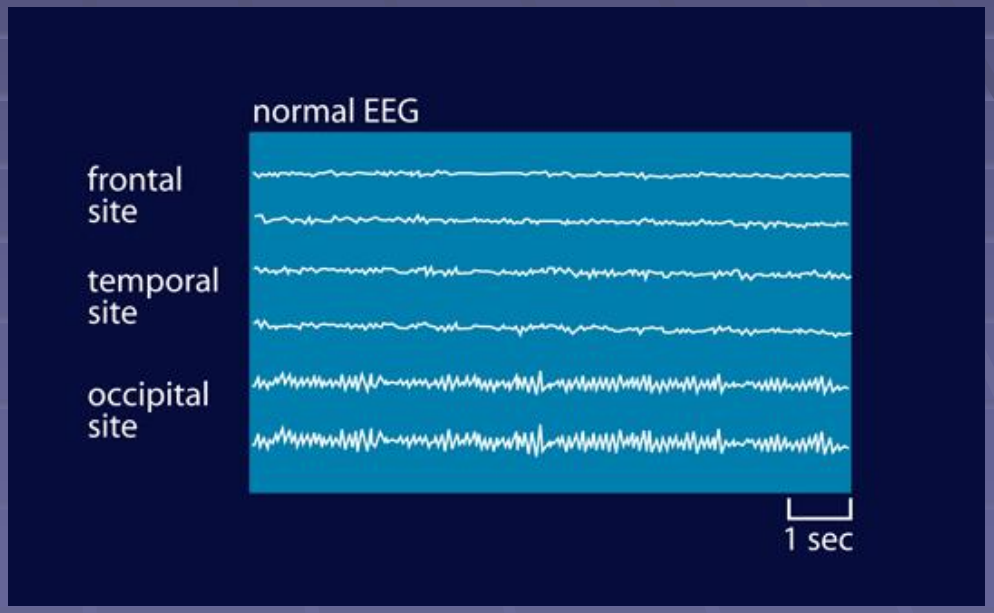


Slow wave sleep (NREM)

EEG waves

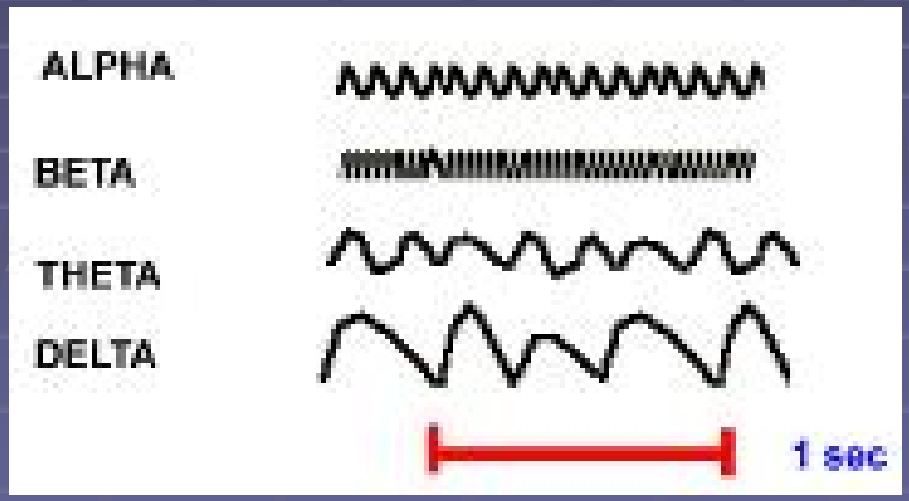
EEG Electrode Placement





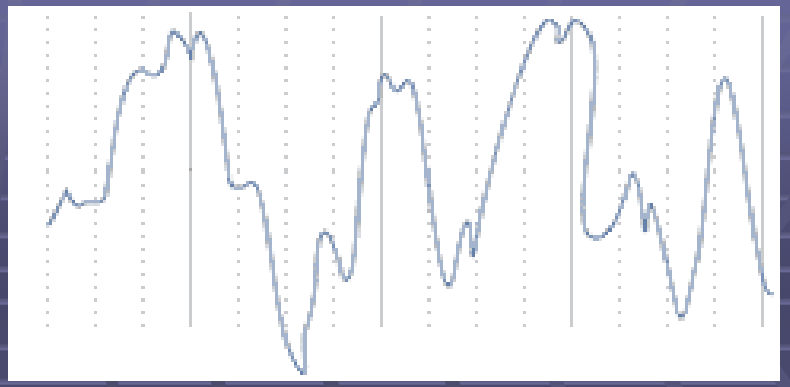
Classifying EEG brain waves

- Frequency: the number of oscillations/waves per second, measured in Hertz (Hz)
  - reflects the firing rate of neurons
  - alpha, beta, theta, delta



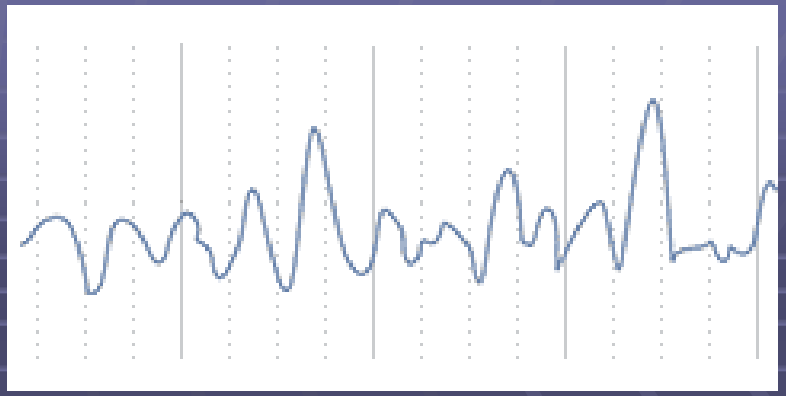
- Amplitude: the magnitude of brain waves, measured in millivolts (mV), gives an indication of the wave's "power".
  - The number of neurons firing in synchrony & the distance between the neurons and the recording electrode

Delta Waves



- **Slowest frequency waves: 1 – 3 Hz**
- **Associated tasks & behaviors:**
  - deep, dreamless sleep, not moving, not attentive, sleeping

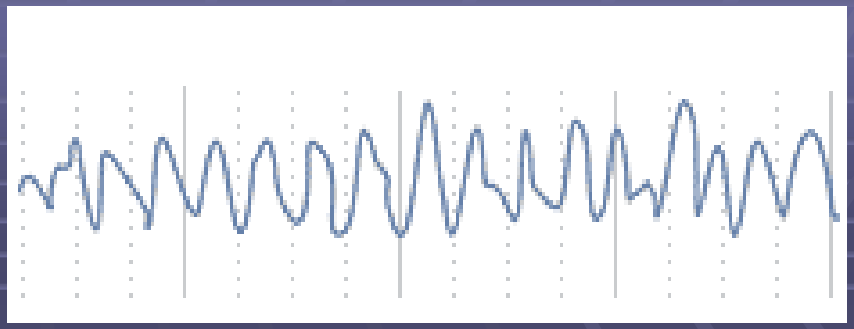
Theta Waves



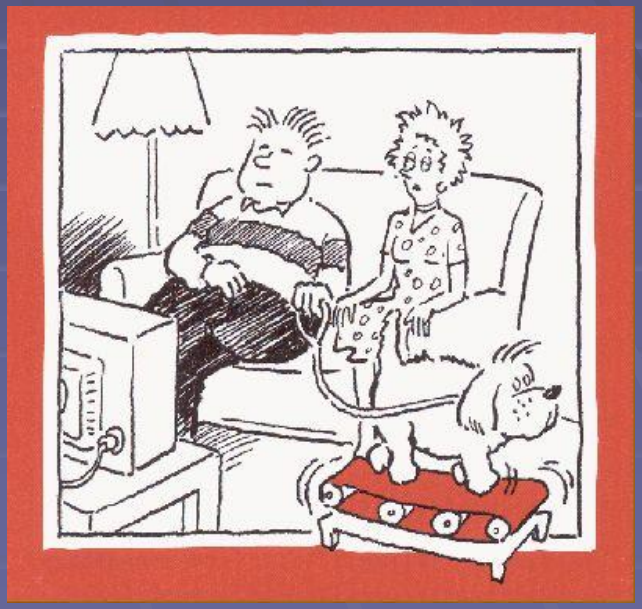
- **Slow wave frequency: 4 – 8 Hz**

- **Associated tasks & behaviors:**
  - State between wakefulness and sleep "Drowsy"
  - during sleep, meditation, internal focus, and prayer; subconsciousness.

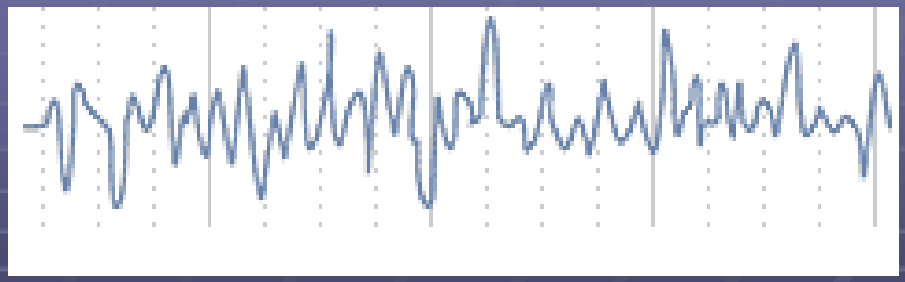
Alpha Waves



- Mid wave frequency: 8 - 13 Hz
- Parietal and occipital lobes
- Associated tasks & behaviors:
  - Relaxing, watching television, light reading (e.g., novel), eyes closed.



Beta Waves



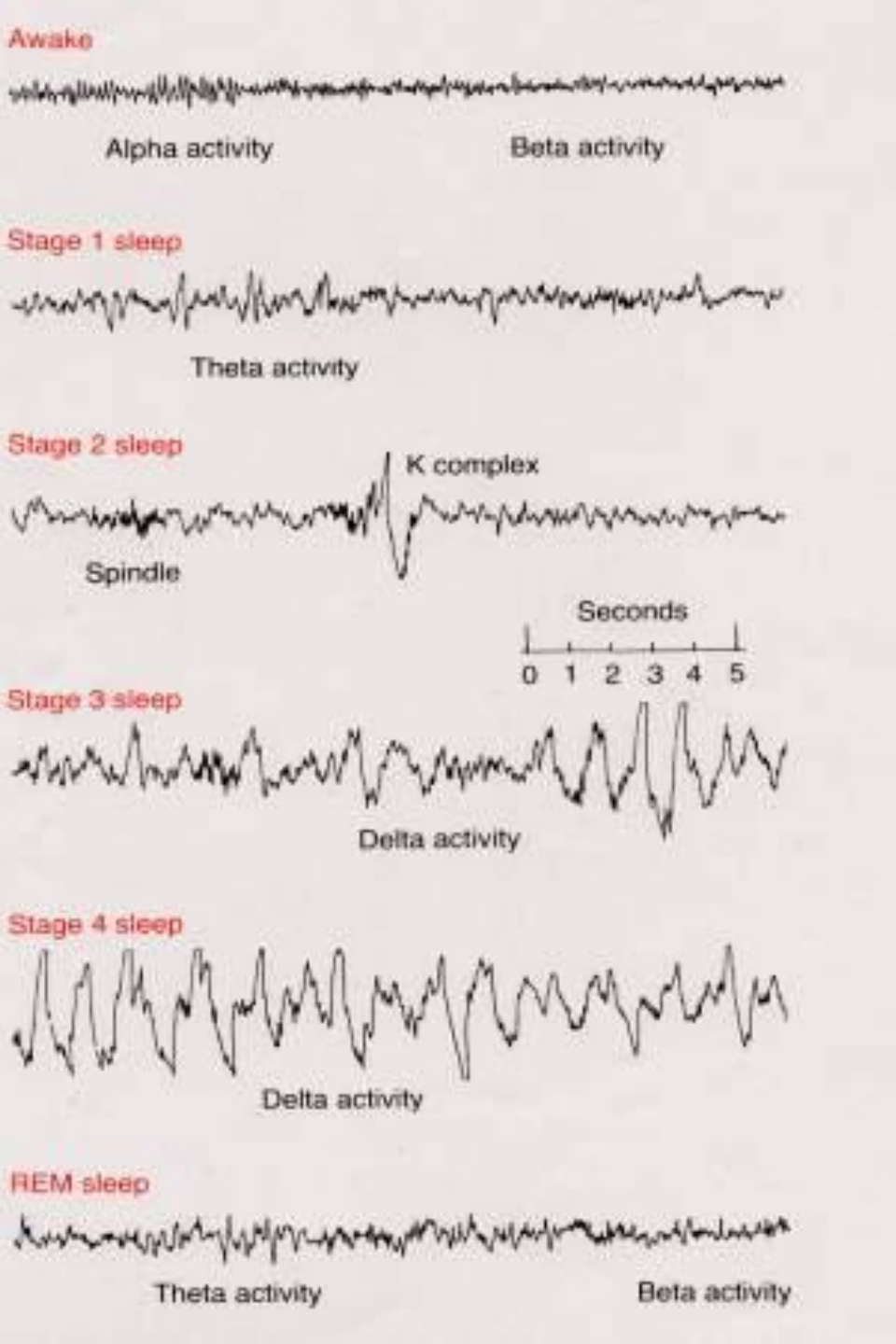
- **High wave frequency: 12 - 35 Hz**
  - The “normal” dominant rhythm \
  - mostly on temporal and frontal lobe
- **Associated tasks & behaviors:**
  - listening and thinking during analytical problem solving, judgment, decision making, processing information,

EEG Waveforms

- Alpha
  - 8-13 Hz
  - Parietal and occipital prominent
  - Relaxed wakeful
- Beta
  - 13-30 Hz
  - Frontal prominent
  - Intense mental activity
- Delta
  - 0.5-4 Hz
  - Drowsiness/early SWS
- Theta
  - 4-7 Hz
  - Drowsiness/early SWS

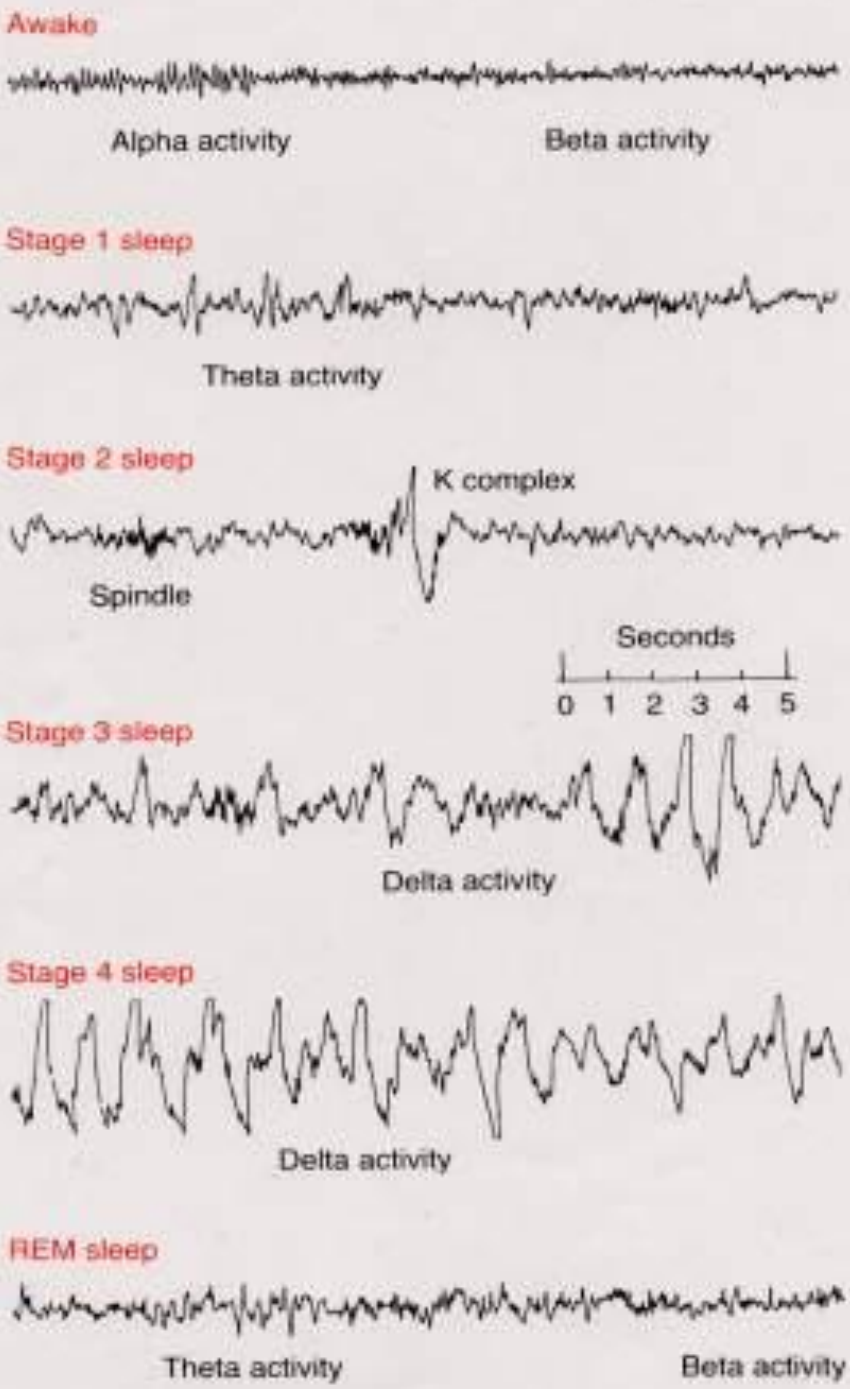
Types and Stages of Sleep: NREM

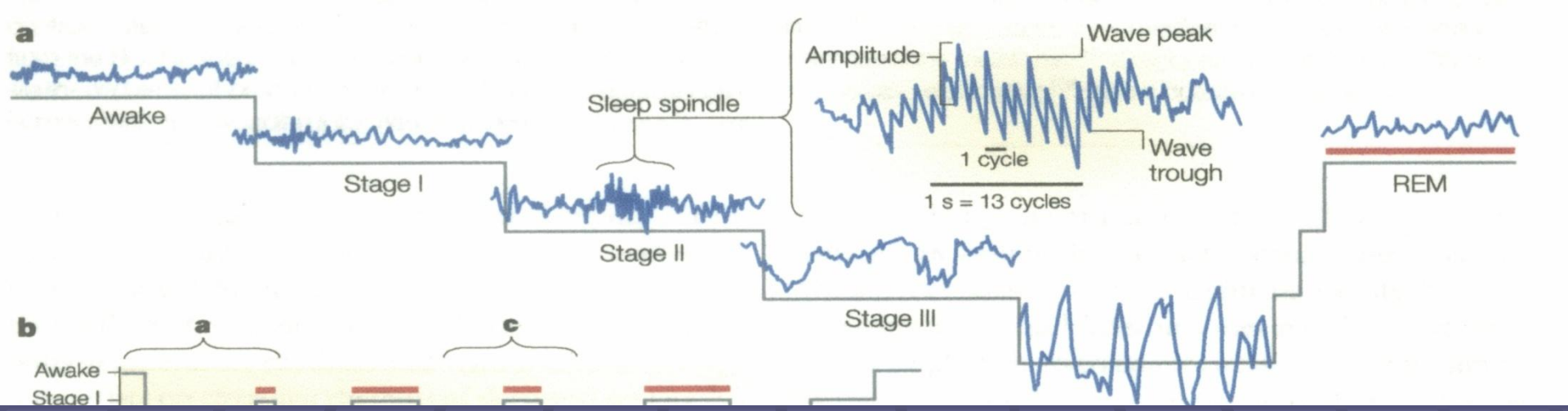
- Stage 1 – eyes are closed and relaxation begins; the EEG shows alpha waves; one can be easily aroused
- Stage 2 – EEG pattern is irregular with sleep spindles (high-voltage wave bursts); arousal is more difficult

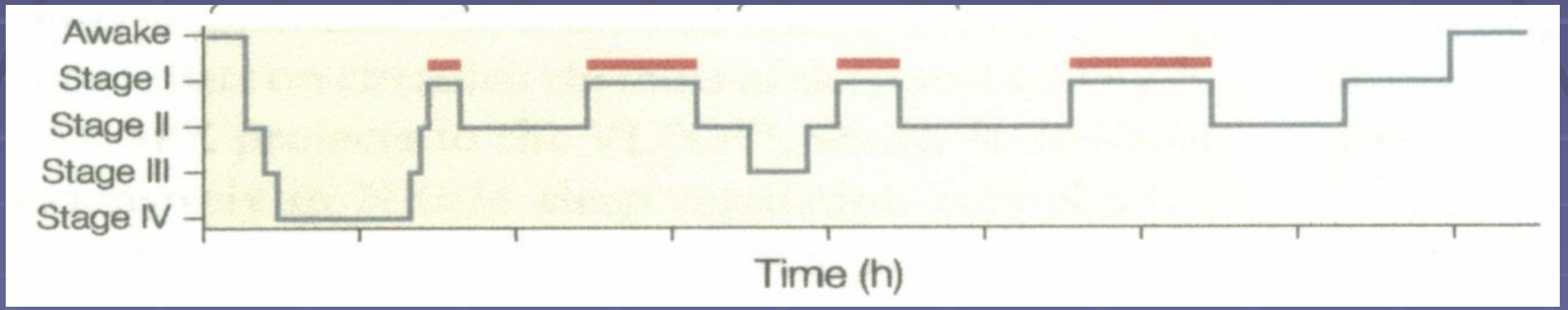


–Stage 3 – sleep deepens;; theta and delta waves appear; vital signs decline; dreaming is common

–Stage 4 – EEG pattern is dominated by delta waves; skeletal muscles are relaxed; arousal is difficult



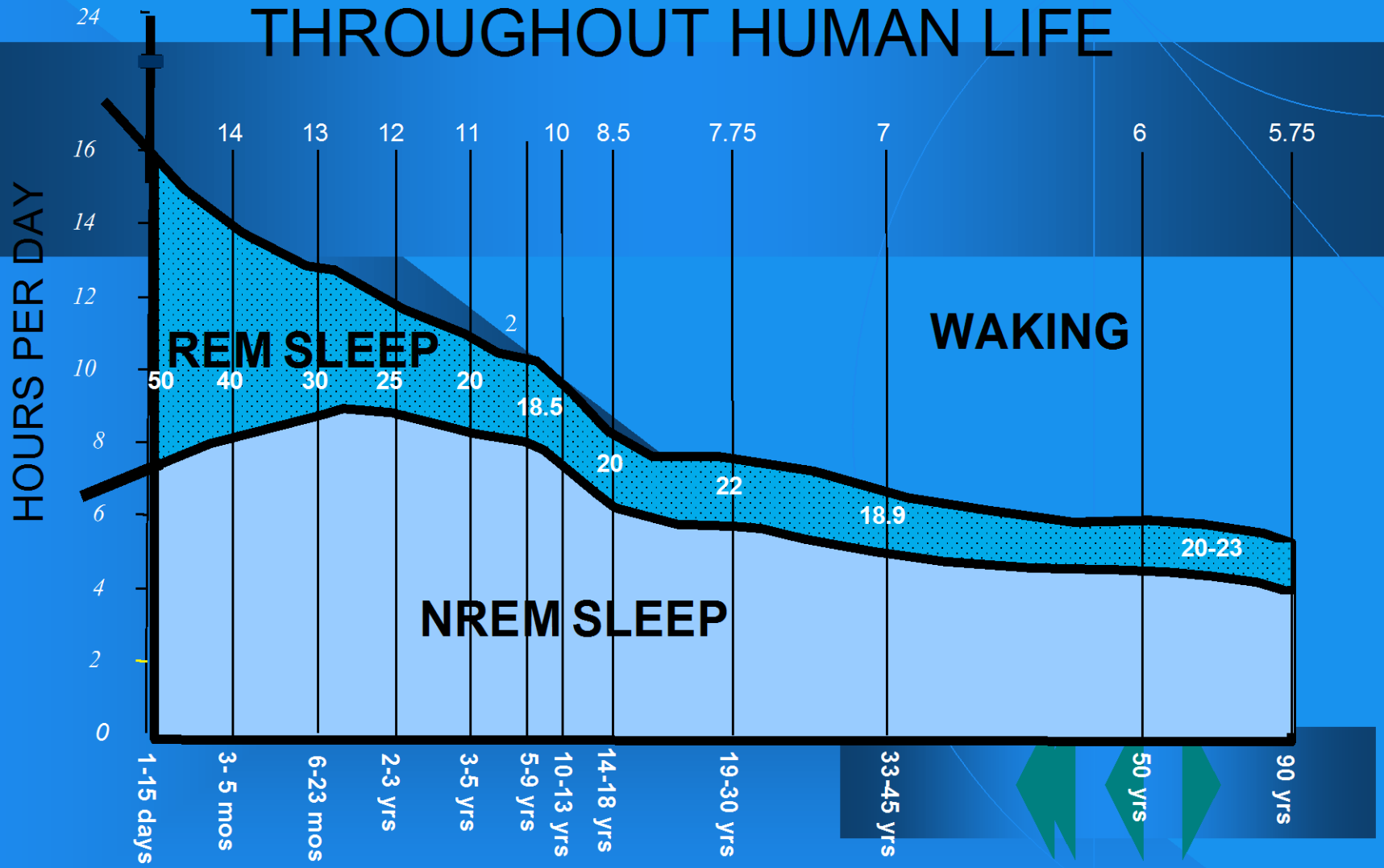

a
Awake
Stage I
Sleep spindle
Stage II
Stage III
Amplitude
Wave peak
1 cycle
Wave trough
1 s = 13 cycles
REM
b
a
c
Awake
Stage I


Awake
Stage I
Stage II
Stage III
Stage IV
Time (h)

REM Sleep

- Presence of beta activity (desynchronized EEG pattern)
- Physiological arousal threshold increases
  - Heart-rate quickens
  - Breathing more irregular and rapid
  - Brainwave activity resembles wakefulness
  - Genital arousal
- Loss of muscle tone (paralysis)
- Vivid, emotional dreams
- May be involved in memory consolidation

SLEEP AND WAKE THROUGHOUT HUMAN LIFE



AFTER ROFFWARG , MUZIO & DEMEMT, *Science* (1966).

REM Dreaming

- “vivid and exciting”
- ~3 per night
- Longer, more detailed
- Fantasy world
- nightmares

NREM Dreaming

- “just thinking”
- Shorter, less active
- Logical, realistic

Dream theories

- Activation synthesis theory
  - Sensory experiences are fabricated by the cortex as a means of interpreting signals from the PGO activity.
- Continual activation theory
  - Encoding of short term into long-term memories.
  - NREM sleep processes the conscious-related memory (declarative memory),
  - REM sleep processes the unconscious related memory (procedural memory).

Sleep Disorders

- insomnia
- sleep walking, talking, and eating
- nightmares and night terrors
- narcolepsy
- sleep apnea

Sleep Disorders

- Insomnia: persistent problems in falling asleep, staying asleep, or awakening too early
- Sleep Apnea: repeated interruption of breathing during sleep
- Narcolepsy: sudden and irresistible onsets of sleep during normal waking hours

Sleep disorders

- **Nightmares**: anxiety-arousing dreams occurring near the end of sleep, during REM sleep
- **Night Terrors**: abrupt awakenings from NREM sleep accompanied by intense physiological arousal and feelings of panic

Sleep Disorders

- Somnambulism…sleepwalking
  - 40% of children will have an episode, peaking at between 11-12 years of age;
  - Can be induced if arouse children during NREM;
  - associated with complete amnesia,
  - Occurs within 2 hours of falling asleep.. EEG..reveals both waking and sleep signals. Considered benign.

Coma & Brain death

- Definition:
  - Greek in origin – “deep sleep or trance”
  - It refers to an unconscious state characterised by a lack of both arousal and responsiveness