

Electroencephalography

Sleep and Arousal Mechanisms

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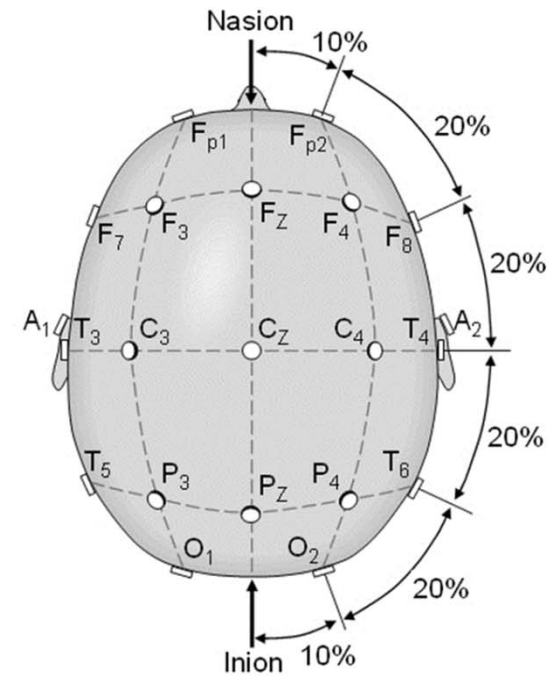
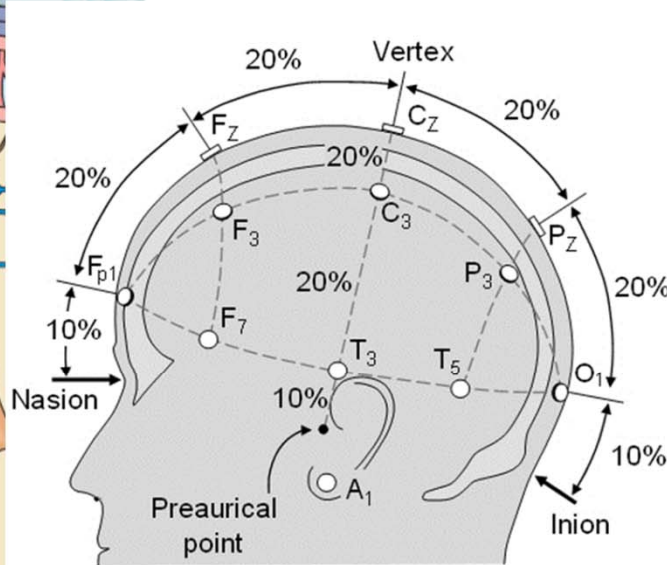
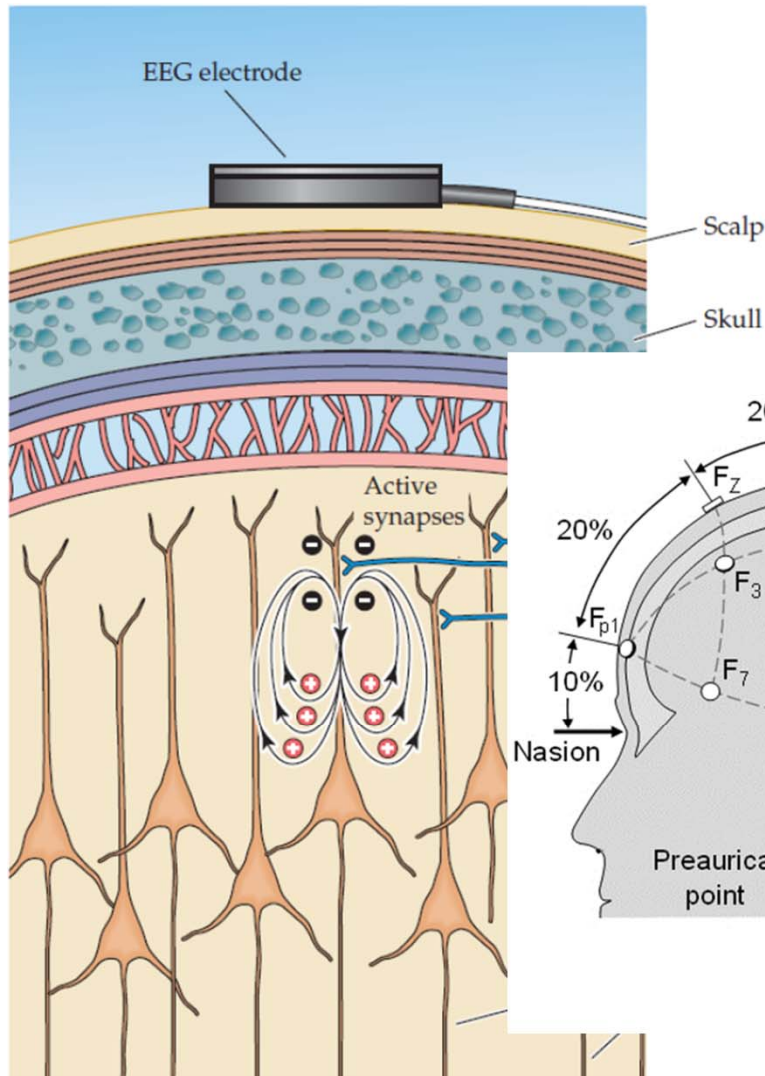


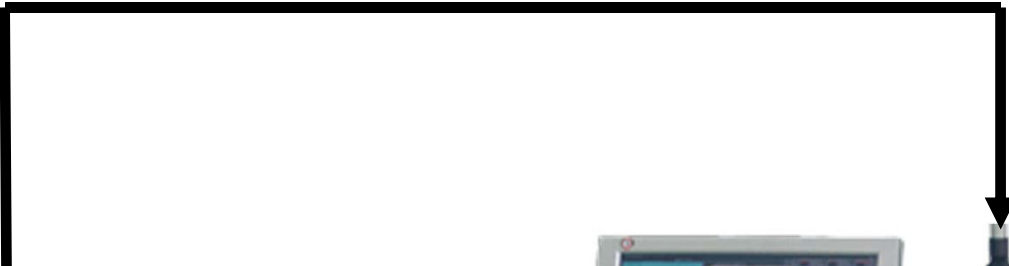
This presentation includes only the most important terms and facts. Its content by itself is not a sufficient source of information required to pass the Neuroscience exam.

Pictures and tables from:

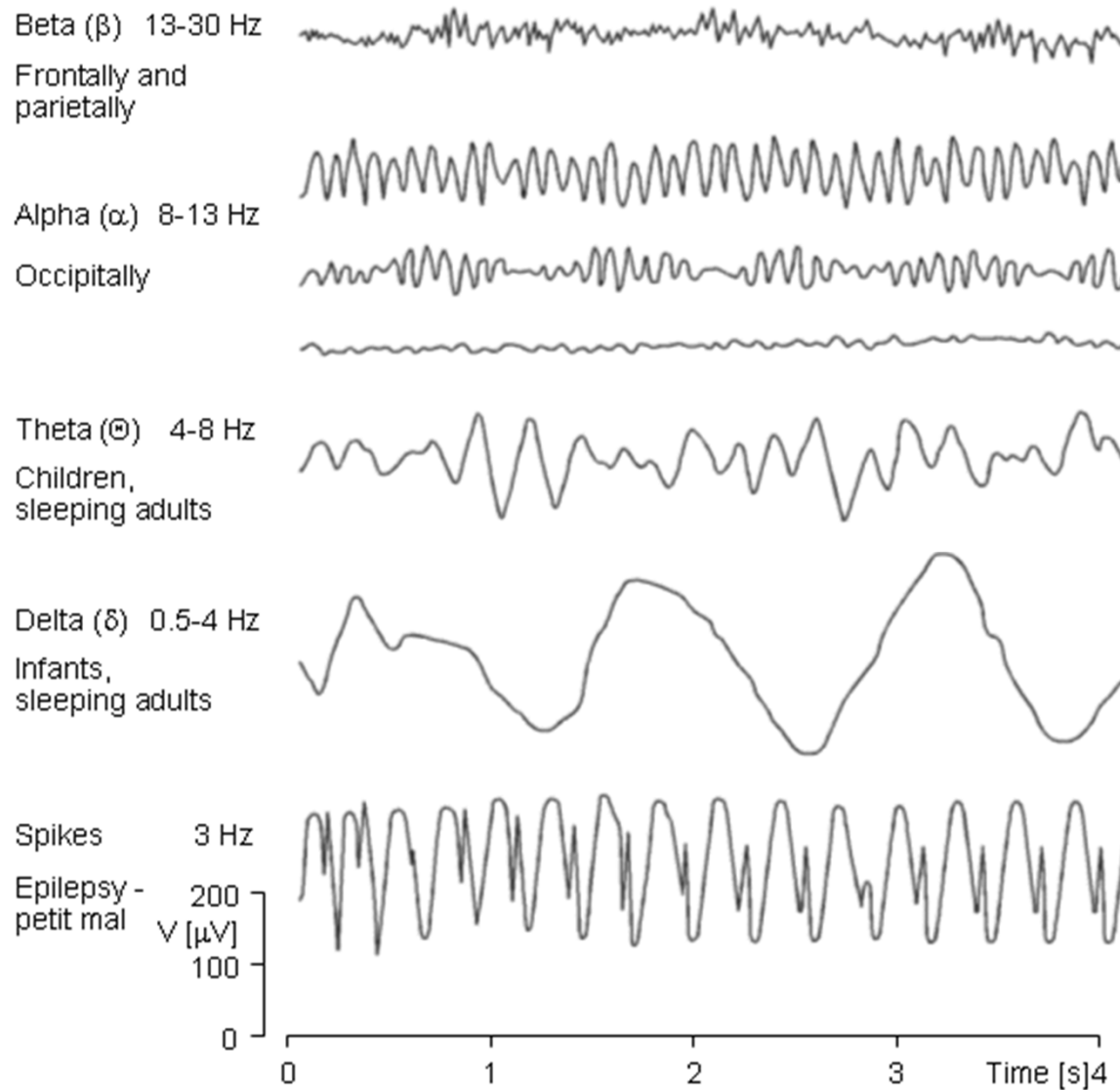
- Principles of Neural Science (5th ed.), Kandel et al. (2013)
- Neuroscience (4th ed.), Purves et al. (2008)
- Joseph LeDoux. Rethinking the emotional Brain, Neuron (2012)
- Přehled lékařské fyziologie (20. vyd.), Ganong (2005)
- Atlas fyziologie člověka (6. vyd.), Silbernagl a Despopoulos (2004)
- Joseph LeDoux. Our emotional brain. <https://www.youtube.com/watch?v=tjhCPhhzBqQ>

Electroencephalography

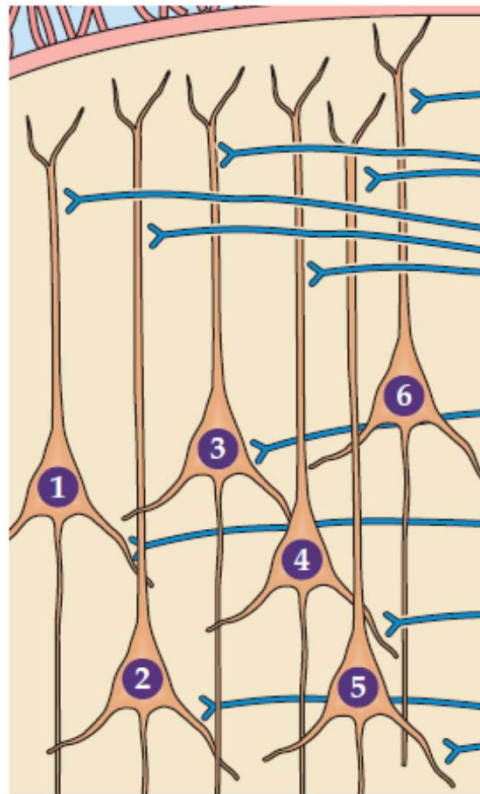




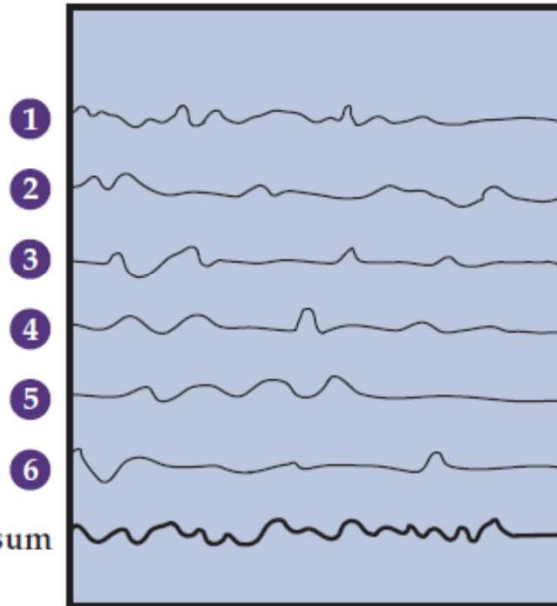
Electroencephalography



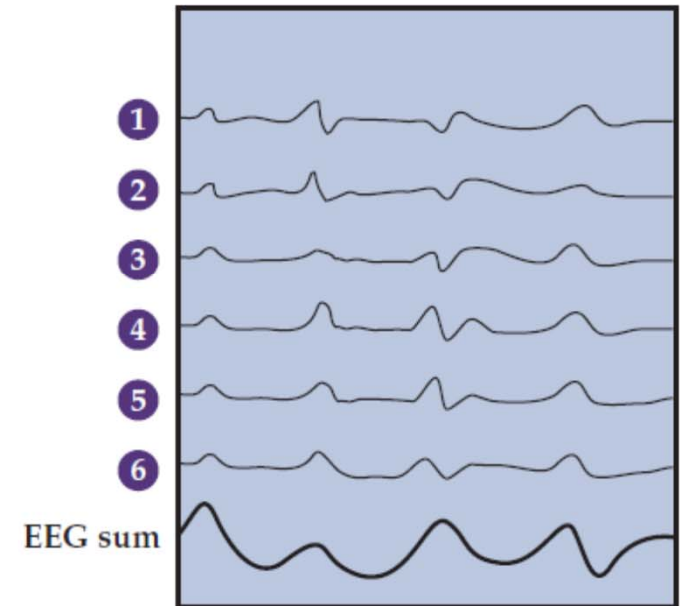
Electroencephalography



Irregular



Synchronized



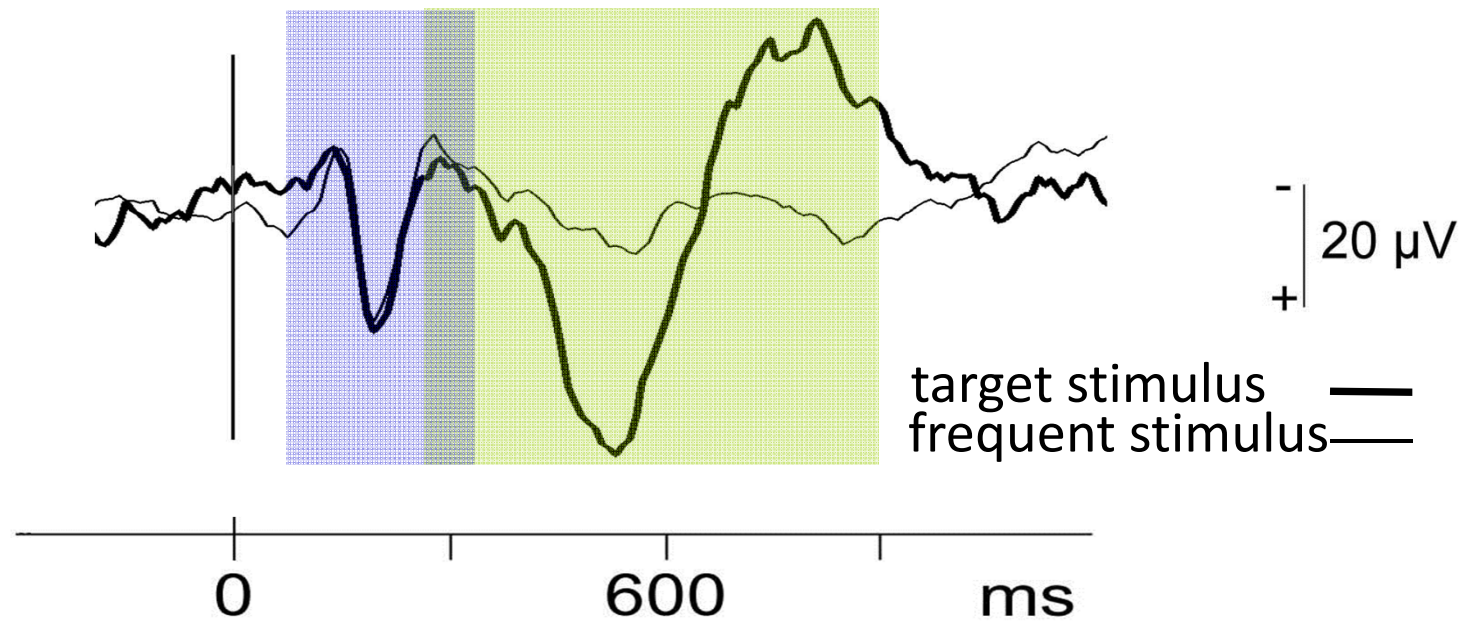
Evoked potentials

- Sensory evoked potential is an electrical manifestation of brain activity evoked by an external sensory stimulus.
- visual, auditory, somatosensory
- **event-related potentials**
 - generated in several cortical and subcortical regions in the post-stimulus period of 50 – 500 ms
 - associated with perceptive, cognitive and movement triggering processes (**P300**)

Event-related potentials

early sensory

late “cognitive”



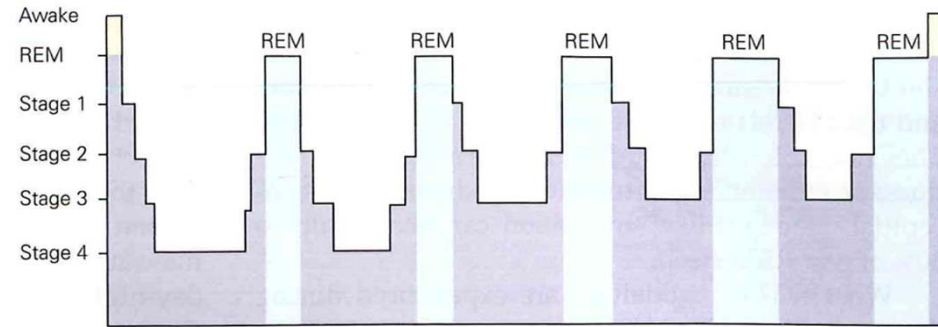
Sleep

Sleep

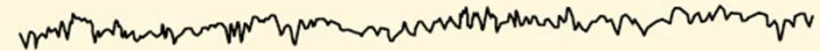
- is **actively induced and highly organized** brain state with different phases
- consumes a third of our lives
- **sleep is essential** to life
- What is the function of sleep?

Non-REM sleep

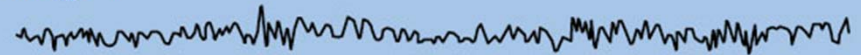
- **slow-wave sleep**
- **Stage 1-4**
- EEG synchronization (deceleration of frequency and increase of amplitude)



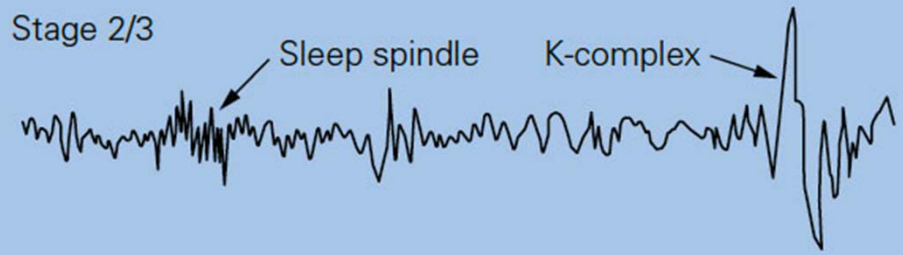
Awake



Stage 1

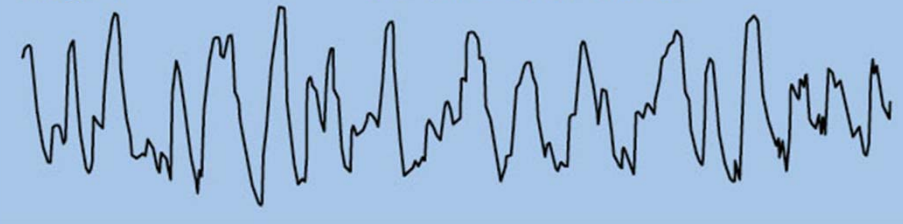


Stage 2/3



Stage 4

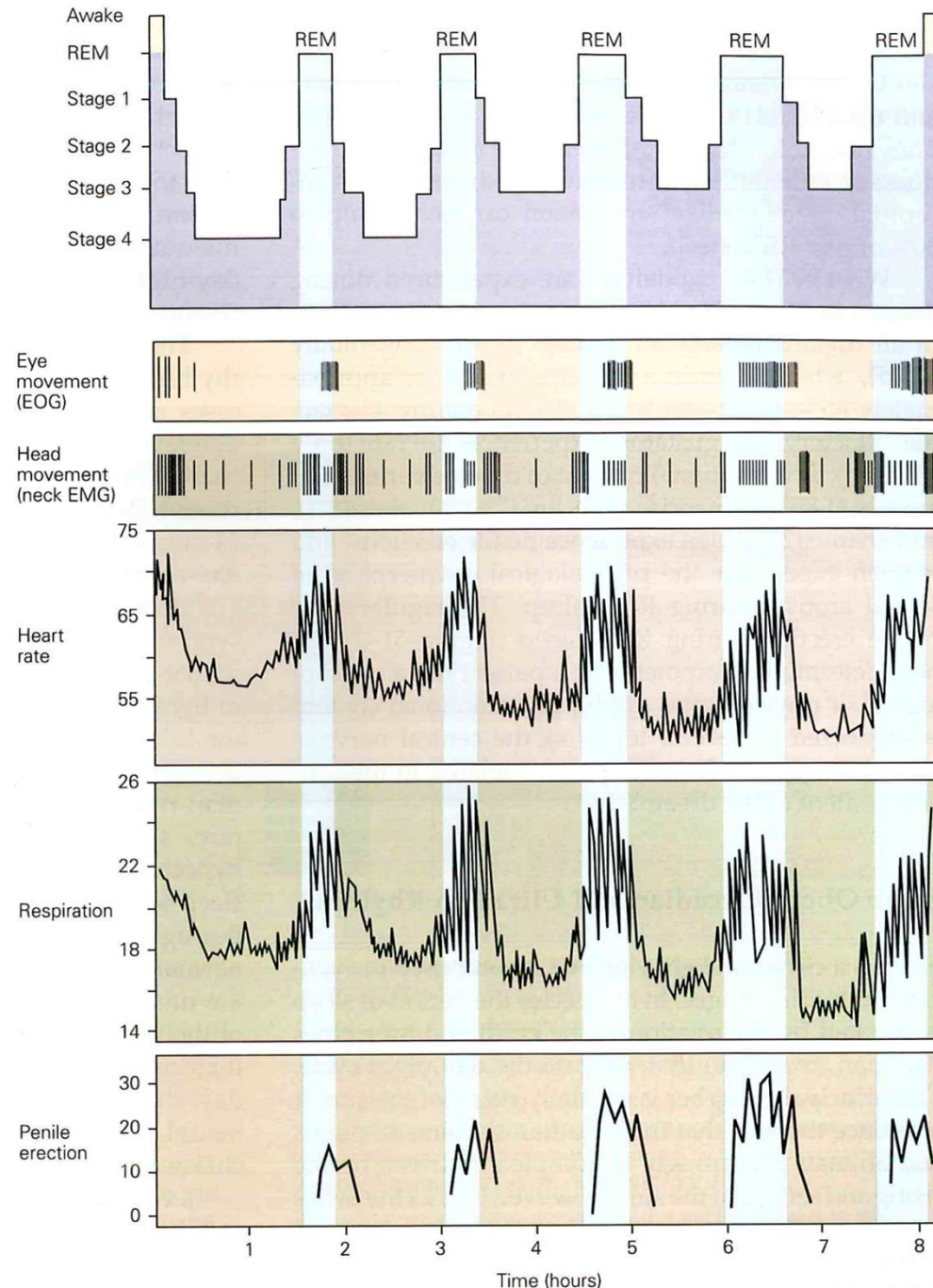
0.5–2 Hz delta waves



1 s

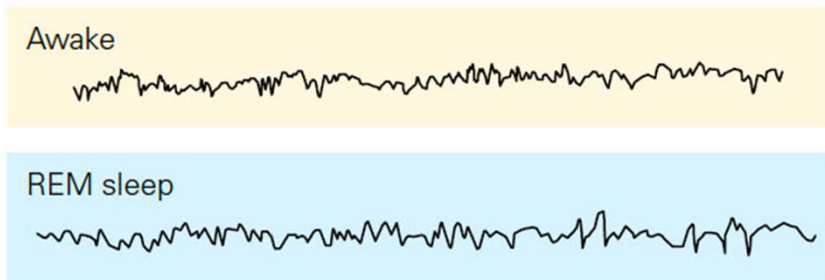
Non-REM sleep

- **slow-wave sleep**
- ↓ sympathetic outflow, ↓ HR, ↓ BP, ↓ ventilation, ↓ temperature
- skeletal muscle relaxed (muscle tone and reflexes intact)
- ↑ threshold for arousal by sensory stimuli

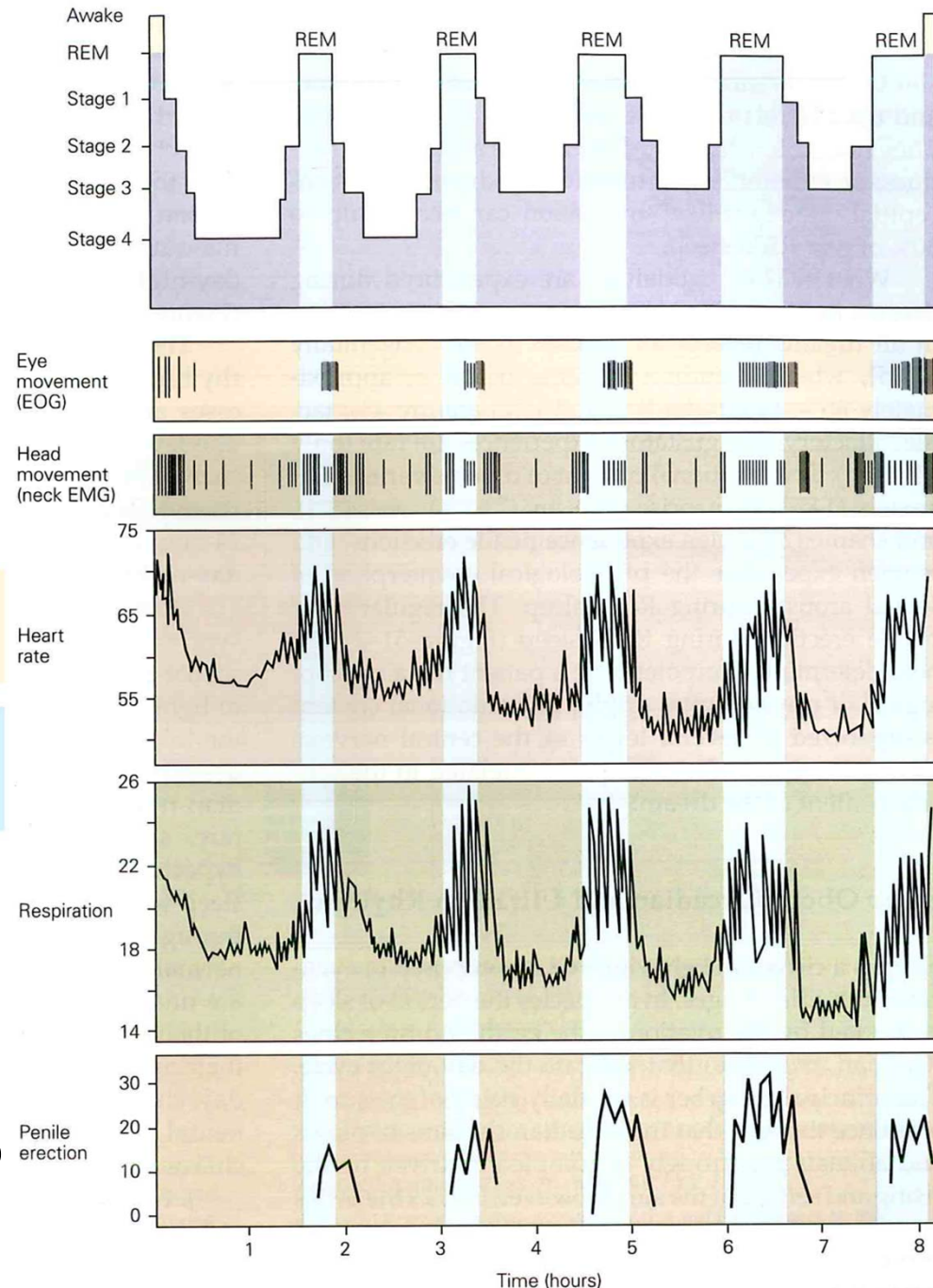


REM sleep

- rapid eye movements
- EEG patterns of REM sleep and wakefulness similar (paradoxical sleep)

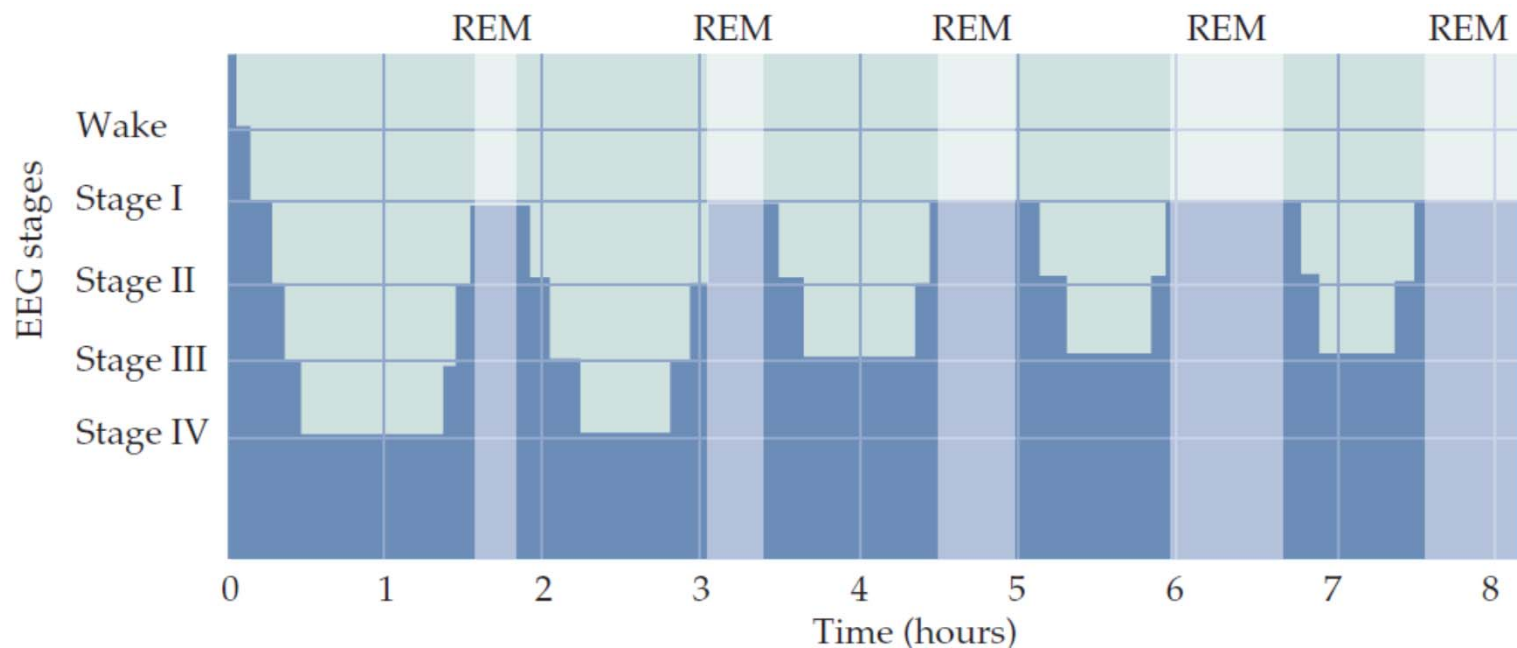


- atonia - ↓ skeletal muscle tone (except eye muscle and diaphragm)
- vivid dreams for 80-95% of time



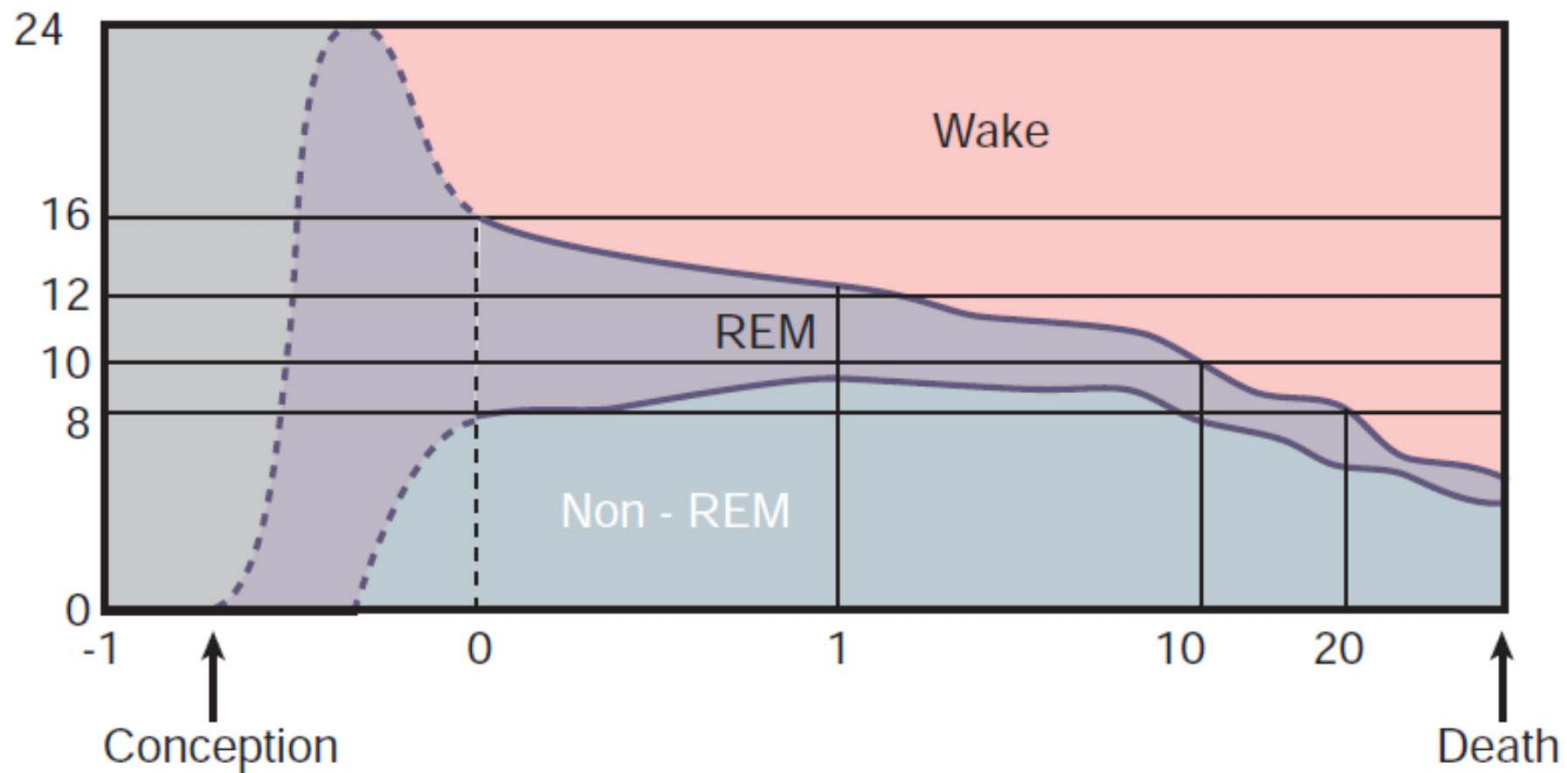
Sleep

- non-REM and REM stages = 90-110 minutes
- 4-6 times per night
- non-REM 3 and 4 stages duration decrease, the depth of non-REM sleep decreases, and REM stages duration increase



Sleep

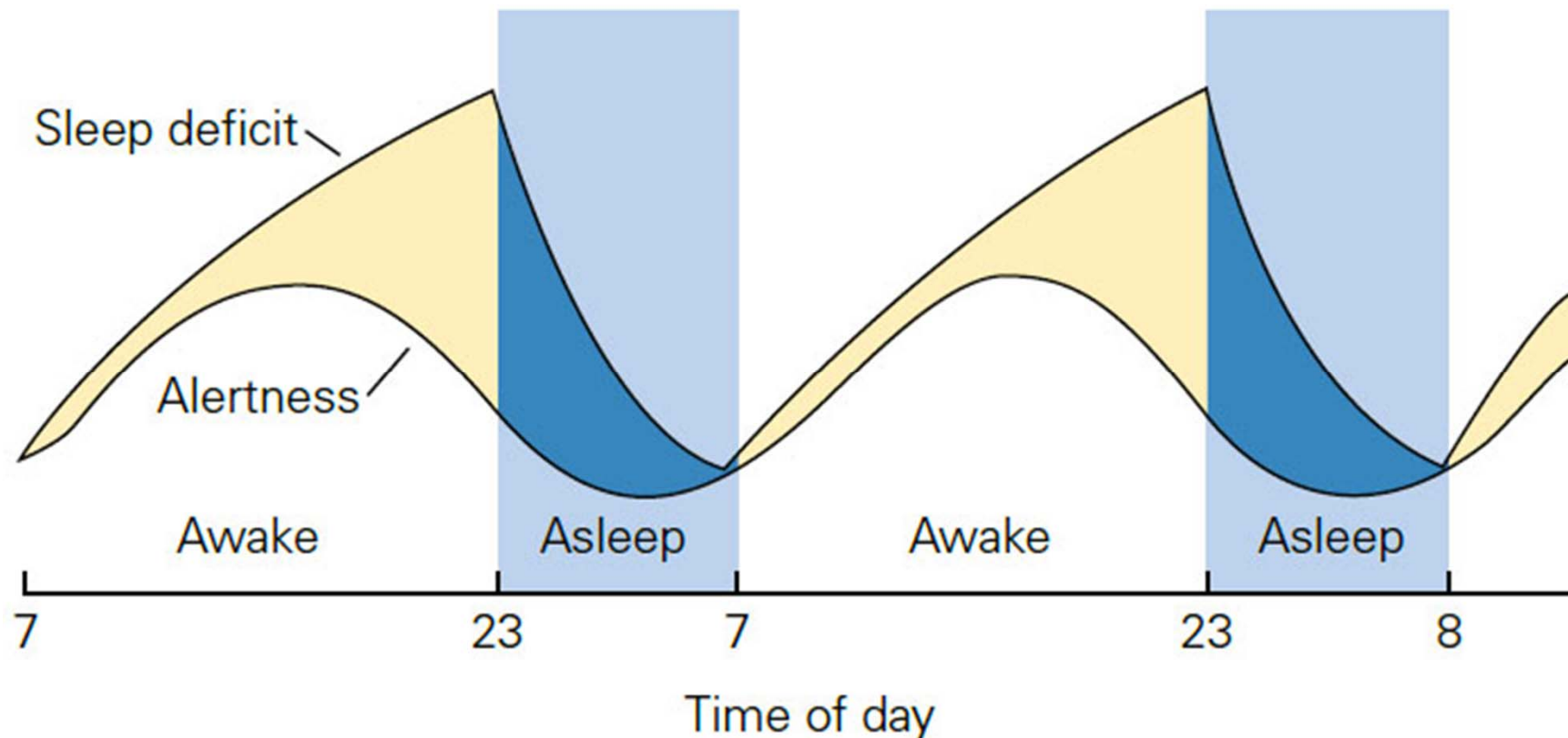
Sleep changes over the life span



Sleepiness

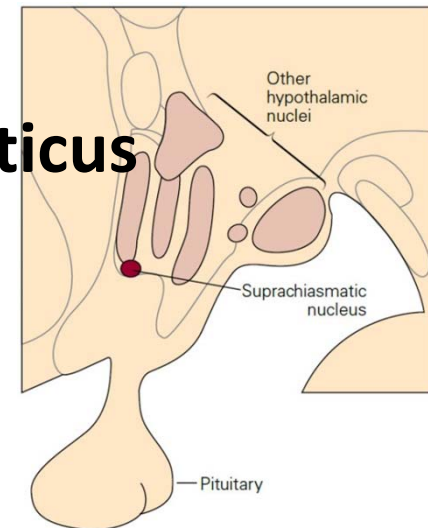
= the drive to sleep

- two strongest factors:
 - time since the last full period of sleep (sleep deficit)
 - circadian rhythmicity in arousal



Sleep

- is a circadian behaviour composed of cyclical (ultradian) stages
- **endogenous circadian (= about 24 hours) rhythm**
 - present **even in complete absence of sun light** and other clues as to the time of day
 - typically **slightly longer** than the normal day-night cycle (*e.g.* 25 hours)
 - guided by firing of **nucl. suprachiasmaticus**
 - **synchronized with day-night cycle** (retina – nucl. suprachiasmaticus; melatonin)



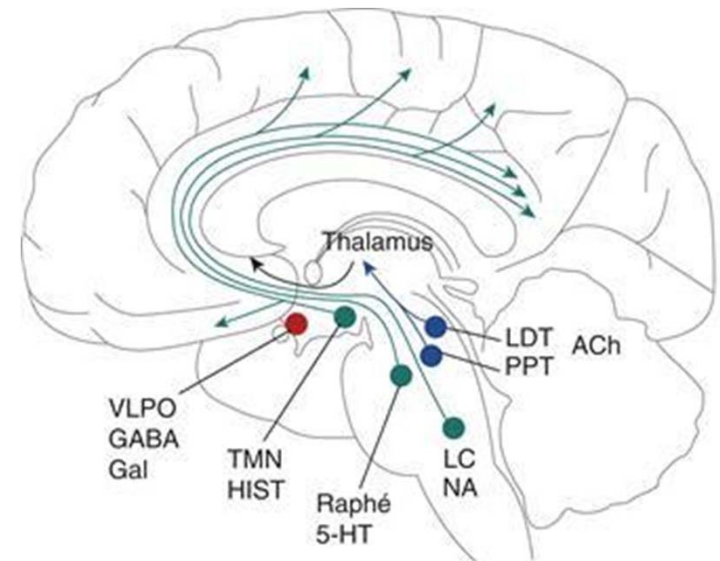
Sleep

Brain Stem and Sleep-wake Cycle

- SCN generates the rhythm but it does not generate sleep and arousal.

critical structures located in the rostral pons and caudal midbrain – **ascendent arousal system**

(widespread projections to other parts of the CNS)



Sleep disorders

- >50% population significant difficulties with sleep at least occasionally

Insomnia

- causes:
 - poor sleep habits (coffee, alcohol, food, exercise before sleep)
 - stress, shift work, jet lag
 - often associated with depression

Sleep apnea

- pattern of interrupted breathing during sleep causing waking up many times per night ($\downarrow pO_2 + \uparrow pCO_2 \rightarrow$ arousal response)

Narcolepsy

- irresistible REM sleep attacks during the day without going through non-REM sleep

Sleep disorders

Others

Parasomnias (sleep walking, sleep talking, night terrors, etc.)

Circadian Rhythm Sleep Disorders

Restless Leg Syndrome

Sleep disorders

Sleep research, sleeping laboratory

- polygraphic monitoring (namely EEG, EOG, EMG, ECG, breathing, saturation, *etc.*)