Basics and Terminology
Development of Sleep and Sleep Function:

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My Introduction

- **Medical School**: Karnataka Institute of Medical Sciences
- **Pediatrics:** All India Institute of Medical Science (Delhi)
- **Pediatrics** in US: Weil Cornel Medical School(new York)
- **Pediatric Pulm**onary: Boston Children's Hospital
- **Sleep Fellowship**: Harvard Medical School (Boston)

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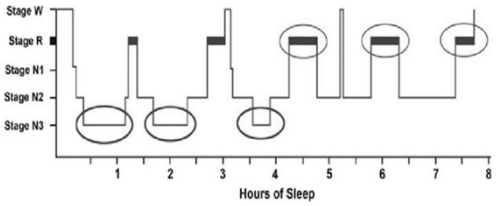
Conflict of Interest

- None

Sleep structure

- **Sleep Architecture**
  - **Definition**: The structure and pattern of sleep cycles throughout a night.
  - **Significance**: Understanding the architecture helps in evaluating the quality of sleep by identifying proportions of different sleep stages, such as REM and non-REM sleep
- **Sleep Latency**
  - **Definition**: The time it takes to transition from wakefulness to sleep.
  - **Significance**: Longer sleep latency can indicate insomnia or other sleep disorders.



- **REM Sleep (Rapid Eye Movement)**
  - **Definition**: A sleep stage characterized by rapid movement of the eyes, vivid dreams, and brain activity similar to wakefulness.
  - **Significance**: Important for emotional regulation and memory consolidation. REM sleep disorders, such as **REM Sleep Behavior Disorder**, can involve acting out dreams.
- **Non-REM Sleep**
  - **Definition**: The stages of sleep excluding REM, which include light sleep (stages 1 and 2) and deep sleep (stages 3 and 4).
  - **Significance**: Non-REM sleep is crucial for physical restoration, immune function, and growth.

- Sleep Efficiency
  - **Definition**: The percentage of time spent asleep compared to time spent in bed.
  - **Significance**: Lower sleep efficiency can suggest insomnia or sleep fragmentation.

- Polysomnography (PSG)
  - **Definition**: A comprehensive sleep study that records brain waves, oxygen levels, heart rate, and breathing during sleep.
  - **Significance**: The gold standard diagnostic tool for various sleep disorders like sleep apnea, insomnia, and restless legs syndrome.

- Arousal Index
  - **Definition**: The number of times a person wakes up or transitions to lighter stages of sleep per hour.
  - **Significance**: High arousal index indicates fragmented sleep, often due to sleep apnea or other disorders

- Hypnogram
  - **Definition**: A graphical representation of sleep stages over time during a sleep study.
  - **Significance**: Helps in visualizing sleep architecture and diagnosing sleep disturbances.

- Sleep Hygiene
  - **Definition**: Practices and habits that promote consistent, restful sleep, such as regular sleep schedules and a conducive sleep environment.
  - **Significance**: Important in preventing and managing insomnia and other sleep disorders.
- Melatonin
  - **Definition**: A hormone produced by the pineal gland that regulates sleep-wake cycles.
  - **Significance**: Often used as a supplement for sleep disorders like **jet lag** or **circadian rhythm sleep disorders**.

- Sleep Efficiency
  - **Definition**: The percentage of time spent asleep compared to time spent in bed.
  - **Significance**: Lower sleep efficiency can suggest insomnia or sleep fragmentation.
- Circadian Rhythm
  - **Definition**: The natural 24-hour cycle that regulates the sleep-wake cycle.
  - **Significance**: A healthy circadian rhythm is crucial for optimal sleep and overall health. Disruption can lead to disorders like **Delayed Sleep Phase Disorder (DSPD)** or **Non-24-Hour Sleep-Wake Disorder**

Sleep Apnea

- **Definition**: A sleep disorder characterized by pauses in breathing during sleep.
- **Types**:
  - **Obstructive Sleep Apnea (OSA)**: Caused by blockage of the airway.
  - **Central Sleep Apnea (CSA)**: Caused by the brain's failure to signal the muscles to breathe.
- **Significance**: Leads to poor sleep quality, fatigue, and cardiovascular issues. Diagnosed through **polysomnography**

Insomnia

- **Definition**: Difficulty falling asleep, staying asleep, or waking up too early.
- **Types**:
  - **Acute Insomnia**: Short-term and often due to stress or life changes.
  - **Chronic Insomnia**: Long-term, lasting over three months.
- **Significance**: A common sleep disorder that affects overall health, mood, and daytime function

Hypersomnia

- **Definition**: Excessive sleepiness during the day despite getting a normal amount of sleep.
- **Types**:
  - **Narcolepsy**: A neurological disorder characterized by excessive daytime sleepiness and sudden loss of muscle tone (cataplexy).
  - **Idiopathic Hypersomnia**: Persistent sleepiness without a clear cause.
- **Significance**: Leads to impaired daytime function and requires medical management.

Sleep Hygiene

- **Definition**: Practices and habits that promote consistent, restful sleep, such as regular sleep schedules and a conducive sleep environment.
- **Significance**: Important in preventing and managing insomnia and other sleep disorders.

Sleep Function and maturation

- Theories of Sleep
- Normal Sleep Across the Night
- Upper Airway and Breathing Development

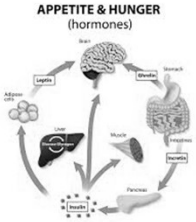
Sleep

- Reduced state of consciousness
  - unresponsive to environment
- Reversible
- Homeostatic
- Species-specific position

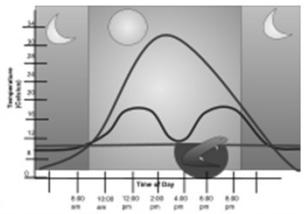


Why sleep is so important….to everyone!

- Restoration of body function:



- Metabolism, Immune function:
  - Detoxification/cleansing
- Mood/Memory/Learning:
  - REM sleep facilitates memory and learning
  - Facilitate memory retention (procedural>declarative)



- Thermoregulatory function:
  - Sleep may also maintain the thermo-regulatory homeostasis
- Others
  - Thought organization, work efficiently, think abstractly
  - React quickly

Brain cleansing: Lymphatic and Glymphatic System

- Lymphatic system: responsible for recycling of undigested protein, removal of excess fluid and metabolic waste
- 'Glymphatic system'- glial dependent transport and functional similarity to Lymphatic system
  - Metabolites cleared: lactate, amyloid- β, tau proteins.
  - Reoxygenation of brain and ApoE (used for lipid metabolism)

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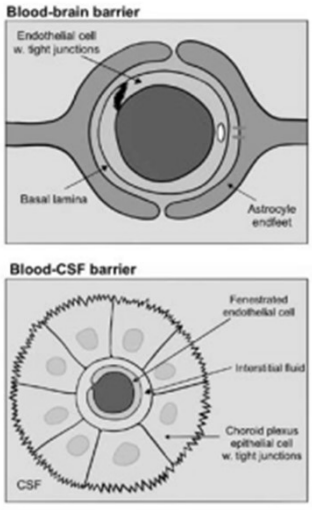
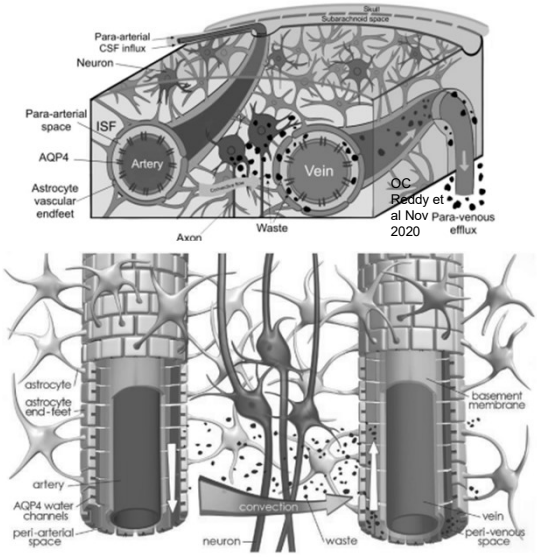
Glymphatic system structure



OC Reddy et al Nov 2020



OC Reddy et al Nov 2020

Benveniste et al Apr 2019

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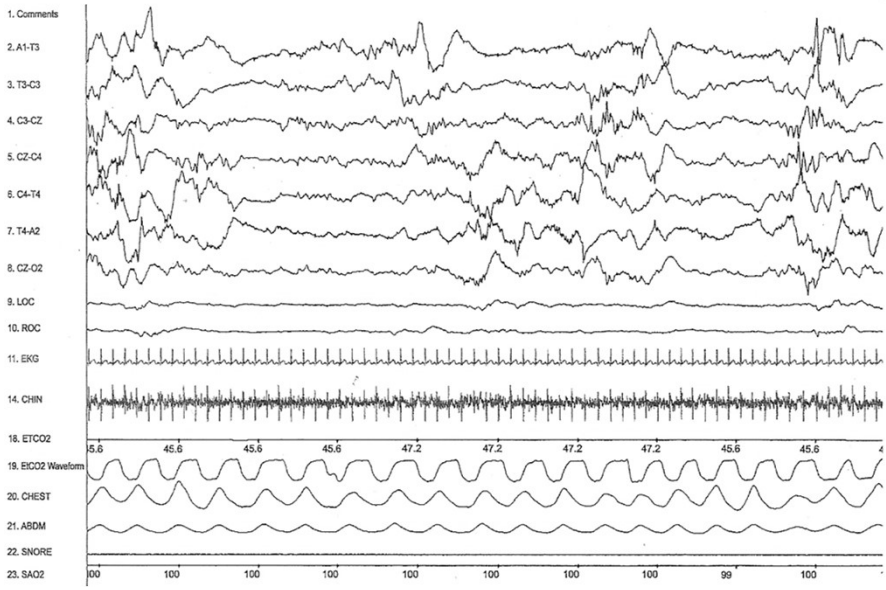
Fetal sleep

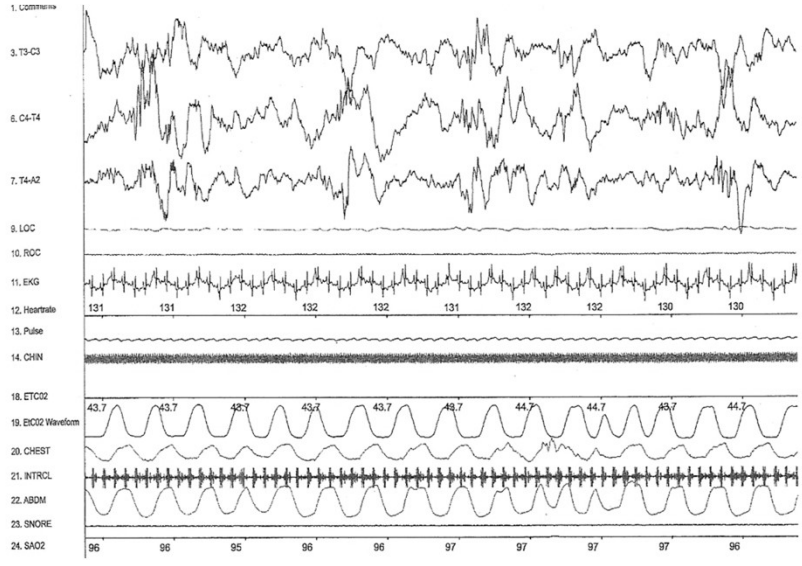
- 7 to 8 weeks of gestation: Fetal brain begins to develop the structures necessary for sleep, including the brainstem, which controls vital functions like heart rate and respiration. The neural groundwork is being laid. No sleep developed yet.
- 20 weeks gestation: First Evidence of Sleep-Like States
- 28 – 30 weeks gestation: Active (REM) and quite sleep (NREM like)

Development of Sleep



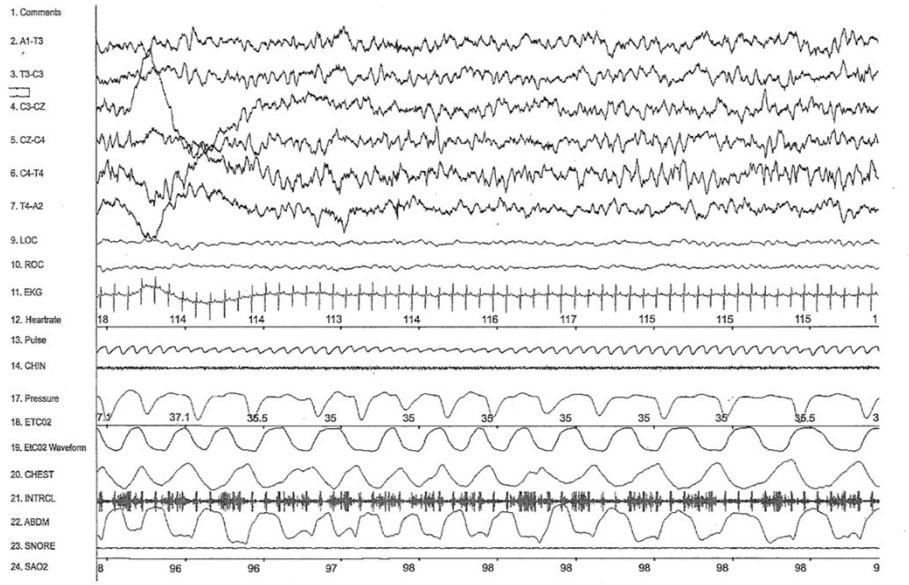
Trace Alternant EEG pattern

Development of Sleep



Quiet Sleep: 44 weeks

Development of Sleep



Active Sleep (REM)

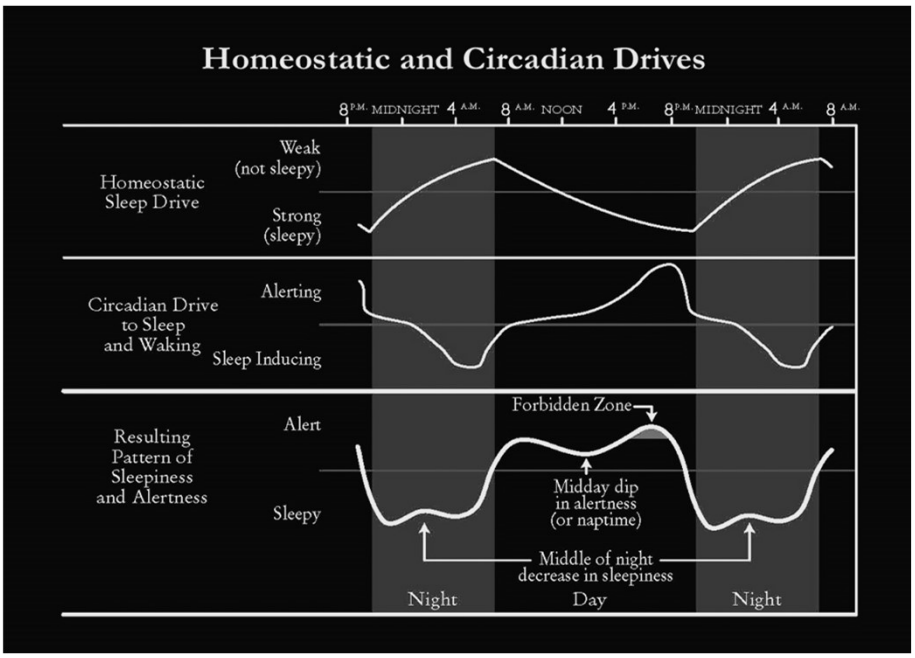
Sleep stage cycling in infants

- Stage N1: Transitional sleep
- Stage N2: Light sleep
- Stage N3: Deep sleep
- REM: Dream sleep
- Cycling: 70-90 min each

Circadian Rhythm Development

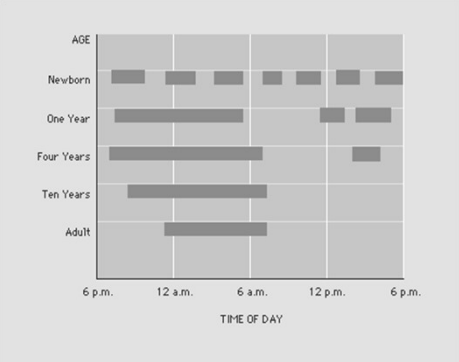
- Term:
  - Sleep-wake periods occur randomly
- 1 month:
  - Core body temperature has a circadian rhythm
- 3 months:
  - Hormones (e.g. melatonin & cortisol) begin to cycle in a circadian rhythm
- 3 - 6 months:
  - Maturation of circadian system leads to sleep consolidation “sleeping through the night”

Sleep and Circadian Rhythm



How Much Sleep do Children Need ?

- Up to 2 years ~ 60% time sleep
- 2-5 years ~ 50% time sleep
- 5 yrs - adolescence ~ 35-40% time sleep



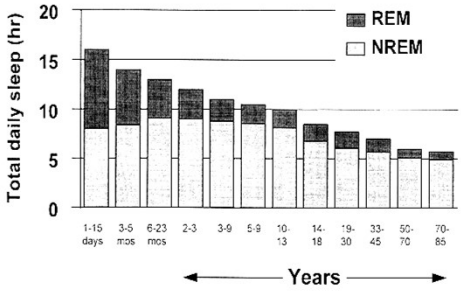


Figure 2–4. The changes in total daily sleep, REM sleep, and NREM sleep with age. Notice the large amount of REM sleep in the neonate and infant. (Based on data from Roffwarg HP, Munzio JN, Dement WC: Ontogenetic Development of the Human Sleep-Dream Cycle. Science 152:604, 1966.)

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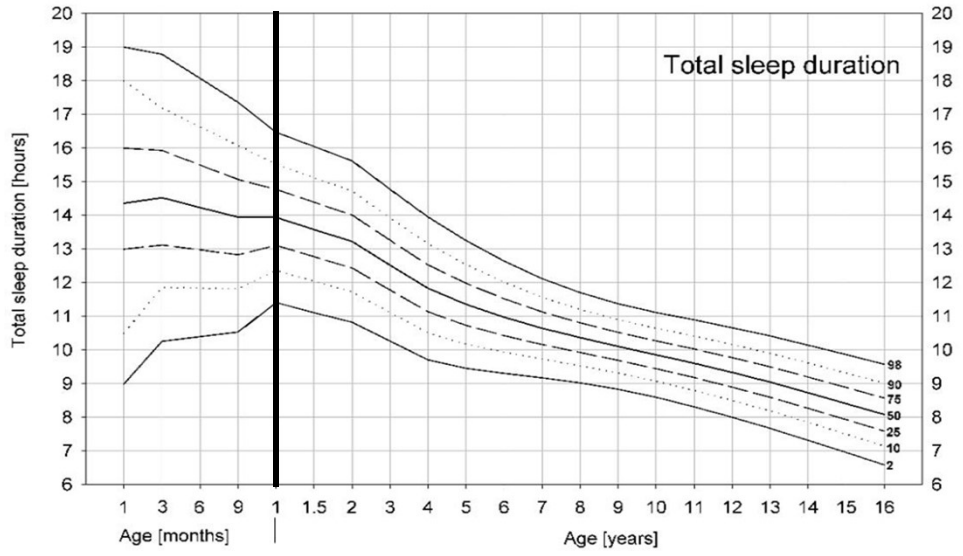
Iglowstein et al; Pediatrics 2003



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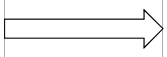
Sleep Stability Depends on…..

- Circadian factors
- Homeostatic factors
- Breathing stability
- Gas exchange:
  - Oxygenation
  - CO2
- Motor activity
- Environment



- Sleep fragmentation/stress
- Impaired sleep cycling
- Reduced REM sleep
- Autonomic arousals
- Increased sympathetic drive

Sleep and Aging

- Longer sleep duration
- Increased N3
- Increased N3 sleep (SWS)

- Longer term changes and effect on health and aging

- Shorter sleep duration
- Dramatic decrease in N3 (SWS)
- Reduced REM sleep
- Dementia/Alzheimer's