

Chapter 9: Sleep and Biological Rhythms

Introduction - Physiology of Sleep

Why Do We Sleep?

The Role of Sleep in Learning and Memory

Sleep Across the Lifespan

Sensory Processing and Sleep

Mechanisms of Sleep

Biological Clocks

Dreaming

Sleep Disorders

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Endogenous Cycles.

- circannual rhythms
- preparation for annual events (migration, mating season, nesting...)
- inputs from sensory stimuli (light cycle, temperature...)
- additional endogenous rhythmicity

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Endogenous Cycles.

- circadian rhythms
- sleep/wakefulness, body temperature, some hormones
- varies by species, varies by individual, varies if artificially exposed to constant light or dark
- reset by exposure to light

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Free-Running Daily Rhythm.

- some slightly longer, some slightly shorter than 24hrs
- in absence of reset, endogenous cycles (e.g. sleep, body temperature, hormones) may desynchronize

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Reset of Daily Rhythm.

- light is best cue, can be assisted by exercise, feeding times, etc.

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Free-Running Daily Rhythm.

- slightly longer than 24 hrs in humans
- approximately 25 hrs on average in absence of reset

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Stages of Sleep.

- electroencephalography (EEG)
- records mostly cortical pyramidal cells
- electromyography (EMG)
- muscle contraction
- electrooculography (EOG)
- eye movements

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Stages of Sleep.

- electroencephalography
- synchrony = high voltage, neurons fire together
- desynchrony = low voltage, neurons fire independently (more active processing)

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Stages of Sleep.

- beta waves:
 - desynchronous, small amplitude, VHF
- 13-30 Hz = arousal
- alpha waves:
 - partially synchronous, jagged, HF
- 8-12 Hz = relaxation
- theta waves:
 - partially synchronous, large amplitude, SF
 - 5-8 Hz = transition from wakefulness to sleep and to deeper sleep

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Stages of Sleep.

- delta waves:
 - synchronous, very large amplitude, SF
- 1-4 Hz = SWS
- sleep spindles:
 - short bursts of 12-14 Hz
 - associated with memory consolidation
- K complexes:
 - sudden sharp wave forms
 - promote deeper sleep

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Stages of Sleep.

- 4 stages of sleep
 - REM in humans
- stage 1:
 - theta activity
 - average about 10 min
 - random thoughts, no dreams
- stage 2:
 - theta activity, sleep spindles, K complexes
 - average about 15 min
 - sleeping soundly, but may report still awake

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Stages of Sleep.

- stage 3:
 - theta and 20-50% delta activity
 - average about 20 min
- little sensory input, deep sleep
- stage 4:
 - more than 50% delta activity
 - average about 45 min
 - difficult to arouse, and if aroused may be confused/disoriented

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Stages of Sleep.

- successive steps = slower heart rate/breathing, slower and higher amplitude EEG activity

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Stages of Sleep.

- REM or paradoxical sleep
- rapid eye movements
- postural muscles paralyzed, loss of tone
- higher rates of breathing, heart rate
- higher levels of desynchronous EEG
- most dreaming and most vivid dreaming
- generally easier to arouse and will be alert if aroused

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Nightly Progress of Sleep.

- first 60-90 min, cycle 1-2-3-4 in order
- at end of 60-90 min, rapidly cycle 4-3-2-REM
- sequence repeats every 60-90 min:
- early in night, 3 and 4 predominate
- later in night, 2 and REM increase

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Nightly Progress of Sleep.

- if sleep deprived, will sleep few additional hours, so only small portion of deficit is made up
- but % recovery of lost sleep is not equal across stages:
- 7% of stage 1 replaced; - 7% of stage 2 replaced
- 68% of stage 4 replaced; - 53% of REM

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