Sleep

Neil R. Kavey, MD
Columbia Presbyterian Medical Center

No longer think of sleep as an isolated block of time at the end of the day.

Sleep is not just the absence of wakefulness,

It is an active physiologic process.
The first demonstration of a circadian rhythm by Jean Jacques d’Ortous de Mairan in 1729.
Over a 24 hour period two discrete systems flow one into the other.
Evening

Activating systems decrease action
Sleep systems increase action

4:30 am

Sleep systems decrease action
Alerting systems increase action

Our biological clocks are demonstrated in jet lag
Neuroanatomical
Neurophysiological
Neurochemical
Studies
To localize sleep and wakefulness
Beginning in the 1930's
3 types of studies to localize sites

1. Transection
2. Stimulation
3. Lesion

1940’s Moruzzi and Magoun

1. Electrical stimulation of the brainstem reticular formation, but not the sensory pathways, produced cortical activation consistent with wakefulness
2. Lesions in the same area produced cortical deactivation and slow waves
3. Most effective lesions that produced cortical deactivation were in the midbrain and extending forward into the posterior hypothalamus

This became known as the:

ASCENDING RETICULAR ACTIVATING SYSTEM
The same types of studies showed that:

Stimulation of certain areas of the brainstem such as the medullary reticular formation (Nucleus of the solitary tract) produced cortical synchronization (sleep).

Lesions of these specific regions produced cortical activation (wakefulness).
Most recently the HYPOTHALAMUS has emerged as an area of great importance for both sleep and wakefulness.

This next slightly different schematic of the cat brain shows the sites of study by Jouvet and colleagues:

REM sleep promoters – cholinergic neurons of the roof of the pons – REM ON
   Laterodorsal tegmentum (LDT)
   Pedunculopontine Tegmentum (PPT)

REM sleep suppressors – monoaminergic neurons
   REM OFF
   Locus Ceruleus (noradrenergic)
   Raphe Nucleus (serotoninergic)
Neurochemical regulation of awake and sleep and REM and Non-REM

- Adrenergic
- Cholinergic
- Serotonergic
- Glutamatergic
- Dopaminergic

GABA (gamma-aminobutyric acid) – mainly inhibitory – hypothalamus, basal forebrain and thalamus

Adenosine – in wakefulness accumulates in basal forebrain

Histamine – wake promoting

Hypocretin/Orexin – hypothalamus – wake promoting
Sleep is not a blank homogeneous state but a complex, cyclical physiologic process.
There are 5 different stages of sleep

Non-REM Sleep
- stage 1
- stage 2
- stage 3
- stage 4

REM Sleep

- >50% of each epoch contains Alpha activity
- Slow rolling eye movements or eye blinks will be seen in the EOG channels
- Relatively high submental EMG muscle tone
• > 50% of the epoch contains Theta activity (3-7 cps.)
  There may be Alpha activity within <50% of the epoch.
  • Slow rolling eye movements in the EOG channels
  • Relatively high submental EMG tone

Stage 1

• Background EEG is Theta (3-7 cps.)
  • K-Complexes and Spindles occur episodically
  • Mirrored EEG in the EOG leads
  • High tonic submental EMG

Stage 2

• 20% to 50% of each epoch and must contain Delta activity
  • EOG channels will mirror Delta activity
  • Submental muscle tone may be slightly reduced
Stage 3
- 20% to 50% of each epoch and must contain Delta activity
- EOG channels will mirror Delta activity
- Submental muscle tone may be slightly reduced

Stage 4
- >50% of the epoch will have scorable Delta EEG activity
- The EOG leads will mirror all of the Delta EEG Activity
- Submental EMG activity will be slightly reduced from that of light sleep

Stage REM
- Rapid eye movements
- Mixed frequency EEG
- Low tonic submental EMG
REM Sleep

- Characteristic EEG
- Variable heart and respiratory rates
- Muscle paralysis
- REM's
■ Video

Sleep architecture

![Young Adult Sleep Histogram](image)
Consequences of Sleep Deprivation

give hints as to the function of sleep

Consequences of Sleep Deprivation

A. Cognitive changes
B. Emotional/Personality changes
C. Physical performance decrements
Sense of Humor in Sleep Deprivation

■ Gone
E. Physical Changes in Body
1. Thyroid function
2. Glucose metabolism
   Insulin response
3. Stress hormone elevation
4. Decreased immune function
5. Increased cardiac risk

REM Deprivation
- REM pressure
- REM rebound
We are not aware of the extent to which our functioning is compromised by sleep deprivation. (U of PA study)

Sleep Disorders

The insomnias
The hypersomnias
Disorders of
the biological clock
NARCOLEPSY TETRAD

1) EXCESSIVE DAYTIME SLEEPINESS
2) CATAPLEXY
3) SLEEP PARALYSIS
4) HYPNAGOGIC HALLUCINATIONS

EXCESSIVE DAYTIME SLEEPINESS IS USUALLY, BUT NOT ALWAYS, THE MOST PROMINENT AND TROUBLE-SOME COMPONENT OF THE TETRAD

CATAPLEXY IS A BRIEF (SECONDS TO MINUTES) EPISODE OF MUSCLE WEAKNESS AND/OR PARALYSIS. WHEN ATTACK IS OVER, PATIENT IS COMPLETELY NORMAL
Snoring
and
Sleep Apnea

Video
Sleep walking - Somnambulism
Sleep terrors

REM sleep behavior disorder
The End