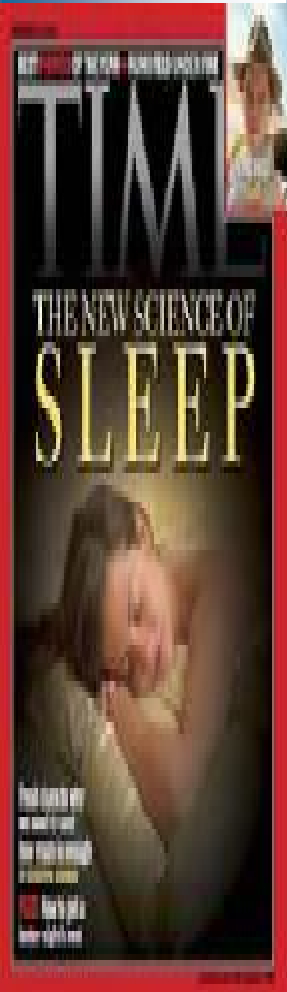


SLEEP PHYSIOLOGY



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Sleep Physiology

WHAT IS SLEEP

Sleep: This is the state of unconsciousness from which a subject can be aroused by appropriate sensory or other stimuli.

Sleep may also be defined as a normal, periodic, inhibition of the reticular Activating system.

Awake: This is the state of readiness / alertness and ability to react consciously to various stimuli.

Coma: This is the state of unconsciousness from which a person cannot be aroused by any external stimuli

SLEEP

FUNCTIONS OF SLEEP

Restoration theory: Body wears out during the day and sleep is necessary to put it back in shape

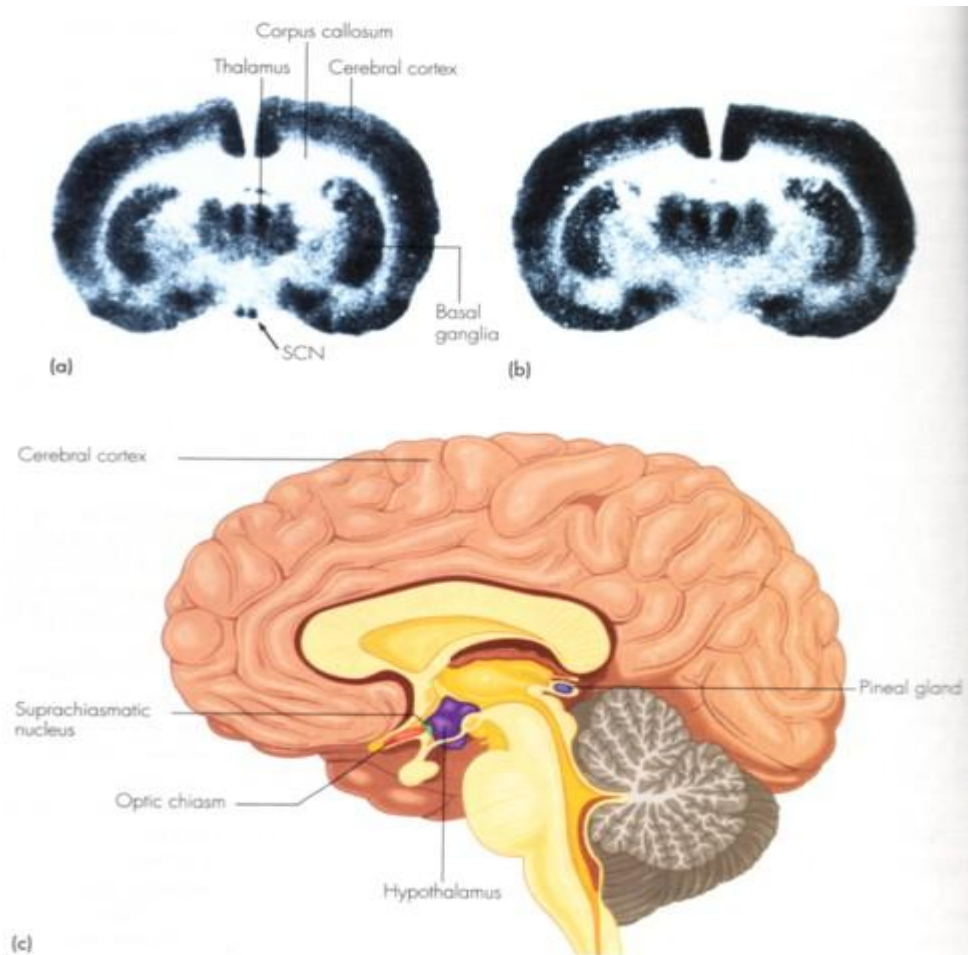
Preservation and protection theory: Sleep emerged in evolution to preserve energy and protect during the time of day when there is little value and considerable danger

SLEEP

SLEEP CENTRE

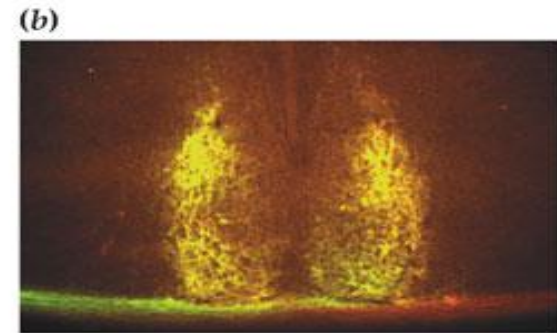
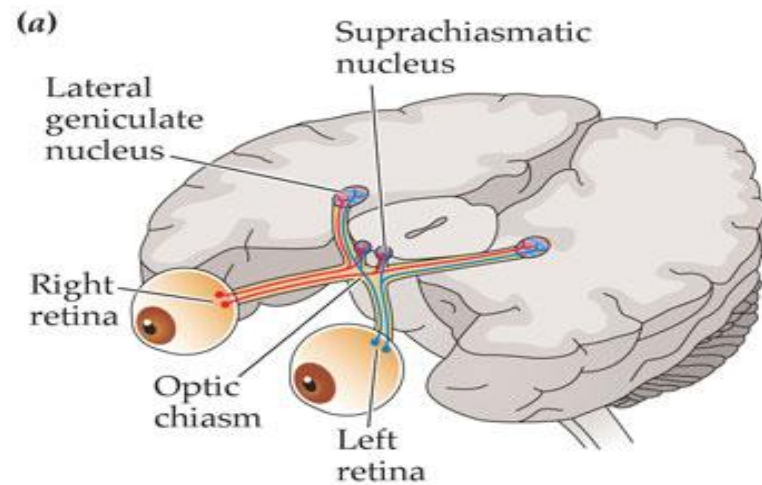
Supra-chiasmatic Nucleus (SCN)

Normal sleep is under control of the reticular activating system in the upper brain stem and diencephalon



SLEEP

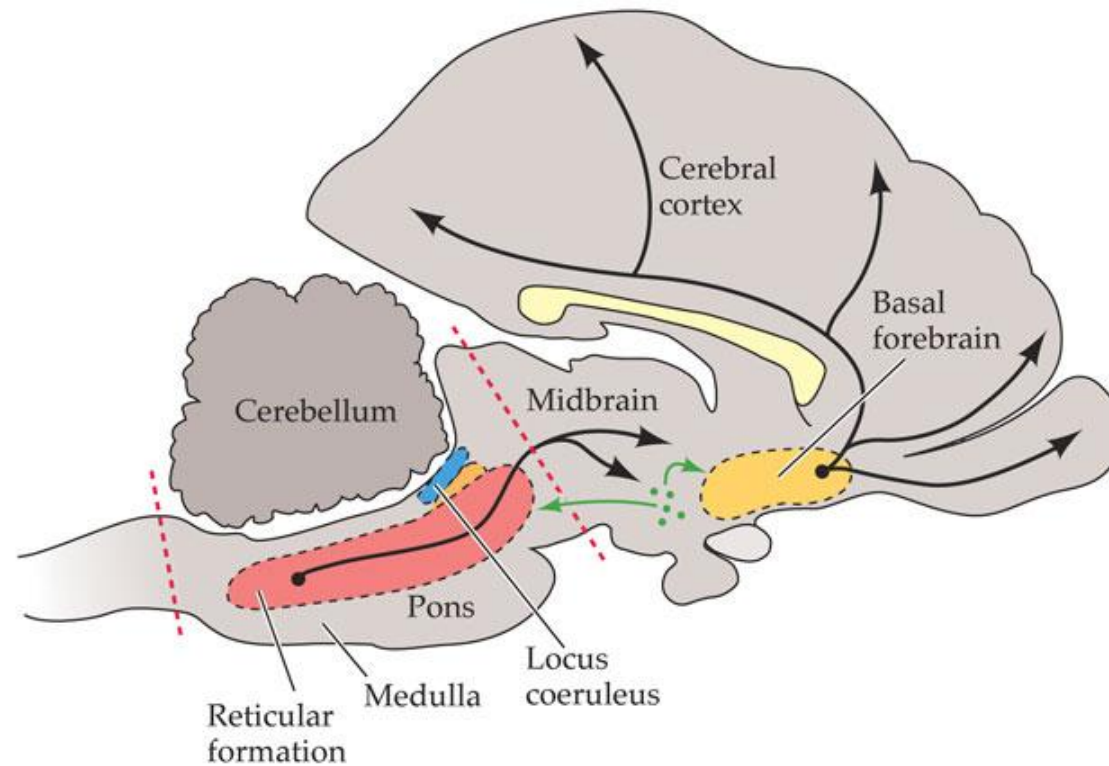
SLEEP CENTRE



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SLEEP

SLEEP CENTRE



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SLEEP

SLEEP CENTRE

Sleep is promoted by a complex set of neural and chemical mechanisms

Daily rhythm of sleep and arousal
suprachiasmatic nucleus of the hypothalamus
pineal gland's secretion of melatonin

Slow-wave sleep: Raphe nuclei of the medulla and pons and the secretion of serotonin

REM sleep: Neurons of the pons

SLEEP

NORMAL SLEEP REQUIREMENT

New born = 15 - 20 hours.

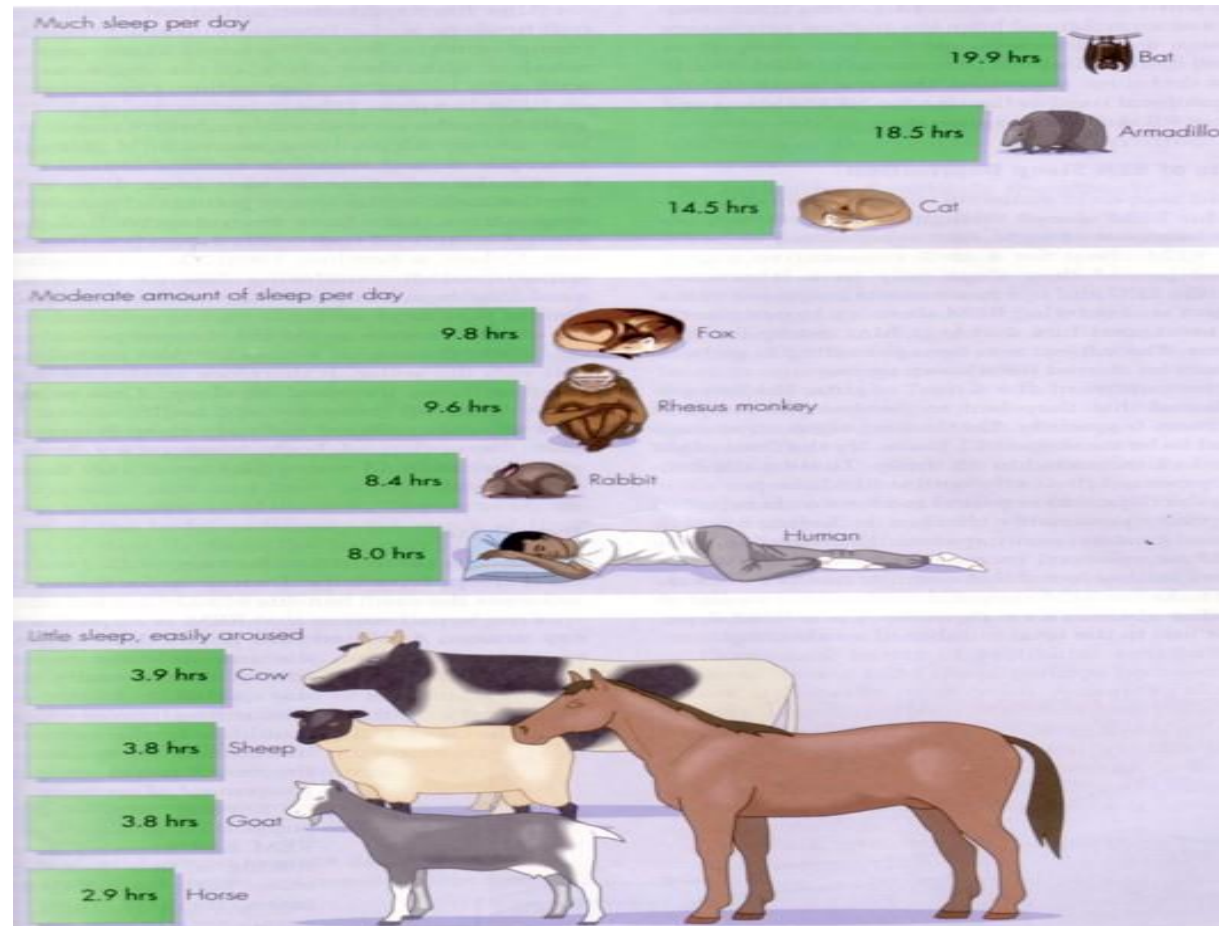
Children = 10 -15 hours.

Adults = 6-9 hours.

Old age = 5-6 hours.

SLEEP

NORMAL SLEEP REQUIREMENT



SLEEP

RETICULAR ACTIVATING SYSTEM

Consists of two parts:

Mesencephalic part:

Mesencephalic part composed of area of grey matter of mid brain and pons when this area is stimulated, nerve impulses going to thalamus and disperse to the cerebral cortex. This greatly effects the cortical activity.

SLEEP

RETICULAR ACTIVATING SYSTEM

Thalamic part: Thalamic part consists of gray matter in the thalamus. When the thalamic part is stimulated there is activity in the specific part of the cerebral cortex.

Mesencephalic part causes wakefulness (consciousness).

SLEEP

RETICULAR ACTIVATING SYSTEM

Thalamic part causes arousal that is awakening from deep sleep [sensory input, pain stimuli, Bright light].

The RAS and cerebral cortex continue to activate each other through a feedback system.

The RAS also has a feedback system with the spinal cord.

SLEEP

CIRCADIAN RHYTHM

Endogenous circadian rhythms

Rhythm that last about a day
humans' last around 24. h

Examples:

- activity
- temperature
- waking and sleeping
- secretion of hormones
- eating and drinking

SLEEP

RETICULAR ACTIVATING SYSTEM

Light:

Retinal ganglion cells send direct projections to the SCN

this provides information about light to the SCN

light can also alter blood-borne factors

SCN is highly vascularized

Melatonin:

secreted from the pineal gland

increased levels of melatonin make you sleepy

melatonin can act on receptors in the SCN to phase-advance the

biological clock

SLEEP

TYPES OF SLEEP

There are two types of sleep:

- 1. Non Rapid Eye Movement Sleep
[Slow Wave Sleep- Dreamless].**
- 2. Rapid eye movement sleep
[Dreamful].**

Both types alternate with each other.

SLEEP

SLOW WAVE SLEEP

1. Slow-wave (non rapid eye movement sleep)

This stage of sleep consists of four stages.

Stage 1: This is an initial stage between awakening and sleep.

It normally lasts from 1-7 minutes.

the person feels relaxed with eye closed.

If awakened, the person will frequently say that he has not been sleeping.

E.E.G. findings: Alpha waves diminish and Theta waves appear on EEG.

SLEEP

SLOW WAVE SLEEP

Stage 2:

This is the first stage of true sleep.

The person experiences only light sleep.

It is a little harder to awake the person.

Fragment of dream may be experienced.

Eyes may slowly roll from side to side.

***E.EG-findings:* Shows sleep spindles (sudden, sharply, pointed waves 12-14-Hz (cycles/sec)).**

SLEEP

SLOW WAVE SLEEP

Stage3:

This is the period of moderately deep sleep.

The person is very relaxed.

Body temperature begin to fall.

B.P decreases.

Difficult to awaken the person.

This stage occurs about 20-25 minutes after falling asleep.

***E.E.G.findings:* Shows mixture of sleep spindles and delta waves.**

SLEEP

SLOW WAVE SLEEP

Stage 4: Deep sleep starts

Person become fully relaxed.

Respond slowly if awakened.

E.E.G.findings: Dominated by Delta Waves.

Note: Most sleep during each night is of a slow wave

Lasts for 80=90 minutes.

Dreams / night mare even occur.

The difference is that the dreams in slow wave sleep are not remembered but in REM, dreams can be remembered.

SLEEP

RAPID EYE MOVEMENT SLEEP

RAPID EYE MOVEMENT SLEEP [PARADOXICAL SLEEP/DREAMFUL SLEEPS]

In normal sleep bouts of REM sleep lasting for 5-20 minutes usually appear on the average after every 90 minutes.

The first such period occurring 80-100 minutes after the person falls a sleep.

When the person is in extreme sleep, the duration of each bout of REM is very short.

It may even be absent.

SLEEP

CHARACTERISTICS OF REMS

CHARACTERISTICS OF REMS:

Active dreaming.

Difficult to arouse by sensory stimuli.

Decreased muscle tone through out the body.

Heart rate and respiration usually become irregular which is characteristic of a dream state.

Brain is highly active in REM sleep and brain metabolism may be increased by 20%.

SLEEP

CHARACTERISTICS OF REMS

E.E.G.findings: Shows pattern of brain wave to those of wakefulness that is which it is called “Paradoxical”.

In summary, REM sleep is a type of sleep in which the brain is quite active.

SLEEP

CHARACTERISTICS OF SWS AND REMS

TABLE 14.1 *Properties of Slow-Wave and REM Sleep*

Property	Slow-wave sleep	REM sleep
AUTONOMIC ACTIVITIES		
Heart rate	Slow decline	Variable with high bursts
Respiration	Slow decline	Variable with high bursts
Thermoregulation	Maintained	Impaired
Brain temperature	Decreased	Increased
Cerebral blood flow	Reduced	High
SKELETAL MUSCULAR SYSTEM		
Postural tension	Progressively reduced	Eliminated
Knee jerk reflex	Normal	Suppressed
Phasic twitches	Reduced	Increased
Eye movements	Infrequent, slow, uncoordinated	Rapid, coordinated
COGNITIVE STATE		
	Vague thoughts	Vivid dreams, well organized
HORMONE SECRETION		
Growth hormone secretion	High	Low
NEURAL FIRING RATES		
Cerebral cortex (sustained) activity	Many cells reduced and more phasic	Increased firing rates; tonic
EVENT-RELATED POTENTIALS		
Sensory-evoked	Large	Reduced

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DREAMS AND REMS

What are true dreams for?

Although research has yet to answer this question, a prevalent view today is that **dreams don't serve any purpose at all, but are side effects of REM**

**To exercise groups of neurons during sleep
some are in perceptual and motor areas
REM occurs in other mammals and to a much
greater extent in fetuses and infants than adults
REM sleep may help consolidate memories**

SLEEP

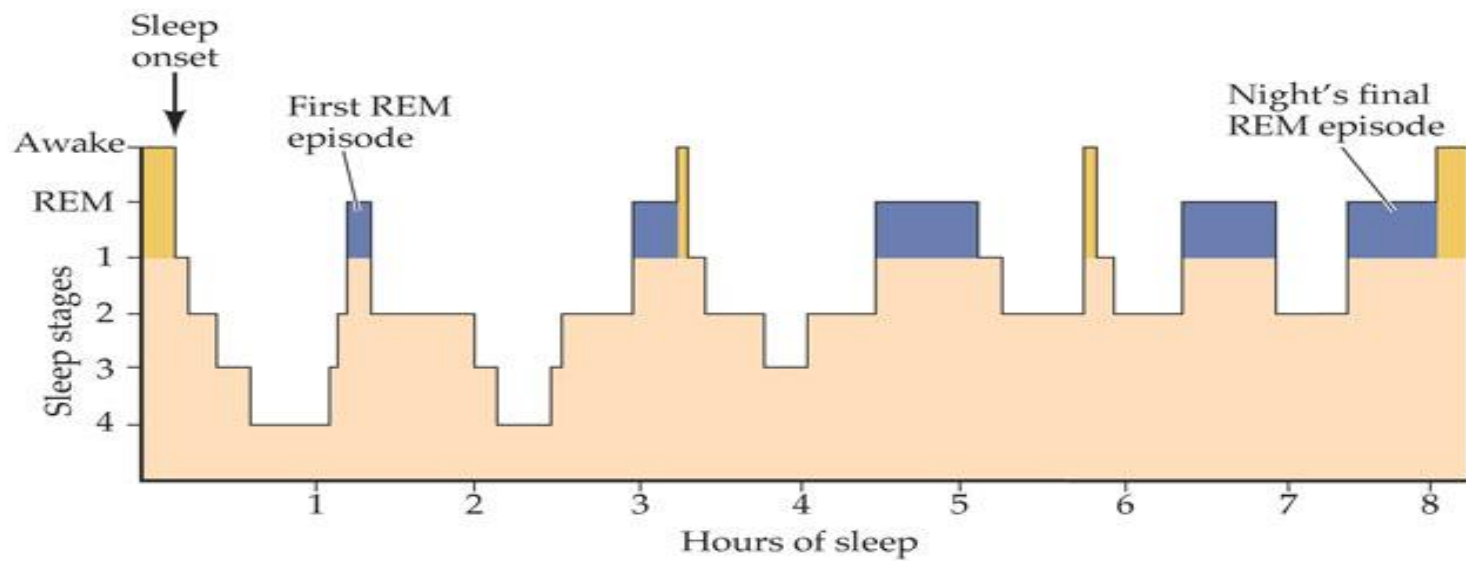
DREAMS AND REMS

True dream - vivid, detailed dreams consisting of sensory and motor sensations experienced during REM

sleep thought - lacks vivid sensory and motor sensations, is more similar to daytime thinking, and occurs during slow-wave sleep

SLEEP

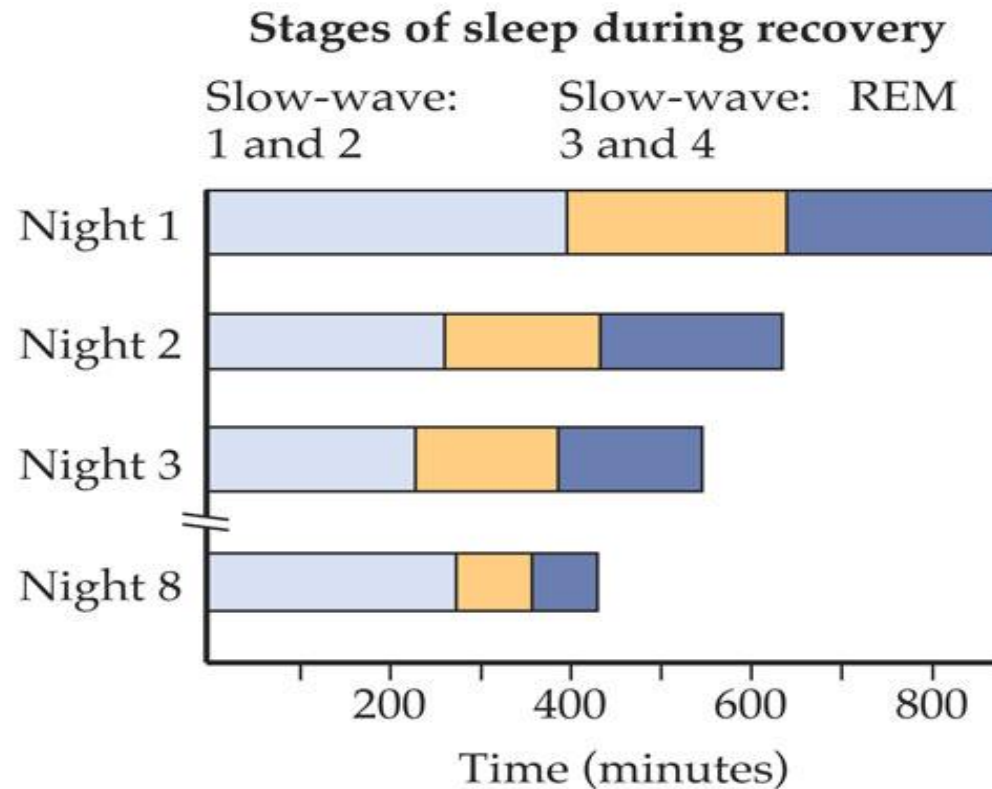
SLEEP / TYPES



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SLEEP

SLEEP / TYPES



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SLEEP

PHYSIOLOGICAL CHANGES IN SLEEP

Physiological changes during sleep:

CVS: Pulse Rate, cardiac output, blood pressure, and vasomotor tone are decreased but the blood volume is increased.

Respiration: Tidal volume and rate of respiration is decreased. BMR is decreased 10-15%.

Urine volume: Urine volume is decreased.

Secretions: Salivary / lacrimal secretions are reduced, gastric/sweet secretions are increased.

SLEEP

PHYSIOLOGICAL CHANGES IN SLEEP

Muscles: Relaxed.

Superficial reflexes are unchanged except plantar reflex.

Deep reflexes are reduced.

Effects produced by awakening after 60-100 hours:

Equilibrium disturbed.

Neuromuscular junction fatigue.

Threshold for pain is lowered.

Some cells shrink.

SLEEP

PHYSIOLOGICAL CHANGES IN SLEEP

TABLE 14.2 *Neural Activity of Neurotransmitter Systems during Sleep and Arousal*

Neurotransmitter	Site of cell bodies	Activity during		
		Wakefulness	SWS	REM
Serotonin	Raphe nuclei	High	Low	Very low
Norepinephrine	Locus coeruleus	High	Low	Very low
Acetylcholine	Brainstem	High	Low	High

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SLEEP

DISORDERS OF SLEEP

Disorder of sleep:

Insomnia: Inability to sleep

Somnolence: Extreme sleepiness

Disorder of slow wave sleep:

Sleep talking / sleep walking

[common in children]

Night tremors: Are seen in III, IV stage of slow wave sleep [common in children].

Disorder of REM sleep:

Night mare = Frightening dream.

Sleep Paralysis= Subject is awake but unable to speak or move. Sleeping Sickness.

SLEEP

DISORDERS OF SLEEP

Somnambulism - sleepwalking

Nightmares - frightening dreams that wake a sleeper from REM

Night terrors - sudden arousal from sleep and intense fear accompanied by physiological reactions (e.g., rapid heart rate, perspiration) that occur during slow-wave sleep

Narcolepsy - overpowering urge to fall asleep that may occur while talking or standing up

Sleep apnea - failure to breathe when asleep

SLEEP

DISORDERS OF SLEEP

Insomnia: Habitual sleeplessness

possible causes: excessive noise, stress, drugs, medications, pain, uncomfortable temperature, sleep apnea, periodic limb movement disorder
three forms: onset, maintenance, termination

Narcolepsy: Frequent, unexpected periods of sleepiness during the day

affects about 1 in 1000 people

symptoms: extreme daytime sleepiness, cataplexy, sleep paralysis, hypnagogic hallucinations
involvement of orexin

SLEEP

DISORDERS OF SLEEP

Night Terrors

experience of intense anxiety from which a person awakens screaming in terror
occur during non REM sleep
more common in children

Sleep Walking

occurs mostly in children
runs in families
expressed early in the night during stage 3 and 4 sleep

SLEEP

DISORDERS OF SLEEP

Epidemiology [Sleep Apnoea]

- **Incidence of sleep disordered breathing:**
- **Males:** 4-9% of Americans
- **Females:** 1-5% of Americans
- **Estimate** - 15 million Americans have sleep disordered breathing (many remain undiagnosed)
- **Sleep apnea incidence higher:**
- **African Americans/Native Americans/Hispanics**
- **With increasing age**
- **With increasing body weight**

SLEEP

DISORDERS OF SLEEP

Pathophysiology [Sleep Apnoea]

- **Complete or partial pharyngeal obstruction during sleep**
- **Narrowing at one or more sites along the upper airway**
- **Between soft palate and posterior pharyngeal wall**
- **Between base of the tongue and posterior pharyngeal wall**
- **Between epiglottis and laryngeal vestibule**

SLEEP

DISORDERS OF SLEEP

Symptoms of Obstructive Sleep Apnea

Nighttime

Snoring
Witnessed Apnea
Choking
Dyspnea
Restlessness
Nocturia
Diaphoresis
Reflux

Day time

Sleepiness
Fatigue
Morning headaches
Poor concentration
Decreased
libido/impotence
Decreased attention
Depression
Personality changes

SLEEP

SLEEP DISORDERS /BURDEN

70 million people in the US **suffer from sleep problems** [50% have chronic sleep disorder]

Insomnia = 30 million

sleep apnea= 18 million

Narcolepsy= 250,000 Americans have

Motor Car Accidents= 100,000

traffic fatalities =1500 drowsy driving / annum

Approximately \$16 billion annually to the cost of health care in the US and result in **\$50 billion annually** in lost productivity

SLEEP

DISORDERS OF SLEEP

Sleep deprivation: “Four to six hours of sleep each night results in a progressive, cumulative deterioration in neurobehavioral function including vigilance, neurocognitive performance, and mood.

This reduction in performance is also associated with changes in cerebral activation during cognitive tasks.

Physiologic changes also occur: insulin resistance, increased sympathetic activation, decreased immune system function.”

SLEEP

DISORDERS OF SLEEP



SLEEP

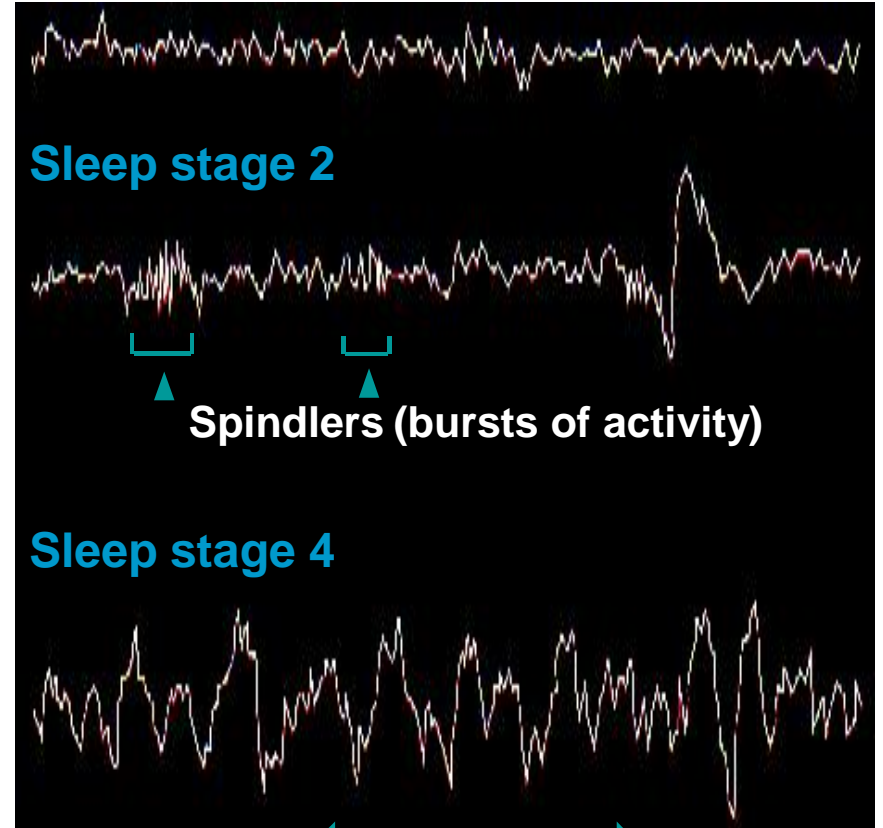
STAGES OF SLEEP

Sleep stage 1 - brief transition stage when first falling asleep

Stages 2 through 4 (slow-wave sleep) - successively deeper stages of sleep

Characterized by an increasing % of slow, irregular, high-amplitude delta waves

Sleep stage 1

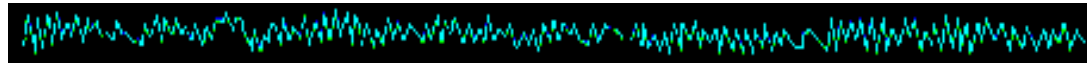


SLEEP

EEG WAVES IN WAKKFULNESS

Awake, but non-attentive - large, regular alpha waves

Awake, nonattentive 1 second



◀ **Alpha waves** ▶

z Awake and attentive - low amplitude, fast, irregular beta waves

Awake, attentive 1 second



◀ **Beta waves** ▶

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