

SLEEP PHYSIOLOGY



Prof. Sultan Ayoub Meo
MBBS, Ph.D (Pak), M Med Ed (Scotland), FRCP (London),
FRCP (Dublin), FRCP (Glasgow), FRCP (Edinburgh)
Professor, Department of Physiology
College of Medicine, King Saud University

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 THEORIES

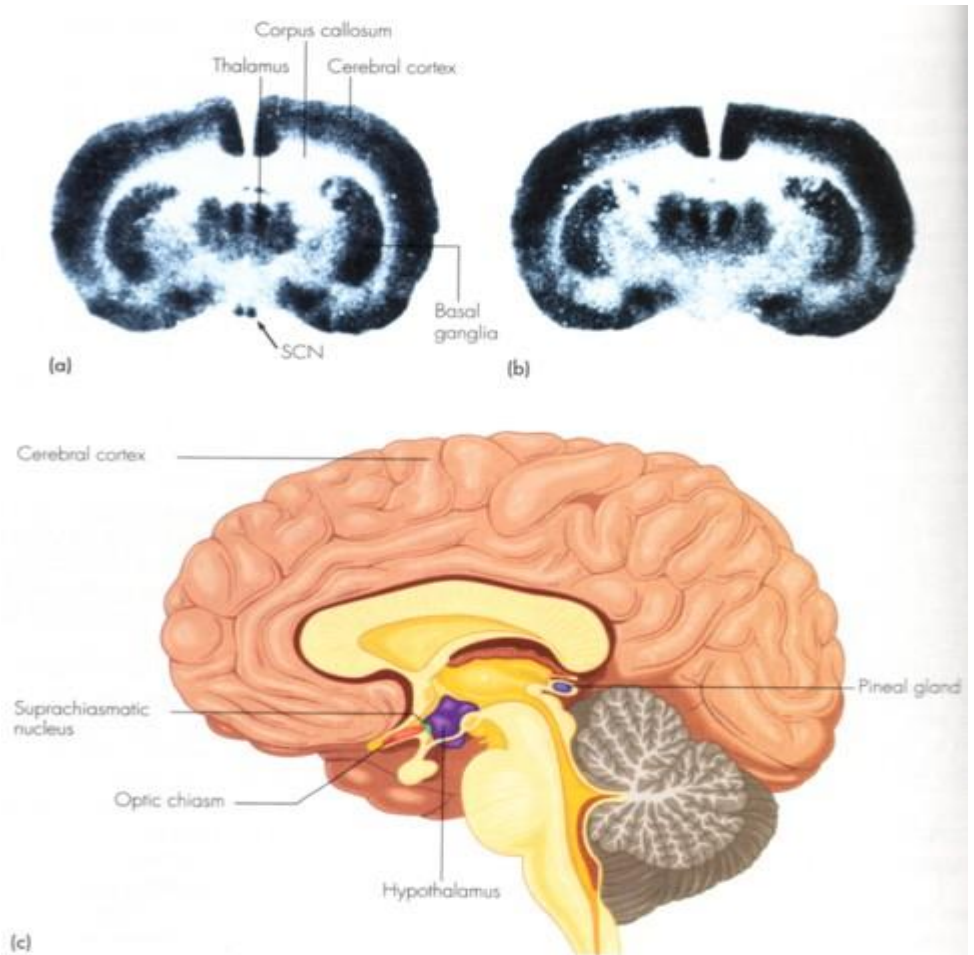
Restoration theory: Body wears out during the day and sleep is necessary to put it back in shape.

Preservation and protection theory: Sleep preserve energy and it provide activity

SLEEP CENTRE

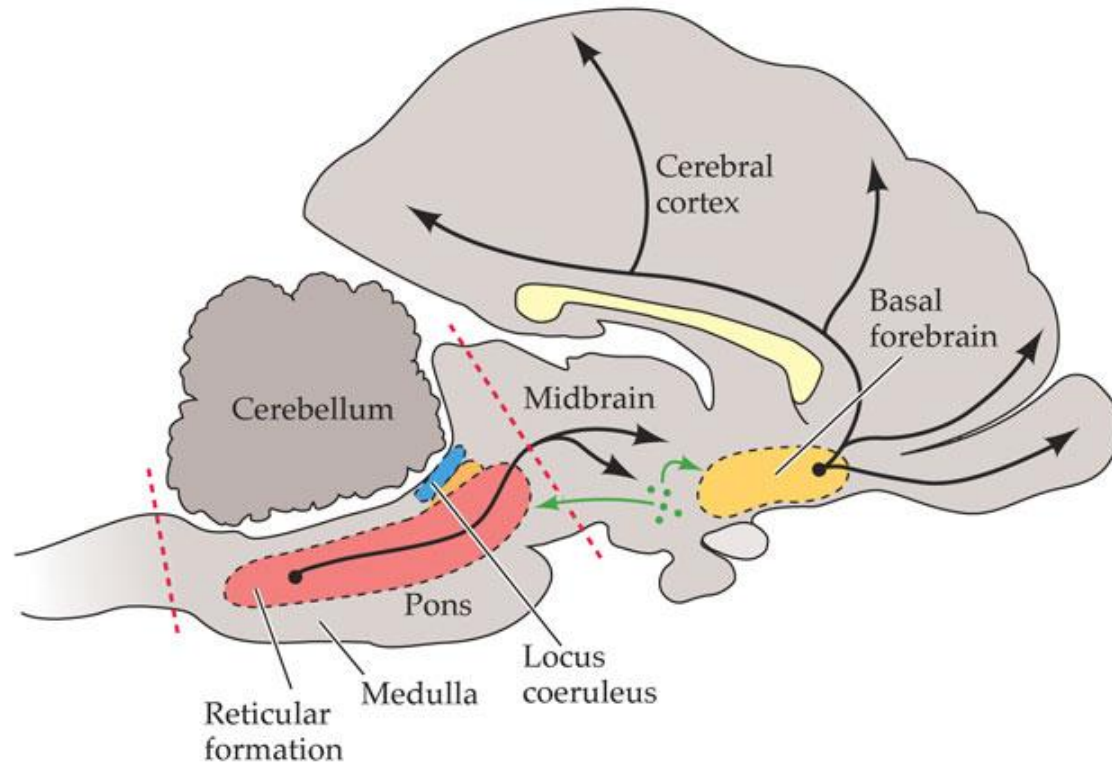
Supra-chiasmatic Nucleus (SCN)

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



SLEEP

SLEEP CENTRE



BIOLOGICAL PSYCHOLOGY, Fourth Edition, Figure 14.20 © 2004 Sinauer Associates, Inc.

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

(Increased melatonin make sleepy)

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

REM sleep: Neurons of the pons

NORMAL SLEEP REQUIREMENT

New born = 15 - 20 hours.

Children = 10 -15 hours.

Adults = 6-9 hours.

Old age = 5-6 hours.

RETICULAR ACTIVATING SYSTEM

Consists of two parts:

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. Mesencephalic part causes consciousness.

SLEEP

RETICULAR ACTIVATING SYSTEM

Thalamic part: Consists of gray matter in the thalamus. When the thalamic part is stimulated, it develop activity in the cerebral cortex.

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

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.

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.

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)).

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.**

SLOW WAVE LEEP

Stage4: 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.**

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.

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 become irregular which is characteristic of a dream state.

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

EEG.: Pattern shows brain wave of wakefulness, REM sleep is a type of sleep in which the brain is quite active.

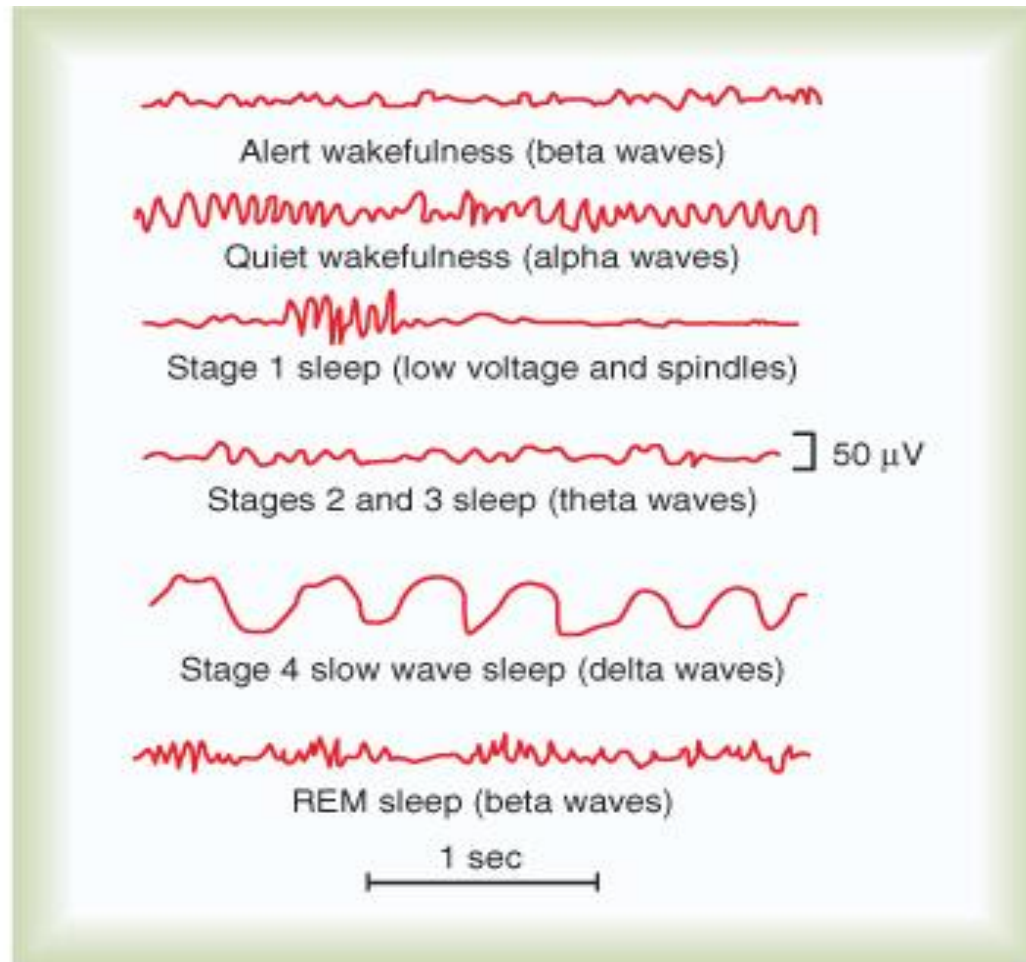
CHARACTERISTICS OF SWS AND REMS

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

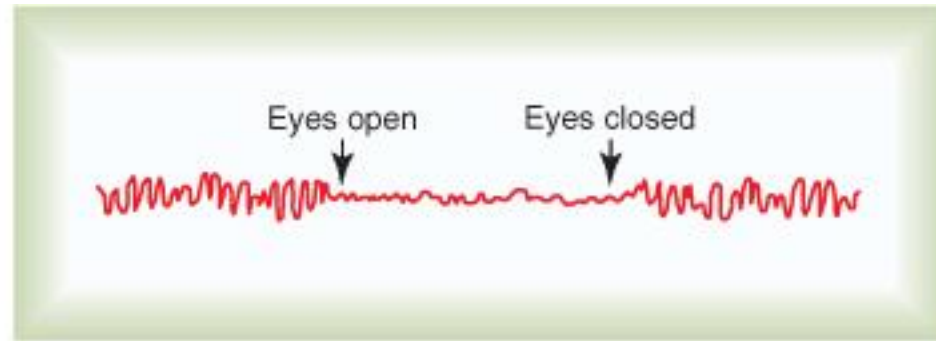
BIOLOGICAL PSYCHOLOGY, Fourth Edition, Table 14.1 © Sinauer Associates, Inc.

SLEEP / TYPES



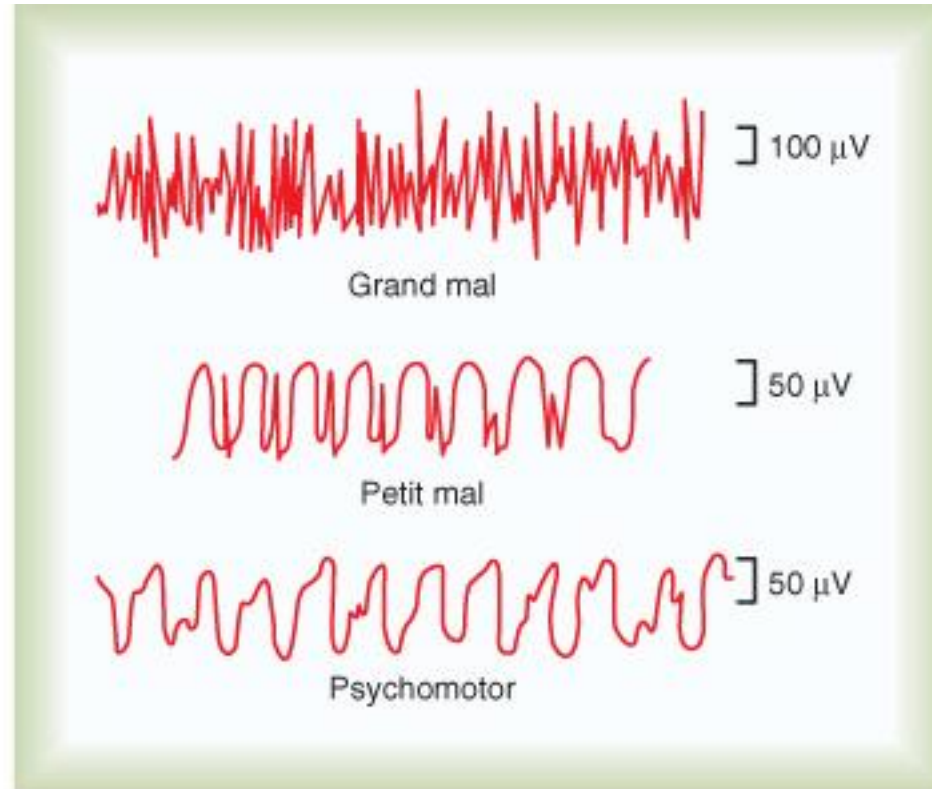
© Elsevier. Guyton & Hall: Textbook of Medical Physiology 11e - www.studentconsult.com

SLEEP / TYPES



© Elsevier. Guyton & Hall: Textbook of Medical Physiology 11e - www.studentconsult.com

SLEEP / TYPES

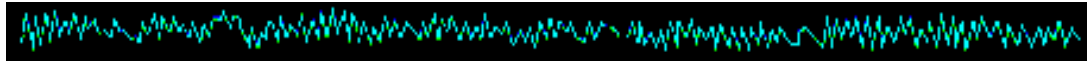


© Elsevier. Guyton & Hall: Textbook of Medical Physiology 11e - www.studentconsult.com

EEG WAVES IN WAKKFULNESS

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

Awake, nonattentive 1 second



◀ Alpha waves ▶

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

Awake, attentive 1 second

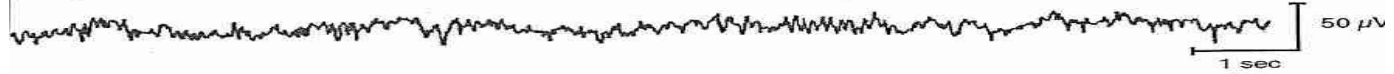


◀ Beta waves ▶

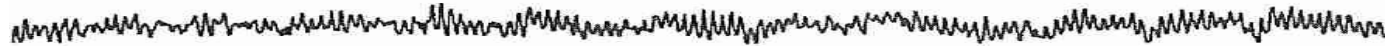
SLEEP

SLEEP AND EEG

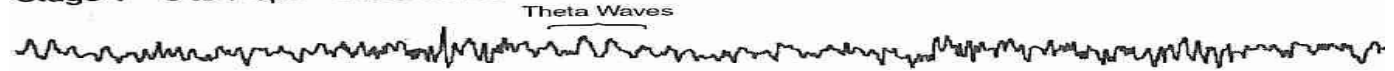
Awake – low voltage – random, fast



Drowsy – 8 to 12 cps – alpha waves



Stage 1 – 3 to 7 cps – theta waves



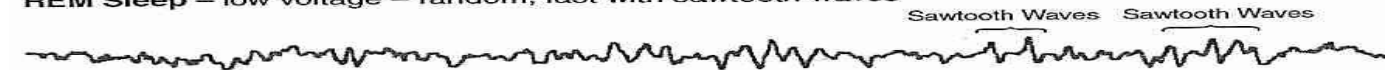
Stage 2 – 12 to 14 cps – sleep spindles and K complexes



Delta Sleep – 1/2 to 2 cps – delta waves >75 μ V

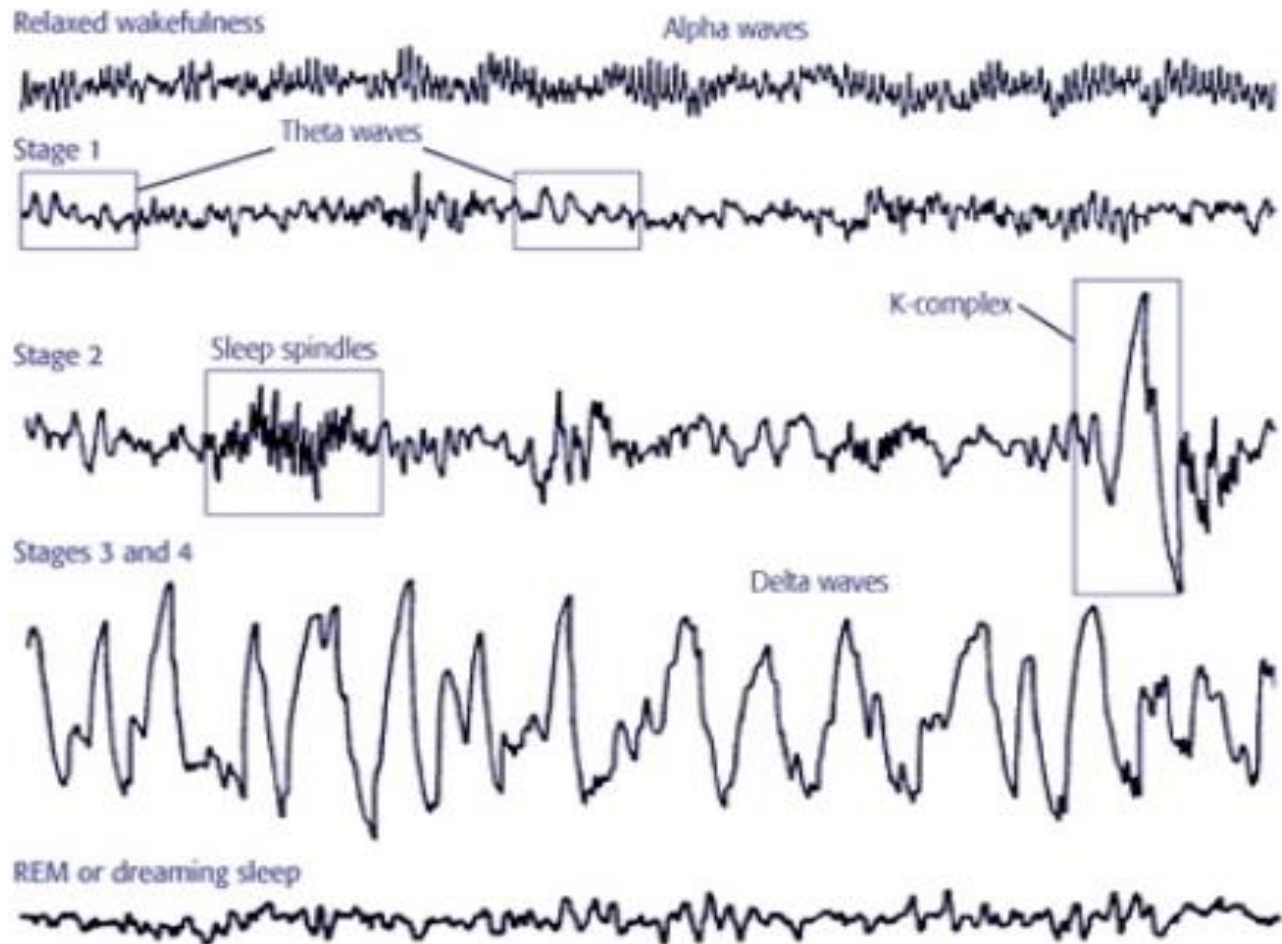


REM Sleep – low voltage – random, fast with sawtooth waves



SLEEP

EEG during Sleep and Wakefulness



SLEEP

PHYSIOLOGICAL CHANGES IN SLEEP

Physiological changes during sleep:

CVS: Pulse Rate, cardiac output, blood pressure, and vasomotortone 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.

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.

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

DISORDERS OF SLEEP

Disorders 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:

Nightmare = Frightening dream.

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

DISORDERS OF SLEEP

Somnambulism –Walking during sleep

Nightmares: Frightening dreams, awake 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 - Excessive sleepiness may occur while talking, sitting, decreased ability to regulate sleep

Sleep apnea - failure to breathe when asleep

THANK



YOU

SLEEP