

# Physiology of sleep

Dr. Deepa.G.S.  
Associate Professor  
SKHMC  
Kulasekaram

Sleep is a physiological process by which bodily functions are periodically rested.

## Physiological changes during sleep:

**CVS**-Heart rate, Cardiac output, vasomotor tone and BP decreases

**Respiratory system**-TV, Respiratory rate, Pulmonary ventilation decreases. Sometimes respiration remains unchanged or becomes faster due to shallow breathing

**BMR**-Decreases by 10-15%

**Urine**-Volume decreases while phosphate content and specific gravity increases

### Secretions:

Salivary and lacrimal secretion decreases

Sweat-Increases

Gastric secretion-remains unaltered or increases

**Muscles**-Completely relaxed and tone is minimum

**Eyes**-Eye balls move up and down due to flaccidity of external ocular muscles

Eyelids come closer due to drooping of eyelids

Pupils constrict

### Blood volume

Increases resulting in dilution of plasma

### Nervous system

EEG –Delta waves

Deep reflexes reduced

Superficial reflexes unchanged

## Types of sleep

Sleep is of two types:

1. Rapid eye movement sleep or REM sleep
2. Non-rapid eye movement sleep, NREM sleep or non-REM sleep

### 1. Rapid eye movement sleep or REM sleep

Deepest sleep associated with rapid conjugate movements of the eyeballs, which occurs frequently. It occupies about **20% to 30% of sleeping period.**

Functionally, REM sleep is very important because, it plays an important role in consolidation of memory. Dreams occur during this period.

## **2. Non-rapid eye movement sleep –NREM or NON-REM sleep**

Non-rapid eye movement (NREM) sleep is the type of sleep without the movements of eyeballs. It is also called **slow-wave sleep**.

Dreams do not occur in this type of sleep and it occupies about **70% to 80% of total sleeping period**.

Non-REM sleep is followed by REM sleep.

## **STAGES OF SLEEP AND EEG PATTERN**

### **RAPID EYE MOVEMENT SLEEP**

During REM sleep, electroencephalogram (EEG) shows irregular waves with high frequency and low amplitude. These waves are **desynchronized waves**.

### **NON-RAPID EYE MOVEMENT SLEEP**

The NREM sleep is divided into four stages, based on the EEG pattern.

During the stage of wakefulness, i.e. while lying down with closed eyes and relaxed mind, the **alpha waves** of EEG appear. When the person proceeds to drowsy state, the alpha waves diminish

#### **Stage I: Stage of Drowsiness**

Alpha waves are diminished and abolished. EEG shows only **low voltage fluctuations** and **infrequent delta waves**.

#### **Stage II: Stage of Light Sleep**

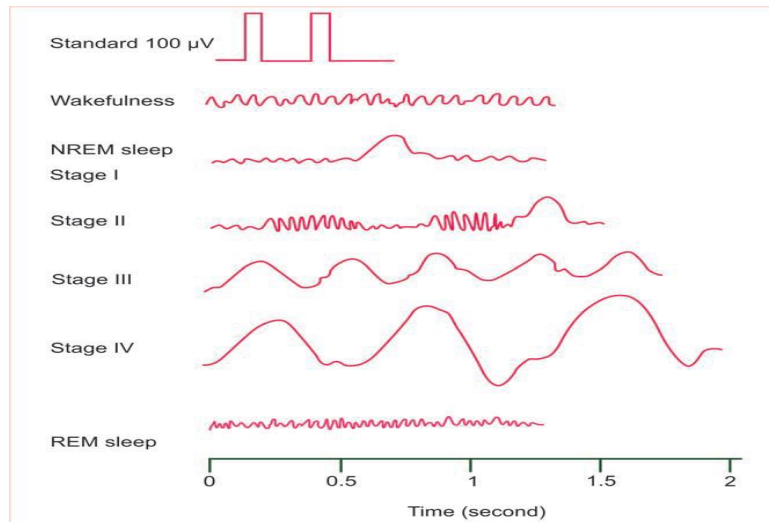
Stage II is characterized by **spindle bursts** at a frequency of 14 per second, superimposed by low voltage **delta waves**.

#### **Stage III: Stage of Medium Sleep**

During this stage, the spindle bursts disappear. Frequency of delta waves decreases to 1 or 2 per second and amplitude increases to about 100  $\mu$ V.

#### **State IV: Stage of Deep Sleep**

**Delta waves** become more prominent with low frequency and high amplitude.



**Electroencephalogram during wakefulness, different stages of NREM sleep and REM sleep.**

### **Characteristics of REM and NREM sleep**

<b>Characteristics</b>	<b>Rapid eye movement sleep</b>	<b>Non rapid eye movement sleep</b>
1. Rapid eye movement	Present	Absent
2. Dreams	Present	Absent
3. Muscle twitching	Present	Absent
4. Heart rate	Fluctuating	Stable
5. Blood pressure	Fluctuating	Stable
6. Respiration	Fluctuating	Stable
7. Body temperature	Fluctuating	Stable
8. Neurotransmitter	Nor-adrenaline	Serotonin

### **Theories of sleep:**

#### **Sleep wake cycle**

Sleeping or remaining wake is due to the alteration between the state of sleep and state of wakefulness of sleep-wake cycle. It is synchronized to the day-night variation in the environment. Circadian rhythm plays an important role in shift between sleep-wake cycles.

#### **Theories:**

#### **Circadian Rhythm**

The center of circadian rhythm is suprachiasmatic nucleus of hypothalamus. SCN is the biological clock.

Circadian activity of SCN correlates with light-dark cycle. If the individual is exposed to bright light during the day, sleep-wake cycle is usually not affected, if exposed to bright light after the evening, onset of sleep is delayed. If exposed in the early morning, onset of next sleep period is accelerated. SCN initiates neurohumoral signals that entertain the circadian rhythm of sleep-wake cycle

### **Role of Pineal gland**

Melatonin is suggested to act on brain reticular activating neurons to mediate sleep wake cycle.

### **Thalamocortical loop**

Neural circuit between thalamus and cortex has been proposed to be an important component of sleep-wake cycle

### **Alteration in Neurochemicals**

Decreased Ach keeps the individual awake and increased Ach induces sleep. Serotonergic neurons from Raphe nucleus and Norepinephrin from locus ceruleus inhibit acetylcholine that keeps the individual awake.

## **Sleep disorders**

### **Insomnia**

Inability to sleep in spite of adequate opportunity to do so is called insomnia.

### **Narcolepsy**

Episodic sudden loss of muscle tone accompanied with irresistible urge to sleep

### **Cataplexy**

Sudden loss of power of movement and posture while the subject is awake followed by irresistible desire to sleep.

### **Somnambulism**

Condition in which the sleeping person is able to stand and walk about

### **Hyperosmia**

Excessive sleep

### **Reference:**

1. Essentials of medical Physiology:K.sembulingam Prema sembulingam,Eigth edition
2. Comprehensive Textbook of medical Physiology,Gopal Krishna Pal,Pravati Pal,Nivedita Nanda.First edition.