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Question 1: Discuss the physiology of sleep

Sleep is the natural periodic state of rest for mind and body with closed eyes characterized by partial or complete loss of consciousness. Sleep is a naturally recurring state of mind and body, characterized by altered consciousness, relatively inhibited sensory activities, reduced muscle activity and inhibition of nearly all voluntary muscles during rapid eye movement (REM) sleep and reduced interactions with surroundings.

Depth of sleep is not constant throughout the sleeping period. It varies in different stages of sleep. Sleep requirement is not constant. However, average sleep requirement per day at different age groups is:

Age group	**Sleep requirement per day**
Newborn infants	18 – 20 hours
Growing children	12 – 14 hours
Adults	7 – 9 hours
Old persons	5 – 7 hours

TYPES OF SLEEP

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

1. **Rapid eye movement sleep (REM sleep)**
   Rapid eye movement sleep is the type of sleep associated with rapid conjugate movements of the eyeballs, which occurs frequently. Though the eyeballs move, the sleep is deep. So, it is also called **paradoxical sleep**. 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. It is the main occasion for dreams (or nightmares), and is associated with desynchronized and fast brain waves, eye movements, loss of muscle tone and suspension of homeostasis.

2. **Non-rapid eye movement sleep (NREM sleep 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. During this phase, body temperature and heart rate fall, and the brain uses less energy. Non-REM sleep is followed by REM sleep.

STAGES OF SLEEP AND EEG PATTERN

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

2. **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
   This stage 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 μV.
   State IV: Stage of Deep Sleep
   Delta waves become more prominent with low frequency and high amplitude

Sleep occurs due to the activity of some **sleep inducing centers** in the brain. Stimulation of these centers induces sleep. Damage of sleep centers results in sleeplessness or persistent wakefulness called **insomnia**. Two centers which induce sleep located in the brainstem are:

1. **Raphe nucleus:** Raphe nucleus is situated in lower pons and medulla. Activation of this nucleus results in non-REM sleep. It is due to release of serotonin by the nerve fibers arising from this nucleus. Serotonin induces non-REM sleep.
2. **Locus ceruleus of pons:** Activation of this center produces REM sleep. **Noradrenaline** released by the nerve fibers arising from locus ceruleus induces REM sleep.

- **Inhibition of Ascending Reticular Activating System (ARAS)**
  Ascending reticular activating system (ARAS) is responsible for wakefulness because of its afferent and efferent connections with cerebral cortex. Inhibition of ARAS induces sleep. Lesion of ARAS leads to **coma**.

SLEEP DISORDERS

1. **Insomnia**
   Insomnia is the inability to sleep or abnormal wakefulness. It is the most common sleep disorder. It occurs due to systemic illness or mental conditions such as psychiatric problems, alcoholic addiction and drug addiction.
2. **Hypersomnia**
   Hypersomnia is the excess need to sleep. It occurs because of lesion in the floor of the third ventricle, brain tumors, disease of muscles and so on.
3. **Narcolepsy and Cataplexy**
   Narcolepsy is the sudden attack of uncontrollable sleep. Cataplexy is a sudden, brief loss of voluntary muscle tone triggered by strong emotions such as laughter.
4. **Sleep apnea syndrome**
   Sleep apnea is the temporary stoppage of breathing repeatedly during sleep. Sleep apnea syndrome is the disorder that involves fluctuations in the rate and force of respiration during REM sleep with short apneic episode. When breathing stops, the resultant hypercapnia and hypoxia stimulate respiration. Sleep apnea syndrome occurs in obesity, myxedema, enlargement of tonsils and lesion in brainstem.
5. Nightmare
6. Somnambulism (sleep walking)

Question 2: Discuss the role of basal ganglia in coordinating movement.

Basal ganglia are the scattered masses of gray matter submerged in subcortical substance of cerebral hemisphere. Basal ganglia form the part of extra pyramidal system, which is concerned with motor activities.

The roles of basal ganglia in coordinating movement are:

- **Control of muscle tone**
  Basal ganglia control the muscle tone. In fact, gamma motor neurons of spinal cord are responsible for development of tone in the muscles. **Basal ganglia decrease the muscle tone by inhibiting gamma motor neurons through descending inhibitory reticular system in brainstem**. During the lesion of basal ganglia, muscle tone increases leading to rigidity.

- **Control of motor activities**
  This is further divided into:
  I. **Regulation of voluntary movements**: Movements during voluntary motor activity are initiated by cerebral cortex. However, these movements are controlled by basal ganglia, which are in close association with cerebral cortex.
  Basal ganglia control the motor activities because of the nervous (neuronal) circuits between basal ganglia and other parts of the brain involved in motor activity.
  II. **Regulation of conscious movements:** Conscious movements are regulated by the fibers between cerebral cortex and caudate nucleus. This function of basal ganglia is also known as the **cognitive control of activity**.
  III. **Regulation of subconscious movements:** Some subconscious movements are regulated by the cortical fibers reaching the putamen (structure involved in regulating movements and influencing various types of learning)

- **Control of reflex muscular activity**
  Visual and labyrinthine reflexes are important in maintaining the posture and basal ganglia are responsible for the coordination and integration of impulses for these reflex activities.

- **Control of automatic associated movements**
  Automatic associated movements are the movements in the body, which take place along with some motor activities. Examples are the swing of the arms while walking, appropriate facial expressions while talking or doing any work. Basal ganglia are responsible for these automatic associated movements.