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**COURSE TITLE: NEUROPHYSIOLOGY**

**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)
3. **Rapid eye movement sleep (REM sleep)**

Rapid eye movement sleep is the type of sleep associated with rapid conjugate movements of theeyeballs, which occurs frequently. Though the eyeballsmove, 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 importantbecause, it plays an important role in consolidation ofmemory. 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.

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

Non-rapid eye movement (NREM) sleep is the type ofsleep without the movements of eyeballs. It is also called**slow-wave sleep**. Dreams do not occur in this type ofsleep and it occupies about 70% to 80% of total sleepingperiod. 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 lowamplitude. These waves are **desynchronized waves**.

1. **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, thealpha waves of EEG appear. When the person proceedsto drowsy state, the alpha waves diminish.

**Stage I: Stage of Drowsiness**

Alpha waves are diminished and abolished. EEG shows only low voltage fluctuations and **infrequentdelta 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 secondand 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 isdue to release of serotonin by the nerve fibers arisingfrom 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 fromlocus ceruleus induces REM sleep.

* **Inhibition of Ascending Reticular Activating System (ARAS)**

Ascending reticular activating system (ARAS) is responsible for wakefulness because of its afferent andefferent connections with cerebral cortex. Inhibitionof 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 occursdue to systemic illness or mental conditions such aspsychiatric problems, alcoholic addiction and drug addiction.

1. **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.

1. **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.

1. **Sleep apnea syndrome**

Sleep apnea is the temporary stoppage of breathing repeatedly during sleep. Sleep apnea syndrome isthe disorder that involves fluctuations in the rate andforce of respiration during REM sleep with short apneicepisode. When breathing stops, the resultant

hypercapnia and hypoxia stimulate respiration. Sleep apnea syndrome occurs in obesity, myxedema, enlargement of tonsils and lesion in brainstem.

1. Nightmare
2. 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. **Basalganglia decrease the muscle tone by inhibiting gammamotor neurons through descending inhibitory reticularsystem in brainstem**. During the lesion of basalganglia, muscle tone increases leading to rigidity.

* **Control of motor activities**

This is further divided into:

1. **Regulation of voluntary movements**: Movements during voluntary motor activity are initiatedby cerebral cortex. However, these movements arecontrolled by basal ganglia, which are in close associationwith cerebral cortex.

Basal ganglia control the motor activities becauseof the nervous (neuronal) circuits between basal gangliaand other parts of the brain involved in motor activity.

1. **Regulation of conscious movements:** Conscious movements are regulated by the fibers between cerebral cortex and caudate nucleus. Thisfunction of basal ganglia is also known as the **cognitivecontrol of activity**.
2. **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 thecoordination 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 motoractivities. Examples are the swing of the arms whilewalking, appropriate facial expressions while talking ordoing any work. Basal ganglia are responsible for these automatic associated movements.