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NEUROPHYSIOLOGY OF SLEEP

1) **Discuss the physiology of sleep**

Sleep is an unconsciousness from which a person can be aroused by sensory or other stimuli.

There are two types of sleep which occurs in stages during each night of normal sleep namely:

- Rapid eye movement sleep (REM): this occurs in episodes of about 5-30 minutes after about every 90 minutes. It is the type of sleep in which there is rapid movement of the eyes though the person is asleep. Certain changes occur during this type of sleep: irregular heart rate, irregular respiratory rate, depression of muscle tone, difficulty in arousal, dreams in this type of dream can be recalled or remembered vividly. Dreams in REM are associated with more bodily muscle activity. In this type of sleep, the brain is active thus it is known as paradoxical sleep.
- Slow – wave sleep: this sleep is referred to as deep sleep as it occur for about one hour after a long period of being awake. Although this is termed a dreamless sleep, dreams and nightmares usually occurs but cannot vividly be remembered because of consolidation of dreams in memory does not occur. It is a very restful sleep and is associated with decreased peripheral vascular tone and many other vegetative functions e.g. blood pressure, respiratory rate, basal metabolic rate.

Mechanism of sleep

Sleep is due to the activity of some sleep-inducing centers of the brain. Damage of sleep centers results in sleeplessness or persistent wakefulness – insomnia. These centers include:

- Raphe nuclei in the lower half of the pons and medulla: many fibers of these raphe neurons secrete serotonin.
- Stimulation of some areas in the nucleus of tractus solitaries can also cause sleep
- Stimulation of certain areas in the diencephalon e.g. the rostral part of the hypothalamus and diffuse nuclei of the thalamus.

Theories of sleep

i. Sleep I caused by an active inhibitory process below by a center below the midpontile level that causes sleep by inhibiting other centers of the brain.
ii. Repair and restoration theory of sleep: sleep is essential for revitalizing and restoring the physiological processes of the body. It also increase the rate of cell division and protein synthesis. Thus it performs housekeeping duties.
iii. Evolutionary theory of sleep; it is also known as the adaptive theory of sleep. It suggests that periods of activity and inactivity evolved as a means of conserving energy.
iv. Information consolidation theory of sleep: it is based on cognitive research and suggests that people sleep in order to process information that has been acquired during the day. It helps to cement things we have learnt into long-term memory.
v. The clean up theory of sleep: sleep allows the brain to clean itself up. Brain cleans itself of toxins and waste produced during the day while asleep.

Cycle of sleep and wakefulness

when the sleep centers are not activated, the mesenphalic and upper pontile reticular activating nuclei are released from inhibition which allows the reticular activating nuclei to become spontaneously active. This spontaneous activity in turn excites both the cerebral cortex and the peripheral nervous system both of which send numerous positive feedback signals to the same reticular activating nuclei to activate them further. Therefore once wakefulness begins, it has a natural tendency to sustain itself because of he positive feedback activity.

After the brain remains activated for many hours, even the neurons in the activating system presumably become fatigued. Consequently, the positive feedback cycle between the mesenphalic reticular nuclei and the cerebral cortex fades and the sleep-promoting effects of the sleep centers take over, leading to rapid transition from wakefulness back to sleep.

Important physiological effects of sleep

i. Nervous effect: lack of sleep does not affect the functions of the central nervous system. Prolonged wakefulness however affects or is associated with prolonged malfunction of the thought processes and sometimes cause abnormal behavioural activities.
ii. Neural maturation
iii. Facilitation of learning or memory
iv. Cognition
v. Clearance of metabolic waste products generated by neural activity in the awake brain
vi. Conservation of metabolic energy

Applied Physiology

i. Insomnia: inability to sleep or abnormal wakefulness
ii. Hypersomnia: excess need to sleep
iii. Narcolepsy and cataplexy: narcolepsy – sudden attack of uncontrollable sleep, cataplexy – sudden outburst of emotion
iv. Somnambulism: getting up from bed and walking in the state of sleep
v. Nocturnal enuresis: involuntary voiding of urine at bed,

2) Discuss the role of basal ganglia in coordinating movement

i. **Regulation of voluntary movements:** movements during voluntary motor activity are initiated by cerebral cortex. However, these movements are controlled by the basal ganglia, which are in close association with the cerebral cortex. During lesions of the basal ganglia, the control mechanism is lost and the movement become inaccurate and awkward . the basal ganglia is able to control the

activities because of the nervous (neuronal) circuits between the basal ganglia and other parts of the brain involved in motor activity. These circuits which arise from the cerebral cortex are from three areas which are:

- premotor area
- primary motor area
- supplementary motor area

all these nerve fibers from the cerebral cortex reach the caudate nucleus. From the caudate nucleus, it goes to the putamen however some fibers from the cerebral cortex move directly to the putamen. The putamen sends fibers to the globus pallidus. From the globus pallidus, fibers move to the thalamus, subthalmic nucleus of luys and substantia nigra. The subthalmic nucleus and the substantia nigra are in turn projected into the thalamus. Now the fibers from the thalamus are projected back into the primary motor area, premotor area and supplementary motor area.

ii. **Regulation of conscious movements:** fibers between the cerebral cortex and caudate nucleus are concerned with the regulation of conscious movements. This function of the basal ganglia is also known as the cognitive control of activity.

iii. **Regulation of subconscious movements:** cortical fibers reaching the putamen are directly concerned with the regulation of some subconscious movements which take place during trained motor activities e.g. writing the learnt alphabet, paper cutting, nail hammering.

iv. **Control of autonomic associated movements:** automatic associated movements are the movements in the body, which take place along with some motor activities. Examples are the swing of arms while walking, appropriate facial expressions while talking or doing any work. Basal ganglia are responsible for the automatic associated movements. Lesion in the basal ganglia causes absence of these automatic associated movements resulting in poverty of movements