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QUESTIONS

1. Discuss the physiology of sleep
2. Discuss the role of basal ganglia in coordinating movement

ANSWER 1

Sleep is a naturally recurring state of mind and body, characterized by altered consciousness, relatively inhibited sensory activity, reduced muscle activity and inhibition of nearly all voluntary muscles during rapid eye movement (REM) sleep, and reduced interactions with surroundings.It is distinguished from wakefulness by a decreased ability to react to stimuli, but more reactive than a coma or disorders of consciousness, with sleep displaying very different and active brain patterns. Sleep occurs in repeating periods, in which the body alternates between two distinct modes: REM sleep and non-REM sleep/slow-wave sleep or deep sleep. During sleep, most of the body's systems are in an anabolic state, helping to restore the immune, nervous, skeletal, and muscular systems; these are vital processes that maintain mood, memory, and cognitive function, and play a large role in the function of the endocrine and immune systems.The internal circadian clock promotes sleep daily at night.

**Slow wave sleep**

This sleep is exceedingly restful and is associated with decreases in both peripheral vascular tone and many other vegetative functions of the body. For instance, there are 10 to 30 percent decreases in blood pressure, respiratory rate, and basal metabolic rate. Although slow-wave sleep is frequently called "dreamless sleep," dreams and sometimes even nightmares do occur during slow-wave sleep. The difference between the dreams that occur in slowwave sleep and those that occur in REM sleep is that those of REM sleep are associated with more bodily muscle activity. Also, the dreams of slow-wave sleep are usually not remembered because consolidation of the dreams in memory does not occur.

**REM Sleep (Paradoxical Sleep, Desynchronized Sleep)**

REM sleep is a type of sleep in which the brain is quite active. However, the brain activity is not channeled in the proper direction for the person to be fully aware of his or her surroundings, andtherefore the person is truly asleep. In a normal night of sleep, bouts of REM sleep lasting 5 to 30 minutes usually appear on the average every 90 minutes. When the person is extremely sleepy, each bout of REM sleep is short and may even be absent. Conversely, as the person becomes more rested through the night, the durations of the REM bouts increase.

REM sleep has several important characteristics:

1. It is an active form of sleep usually associated with dreaming and active bodily muscle

movements.

2. The person is even more difficult to arouse by sensory stimuli than during deep slow-wave sleep,

and yet people usually awaken spontaneously in the morning during an episode of REM sleep.

3. Muscle tone throughout the body is exceedingly depressed, indicating strong inhibition of the

spinal muscle control areas.

4. Heart rate and respiratory rate usually become irregular, which is characteristic of the dream

state.

5. Despite the extreme inhibition of the peripheral muscles, irregular muscle movements do occur.

These are in addition to the rapid movements of the eyes.

6. The brain is highly active in REM sleep, and overall brain metabolism may be increased as much

as 20 percent. The electroencephalogram (EEG) shows a pattern of brain waves similar to those

that occur during wakefulness. This type of sleep is also called paradoxical sleep because it is a

paradox that a person can still be asleep despite marked activity in the brain.

**Neuronal Centers, Neurohumoral Substances, and Mechanisms That Can Cause Sleep**

1. The most conspicuous stimulation area for causing almost natural sleep is the raphe nuclei in the

lower half of the pons and in the medulla. These nuclei comprise a thin sheet of special neurons

located in the midline. Nerve fibers from these nuclei spread locally in the brain stem reticular

formation and also upward into the thalamus, hypothalamus, most areas of the limbic system, and

even the neocortex of the cerebrum. Many nerve endings of fibers from these raphe neurons secrete serotonin. When a drug that blocks the formation of serotonin is administered to an animal, the animal often cannot sleep for the next several days. Therefore, it has been assumed that

serotonin is a transmitter substance associated with production of sleep.

2. Stimulation of some areas in the nucleus of the tractus solitarius can also cause sleep. This

nucleus is the termination in the medulla and pons for visceral sensory signals entering by way of

the vagus and glossopharyngeal nerves.

3. Sleep can be promoted by stimulation of several regions in the diencephalon, including (1) the

rostral part of the hypothalamus, mainly in the suprachiasmal area, and (2) an occasional area in

the diffuse nuclei of the thalamus.

**Cycle between sleep and wakefulness**

When the sleep centers are not activated, the mesencephalic and upper pontile reticular activating nuclei are released from inhibition, which allows the reticular activating nuclei to become spontaneously active. This in turn excites both the cerebral cortex and the peripheral nervous system, both of which send numerous positive feedback signals back to the same reticular activating nuclei to activate them still further. Therefore, once wakefulness begins, it has a natural tendency to sustain itself because of all this positive feedback activity. Then, after the brain remains activated for many hours, even the neurons themselves in the activating system presumably become fatigued. Consequently, the positive feedback cycle between the mesencephalic 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.

**Sleep has been postulated to serve many functions including** ;(1) neural maturation, (2) facilitation of learning or memory, (3) cognition, and (4) conservation of metabolic energy.

Physiologic effect of sleep

Sleep causes two major types of physiologic effects: first, effects on the nervous system itself, and second, effects on other functional systems of the body. The nervous system effects seem to be by far the more important because any person who has a transected spinal cord in the neck (and therefore has no sleep-wakefulness cycle below the transection) shows no harmful effects in the body beneath the level of transection that can be attributed directly to a sleep-wakefulness cycle.

Lack of sleep certainly does, however, affect the functions of the central nervous system. Prolonged wakefulness is often associated with progressive malfunction of the thought processes and sometimes even causes abnormal behavioral activities. We are all familiar with the increased sluggishness of thought that occurs toward the end of a prolonged wakeful period, but in addition, a person can become irritable or even psychotic after forced wakefulness. Therefore, we can assume that sleep in multiple ways restores both normal levels of brain activity and normal "balance" among the different functions of the central nervous system.

**Sleep disorders**

1. Insomnia; a general term for difficulty falling asleep and/or staying asleep. Insomnia is the most common sleep problem, with many adults reporting occasional insomnia, and 10–15% reporting a chronic condition.Insomnia can have many different causes, including psychological stress, a poor sleep environment, an inconsistent sleep schedule, or excessive mental or physical stimulation in the hours before bedtime. Insomnia is often treated through behavioral changes like keeping a regular sleep schedule, avoiding stimulating or stressful activities before bedtime, and cutting down on stimulants such as caffeine.
2. Obstructive sleep apnea; a condition in which major pauses in breathing occur during sleep, disrupting the normal progression of sleep and often causing other more severe health problems. Apneas occur when the muscles around the patient's airway relax during sleep, causing the airway to collapse and block the intake of oxygen. Obstructive sleep apnea is more common than central sleep apnea. As oxygen levels in the blood drop, the patient then comes out of deep sleep in order to resume breathing. When several of these episodes occur per hour, sleep apnea rises to a level of seriousness that may require treatment.

Answer 2

The basal ganglia (or basal nuclei) are a group of subcortical nuclei, which are situated at the base of the forebrain and top of the midbrain. The basal ganglia are of major importance for normal brain function and behaviour. Their dysfunction results in a wide range of neurological conditions including disorders of behaviour control and movement, as well as cognitive deficits that are similar to those that result from damage to the prefrontal cortex.

**Movement coordinations by the basal ganglia**

Eye movements

One intensively studied function of the basal ganglia is its role in controlling eye movements.Eye movement is influenced by an extensive network of brain regions that converges on a midbrain area called the superior colliculus (SC). The SC is a layered structure whose layers form two-dimensional retinotopic maps of visual space. A "bump" of neural activity in the deep layers of the SC drives an eye movement directed toward the corresponding point in space. The SC receives a strong inhibitory projection from the basal ganglia, originating in the substantia nigra pars reticulata (SNr).

2. CONTROL OF MUSCLE TONE: Gamma motor neurons in the spinal cord are responsible for the development of muscle tone. But the basal ganglia decrease the muscle tone by inhibiting the gamma motor neurons in the spinal cord through descending reticular system in the brainstem. Lesion of the basal ganglia leads to muscle tone rigidity.

3. CONTROL OF MOTOR ACTIVITY: The basal ganglia regulate three things here:

• Voluntary movements

• Conscious movements

• Subconscious movements

• VOLUNTARY MOVEMENTS: They are initiated by the cerebral cortex but they are controlled by the basal ganglia which are closely associated with the cerebral cortex. They are able to control these movements due to its nervous circuits with other parts of the brain involved in motor activity. The nervous circuits arise from the 3 areas of the cerebral cortex:

 Premotor area

 Primary motor area

 Supplementary motor area

From the cerebral cortex, these nerve fibersare connected between the basal ganglia (caudate nucleus, putamen and globuspallidus), thalamus and back to the motor areas of the cerebral cortex. Lesions to the basal ganglia would result in awkward and inaccurate movements due to the loss of its control effect.

• CONSCIOUS MOVEMENTS: This is regulated by fibers between the caudate nucleus and cerebral cortex. This control is cognitive by the basal ganglia.

• SUBCONSCIOUS MOVEMENTS: This is regulated by fibers between the putamen and cerebral cortex. It takes place during trained motor activities e.g typing, writing etc.

4. CONTROL OF REFLEX MSUCULAR ACTIVITY: Basal ganglia controls and integrates impulses for reflex activities like the visual and labyrinthine reflexes. Lesions of the basal ganglia renders the reflexes abnormal due to rigidity. The rigidity is caused by the absence of inhibitory impulses from the cerebral cortex to the spinal cord via the basal ganglia.

5. CONTROL OF AUTOMATIC ASSOCIATED MOVEMENTS: These are movemnts that take place simultaneously with other motor activities. E.G, swinging the arms while walking.

**APPLIED PHYSIOLOGY**

1. PARKINSON’S DISEASE: This is a progressive degenerative disease of the nervous system that occurs due to the destruction of the dopamine-producing cells in the substantia nigra and nigro-striatal pathway of the basal ganglia. The destruction could be caused by viral infections, antihypertensive drugs etc.

SYMPTOMS: Tremor, rigidity, akinesia, postural instabilityetc.

2. CHOREA:Abnormal involuntary movement, RAPID JERKY MOVEMENT, caused by damage to the caudate nucleus and putamen.

3. ATHETOSIS: Slow, rhythmic, twisting movements caused by lesion to the caudate nucleus and putamen.