CNS
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Physiology

Modified (19)

Writer: Malak Alkhateeb

Corrector:

Doctor: Fatima Ryalat

We will first complete our talk about prefrontal cortex

- Recall: prefrontal association area is very important in deciding effective complex movement and planning for , also it’s critical for the elaboration of thoughts this is carried out upon reference to the working memory , so you can await the consequences of the motor plan to be performed and check whether these plans accord to moral laws ,this in turn improves the decision of appropriate motor action in the background of the current settings time and place , and ensures these cortical output to be in accord with the moral laws .
- Prefrontal Association area helps in future planning and performance of complex mathematical or legal problems in thinking processes.

Prefrontal association area

- Much of the output from the prefrontal area into the motor control system passes through the caudate portion of the basal ganglia–thalamic feedback circuit for motor planning, which provides many of the sequential and parallel components of movement stimulation.

- It is important for **elaboration of thoughts**, and it is said to store on a short-term basis “working memories” that are used to combine new thoughts while they are entering the brain.

Prefrontal association area

- studies in patients who had prefrontal lobotomy showed the following mental changes:
- 1. The patients lost their ability to solve complex problems.
- 2. They became unable to string together sequential tasks to reach complex goals.
- 3. They became unable to learn to do several parallel tasks at the same time.
- 4. Their level of aggressiveness decreased, sometimes markedly, and they often lost ambition.

Prefrontal association area

- 5. Their social responses were often inappropriate for the occasion, often including loss of morals and little reticence in relation to sexual activity and excretion.
- 6. The patients could still talk and comprehend language, but they were unable to carry through any long trains of thought, and their moods changed rapidly from sweetness to rage to exhilaration to madness.
- 7. The patients could also still perform most of the usual patterns of motor function that they had performed throughout life, but often without purpose.

Prefrontal association area

- By combining all these temporary bits of working memory, we have the abilities to do the following:
- (1) prognosticate; (2) plan for the future; (3) delay action in response to incoming sensory signals so that the sensory information can be weighed until the best course of response is decided; (4) consider the consequences of motor actions before they are performed; (5) solve complicated mathematical, legal, or philosophical problems; (6) correlate all avenues of information in diagnosing rare diseases; and (7) control our activities in accord with moral laws.

The dominant hemisphere

- The general interpretative functions, more specifically, these related to speech areas, such as Wernicke,s area , Broca's area and the angular gyrus, as well as the functions of the speech and motor control areas (rt vs lt handedness), are usually much **more highly developed in one cerebral hemisphere –as the name indicates-** than in the other. Therefore, this hemisphere is called the dominant hemisphere.
- In about 95% of all people, the left hemisphere is the dominant one, and in the remaining 5%, either both sides develop simultaneously to have active dual function or, more rarely, the right side alone becomes highly developed, with full dominance.

The dominant hemisphere

- Although **the interpretative areas** of the temporal lobe and angular gyrus, as well as many of the motor areas, are usually highly developed in only the left hemisphere, these areas **receive sensory information from both hemispheres and are also capable of controlling motor activities in both** hemispheres. For this purpose, they use mainly fiber pathways in the corpus callosum for communication between the two hemispheres.

The nondominant hemisphere

- studies in patients with damage to the nondominant hemisphere have suggested that this hemisphere may be especially important for understanding and interpreting music, nonverbal visual experiences (especially visual patterns), spatial relations between the person and their surrounding objects , the significance of “body language”, which adds a critical value on how we communicate and understand each other, and intonations of people’s voices, and probably many somatic experiences related to use of the limbs and hands.

Corpus callosum

- Fibers in the corpus callosum provide abundant bidirectional neural connections between most of the cortical areas of the two cerebral hemispheres, except for the anterior portions of the temporal lobes; these temporal areas, including especially the amygdala, are interconnected by fibers that pass through the anterior commissure.
- One of the functions of the corpus callosum and the anterior commissure is to make information stored in the cortex of one hemisphere available to corresponding cortical areas of the opposite hemisphere.

- the two halves of the brain have independent capabilities for consciousness, memory storage, communication, and control of motor activities.
- Therefore, the corpus callosum is **required for the two sides to operate cooperatively** at the superficial subconscious level, and the anterior commissure ,more specifically, plays an important additional role in **unifying the emotional responses** of the two sides of the brain.

Neurophysiology

Sleep and brain waves

Fatima Ryalat, MD, PhD

Sleep

- Sleep is defined as reversible state of unconsciousness from which a person can be aroused from by sensory or other stimuli.

Unlike coma which most likely will not be aroused .

- It is to be distinguished from coma, which is unconsciousness from which a person cannot be aroused.

- Sleep is divided into two types: rapid eye movement “REM” sleep and slow wave “non-REM” sleep

Sleep

- Each night, a person goes through different stages of these two types of sleep (the REM and the non-REM) , alternate with each other ,

- REM sleep occurs in episodes (bouts)of 5-30 minutes that occupy about 25% of the sleep time in young adults ,while the non-REM , slow wave sleep stages contribute dominantly to duration of the sleep , occupying three quadrants of it .

- each episode normally recurs about every 90 minutes.

REM (Paradoxical or Desynchronized) Sleep

- This type of sleep is not so restful, it is sort of an active sleep
- The length of a single REM bout during the sleep period increases along with the decrease of level of the general tiredness as sleeping time progresses .
- When a person is extremely sleepy, at the time they fall asleep , they are most tired (at the beginning of the sleep), it's then where each bout of REM sleep is very short and may even be absent.
- As the person becomes more rested through the night, the durations of the REM bouts increase.

REM Sleep

- REM sleep is a type of sleep in which the brain is quite active with a 20% increase in the metabolic rate However, the person is not fully aware of the surroundings , thus REM sleep is called paradoxical sleep.

- It is an active form of sleep usually associated with a state of dreaming , that's why there would be simultaneous rapid eye movement along with kind of thinking during this sleep associated maybe with involuntary movement in different muscles of the body , however , the muscle tone of the body is said to be depressed then .

- The overall brain metabolism may be increased as much as 20%.

REM Sleep

- The person is even more difficult to arouse by sensory stimuli from REM sleep than during deep slow-wave sleep, and yet people usually awaken spontaneously in the morning during an episode of REM sleep.

- Muscle tone throughout the body is exceedingly depressed, indicating strong inhibition of the spinal muscle control areas.

REM Sleep

- Despite the extreme inhibition of the peripheral muscles, irregular muscle movements do occur in addition to the rapid movements of the eyes.

- REM sleep is importantly associated usually with irregularities in the heart rate and respiratory rate , which is characteristic of the dream state.

REM Sleep

- An 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 the presence of marked activity in the brain.

Slow wave (NREM) sleep

The other type of sleep

- Most sleep during each night is of the slow-wave (NREM) variety, which is the deep, restful sleep that the person experiences during the night, especially in the first hour of sleep after having been awake for many hours.

Slow Wave Sleep

- This sleep is associated with decreases in peripheral vascular tone , blood pressure , respiratory rate , metabolism and many other vegetative functions of the body.
- For example, 10% to 30% decreases occur in blood pressure, respiratory rate, and basal metabolic rate.

- Although slow-wave sleep is frequently called “dreamless sleep,”however ,this type of sleep is also associated with un-remembered dreams and sometimes even nightmares that do occur during slow-wave sleep

Slow Wave Sleep

- The difference between the dreams that occur in slow-wave sleep and those that occur in REM sleep is that those of REM sleep are associated with more bodily muscle activity.
- So the NREM sleep is less associated with muscle activity .

- Also, the dreams of slow-wave sleep are usually not remembered because consolidation of the dreams in memory does not occur.

- Sleep in general is not well understood yet , there are so many theories trying to explain it , but none yet has explained the whole mechanism precisely , or described the exact importance or physiologic functions of sleep.
- Many nuclei play major role in the sleeping , such as the Raphi , Reticular ,some hypothalamic nuclei , nucleus tractus solitaries .
- Sleep is an important, neurotransmitter- mediated state.

Brain waves

- Electrical recordings from the outer surface of the head , called Electro-encephalography EEG demonstrate that there is continuous electrical activity in the brain , represented in the graph as waves of different intensity and pattern .

- Both the intensity and the patterns of this electrical activity are determined by the level of excitation of different parts of the brain in various states , for example the electrical activity in the state of wakefulness compared to sleep state compared to certain diseases - such as highly excited seizures - will be recorded by distinct waves .

- In healthy people, most waves in the EEG can be classified as alpha, beta, theta, and delta waves.

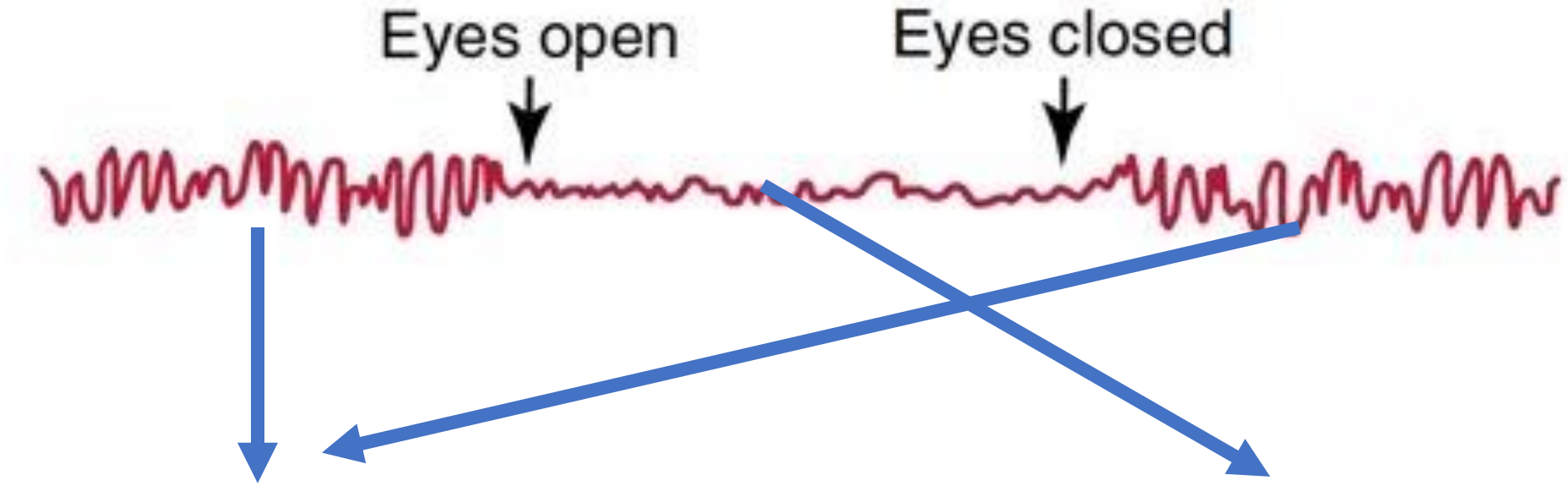
Brain waves

- The discharge of a single neuron or single nerve fiber in the brain can never be recorded from the surface of the head.

- Instead, many thousands or even millions of neurons or fibers must fire synchronously , that it's possible for the potentials from these individual neurons or fibers to summate enough to be recorded through the skull as EEG waves.

Brain waves

- EEG waves reflect only the net-summated potential fired by group of neurons acting synchronously (simultaneously) at the point of record, thus , the intensity of the recorded brain waves from the scalp is determined mainly by the numbers of neurons and fibers that fire in synchrony, with one another, the greater the number of firing neurons , the greater is their instantaneous net-summated potential , and finally the higher in amplitude–intensity is the wave of their recorded activity, not the total level of electrical activity performed by groups of neurons acting a-synchronously on separate points of record in the brain .
- In fact, strong nonsynchronous nerve signals often nullify one another in the recorded brain waves because of opposing polarities.

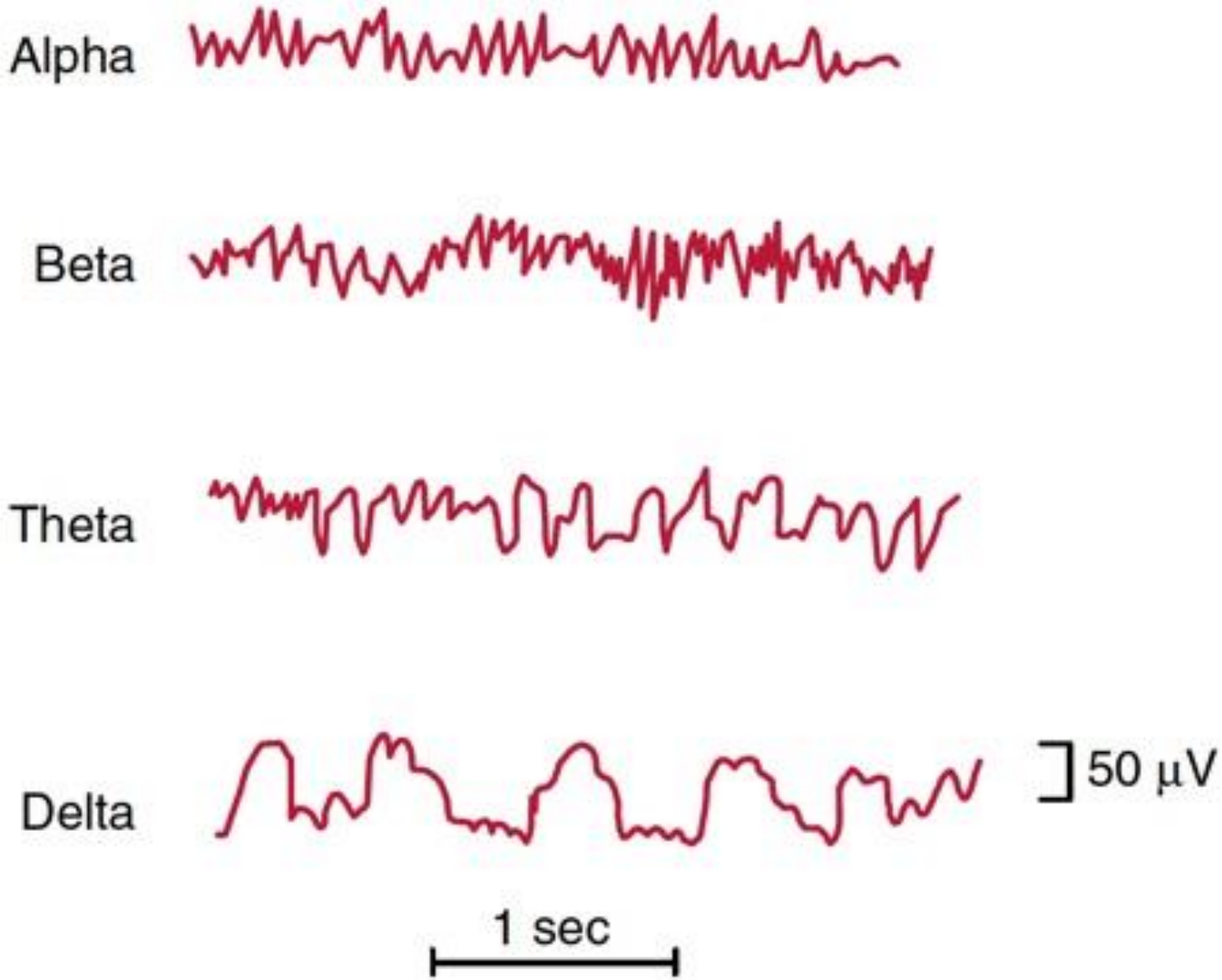


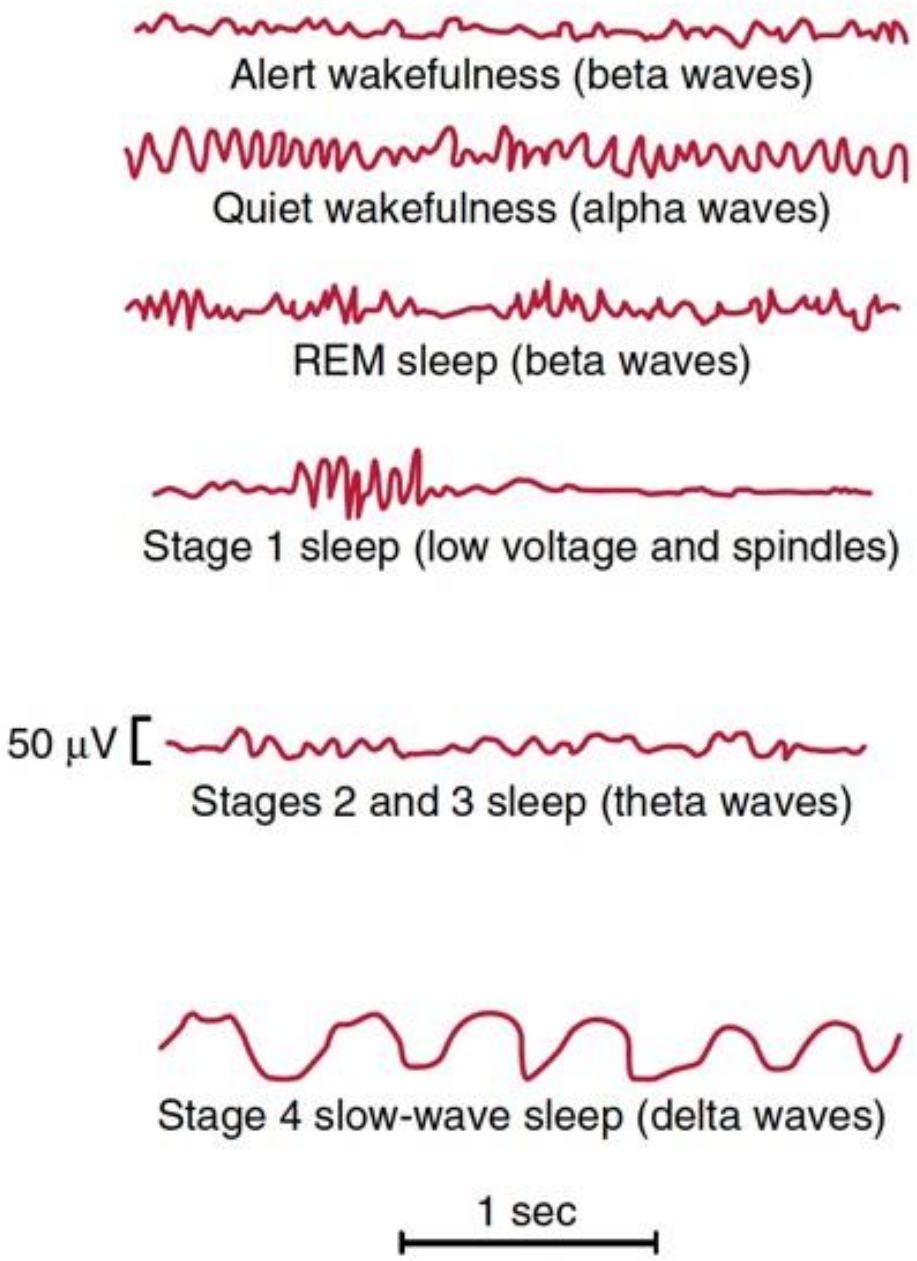
In the setting of closed eyes , each point of record is gonna encounter adequate synchronously-acting neuronal group with a net potential intense enough to record the electrical activity in the form of an alpha wave . Subsequent points record a series of alpha waves , the intensity of each alpha wave correlates with number of instantaneous synchronously –acting neuronal group

In the setting of opened eyes , despite the increase in the total level of electrical activity in the brain to integrate the visual inputs , however , this activity comes to exist in an a-synchronous pattern ,tiny neuronal groups are found to fire in synchrony, therefore , less intense beta waves are recorded.
A- synchronization will kind of nullify firing.

The electrical recording reflect the degree of synchronization not the total degree of activity of the neurons.

In young adults brain waves are device mainly into four types , alpha, beta, theta and delta





- Adjacent graph shows the typical EEG patterns of different stages of wakefulness and sleep, for example alpha waves associate quiet wakefulness.
- Whereas during alert wakefulness alpha waves are converted and beta waves are recorded because of the a-synchronization in the electrical activity. This is very similar to REM paradoxic sleep characterized by active wakefulness, but the person is not aware about the surroundings , as a-synchronized reactivity approaches, lower-voltage waves are recorded.
- Stage 1 of deep sleep is characterized by spikes or spindles of alpha-like waves followed by large prolonged stage of decreased voltage due to desynchrony in activity.
- Stages 2,3,4 of deep sleep show decrease in the frequency of the recorded waves (example is typical delta waves)

Alpha waves

- Alpha waves are rhythmical waves that occur at frequencies between 8 and 13 cycles/sec and are found in the EEGs of almost all healthy adults when they are awake and in a quiet, resting state of cerebration, once there is deep sleep , these alpha waves will disappear.
- These waves occur most intensely in the occipital region but can also be recorded from the parietal and frontal regions of the scalp.
- Their voltage is usually about 50 microvolts.
- During deep sleep, the alpha waves disappear.
- Upon specific mental activities especially in the occipital lobe, as the previous example of integrating visual field when eyes are opened, these alpha waves will be converted into beta waves , beta waves are of lower voltage.

Alpha waves

- alpha waves are thought to result from spontaneous feedback oscillation in this diffuse thalamocortical system, possibly including the reticular activating system in the brain stem as well.

Beta waves

- When the awake person's attention is directed to some specific type of mental activity, the alpha waves are replaced by asynchronous, higher frequency but lower voltage beta waves.
- Beta waves occur at frequencies greater than 14 cycles/sec and as high as 80 cycles/sec.
- They are recorded mainly from the parietal and frontal regions during specific activation of these parts of the brain.

Theta waves

- Theta waves are present in children, but also in person with strong emotional stress: frustration, disappointment, etc.
- Theta waves have frequencies between four and 7 cycles/sec.
- They occur normally in the parietal and temporal regions in children, but they also occur during emotional stress in some adults, particularly during disappointment and frustration.
- Theta waves also occur in many brain disorders, often in degenerative brain states.

Delta waves

- Delta waves include all the waves of the EEG with frequencies less than 3.5 cycles/sec, and they often have voltages two to four times greater than most other types of brain waves.
- They occur mainly in very deep sleep, in infancy, and in persons with serious organic brain disease.
- Therefore, delta waves can occur strictly in the cortex independent of activities in lower regions of the brain.

Delta waves

- some synchronizing mechanism can occur in the cortical neuronal system by itself—mainly independent of lower structures in the brain—to cause the delta waves.

- Delta waves also occur during deep slow-wave sleep, which suggests that the cortex then is mainly released from the activating influences of the thalamus and other lower centers.

Epilepsy

- Seizures are temporary disruptions of brain function caused by uncontrolled excessive neuronal activity.

- Treatable seizures are those of known cause and underlying mechanism , possible mechanisms include electrolyte imbalance, hypoglycemia and reactions of certain drugs, or maybe infections.

- epilepsy is a chronic condition of recurrent seizures that can also vary by wide range of presentation from nearly undetectable temporary symptoms to periods of vigorous convulsions.
- Epilepsy is not a single disease.
- Its clinical symptoms are heterogeneous and reflect multiple underlying pathophysiological mechanisms.

Epilepsy

- Epileptic seizures can be classified into two major types:
- (1) focal seizures (partial seizures) that are limited(localized)to a focal area of one cerebral hemisphere.
- (2) generalized seizures that diffusely involve both hemispheres of the cerebral cortex.

Focal seizures

- Focal seizures in general can result from localized causes , such as scarring in the tissue of the brain, or maybe tumor compressing on that part of the brain .
- Focal seizures are often classified as simple partial seizures when there is no major change in consciousness or as complex partial seizures when consciousness is impaired.
- Simple partial seizures may be preceded by an aura (kind of sensation , fear , etc)
- Complex partial seizures may also begin with an aura followed by impaired consciousness and strange repetitive movements.
- The time after the seizure, prior to the return of normal neurological function, is called the postictal period.

Generalized seizures

- Generalized epileptic seizures are characterized by diffuse, excessive, and uncontrolled neuronal discharges that at the outset spread rapidly and simultaneously to both cerebral hemispheres through interconnections between the thalamus and cortex.

The first type of generalized seizures

Generalized tonic-clonic seizures

- Generalized tonic-clonic seizures, previously called grand mal seizures, are characterized by an abrupt onset of loss of consciousness and extreme neuronal discharges in all areas of the brain—the cerebral cortex, the deeper parts of the cerebrum, and even the brain stem , this gives rise to neurological symptoms mainly tonic seizures.
- Also, discharges transmitted all the way into the spinal cord sometimes cause generalized tonic seizures of the entire body increasing the generalized tone of the body, followed toward the end of the attack by alternating tonic and spasmodic muscle contractions called tonic-clonic seizures.

Generalized tonic-clonic seizures

- Often the person bites or “swallows” his or her tongue and may have difficulty breathing, sometimes to the extent that cyanosis occurs, so patients must be protected from such complications.
- Also, signals transmitted from the brain to the viscera frequently cause urination and defecation.
- The usual generalized tonic-clonic seizure lasts from a few seconds to 3 to 4 to 5 minutes.
- It is also characterized by post-seizure (postictal) state of generalized depression of the entire nervous system.
- After generalized tonic-clonic seizures, patients seek sleep and to get more rest.

Generalized tonic-clonic seizures

- The majority of generalized seizures are idiopathic, which means that the cause is unknown.
- factors that can increase the excitability of the abnormal “epileptogenic” circuitry enough to precipitate attacks include (1) strong emotional stimuli, (2) alkalosis caused by over-breathing, (3) drugs, (4) fever, and (5) loud noises or flashing lights.(increase in the visual or auditory sensation)

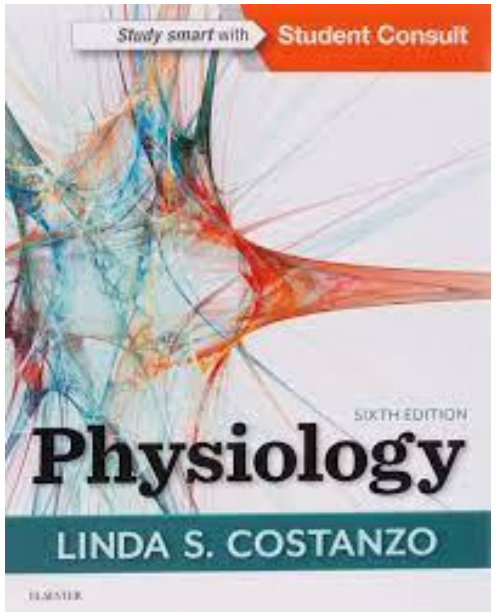
The other type of generalized seizures

Absence seizures

- Absence seizures, formerly called petit mal seizures, usually begin in childhood or early adolescence
- Absence seizures almost certainly involve the thalamocortical brain activating system.
- They are usually characterized by 3 to 30 seconds of unconsciousness or diminished consciousness, with certain types of twitch-like contraction, during which time the person often stares and has twitch-like contractions of muscles, usually in the head region, especially blinking of the eyes; for few seconds, this phase is followed by a rapid return of consciousness and resumption of previous , normal activities.
- This type of seizures requires fine observation of pediatrician , the family, to notice carefully this kind of symptoms and refer to neurologist.

Thank you

References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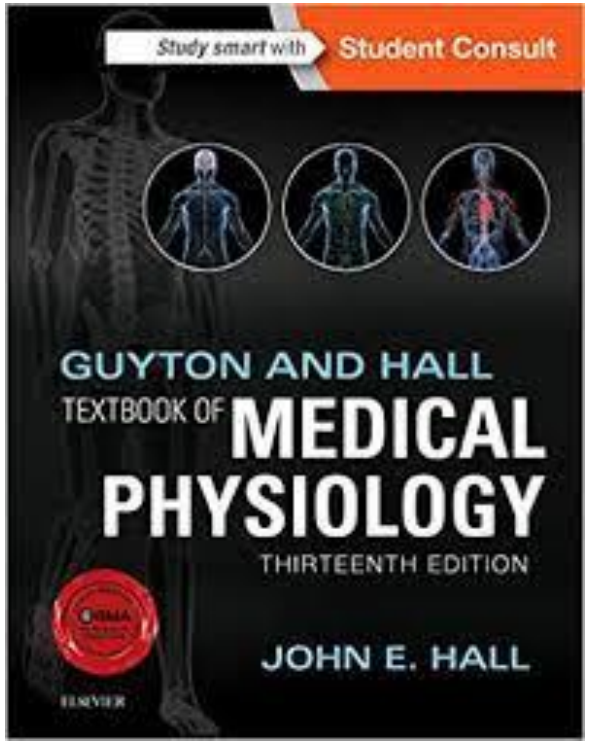
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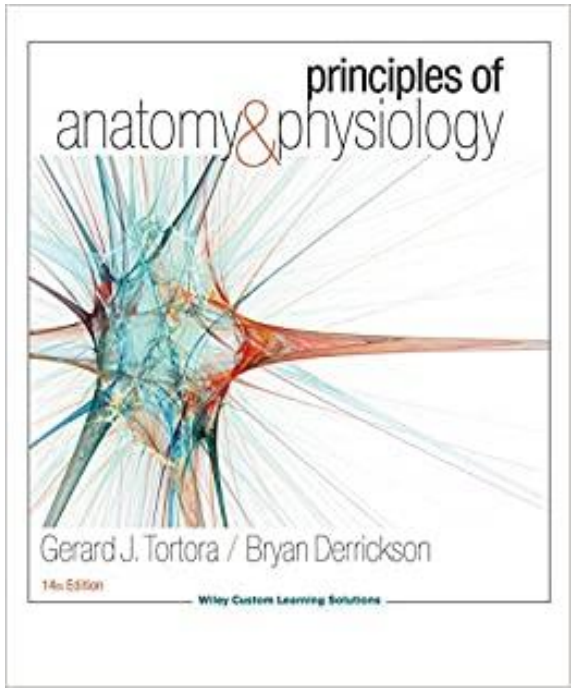
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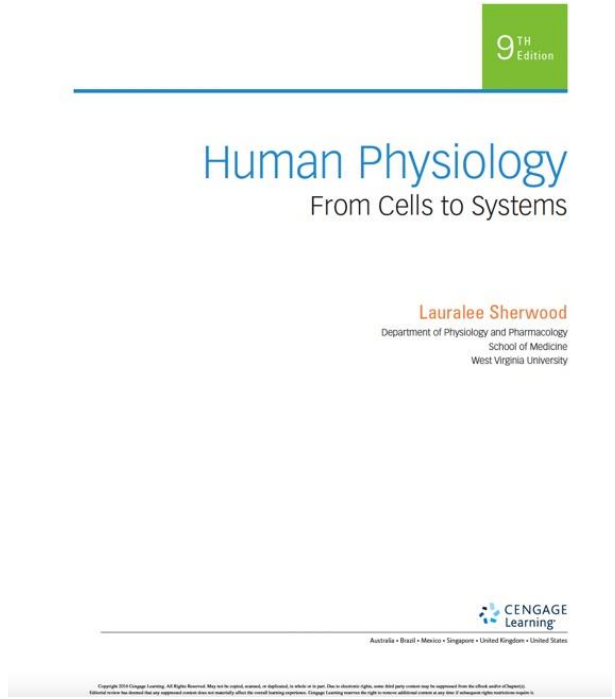
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