CNS
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Physiology

Modified (17)

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Neurophysiology

Behavior, motivation and emotions

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Activating the brain

- Without continuous transmission of nerve signals from the lower brain(mainly from reticular formation) into the cerebrum, the cerebrum becomes useless.(If any cut happen between them ,that will result in coma) .
- Nerve signals in the brain stem activate the cerebrum in two ways:
- (1) first one:by directly stimulating a background level of neuronal activity in wide areas of the brain.
- (2) second one :by activating neurohormonal systems that release specific facilitory or inhibitory hormone-like neurotransmitters into selected areas of the brain.

(1) The first type of signaling that will stimulate the cerebrum directly through neuronal pathway :

-The reticular formation found all over the brainstem and upper part of spinal cord as well as the lower part of diencephalon ,it plays an important role in consciousness (switch pattern in awakness).

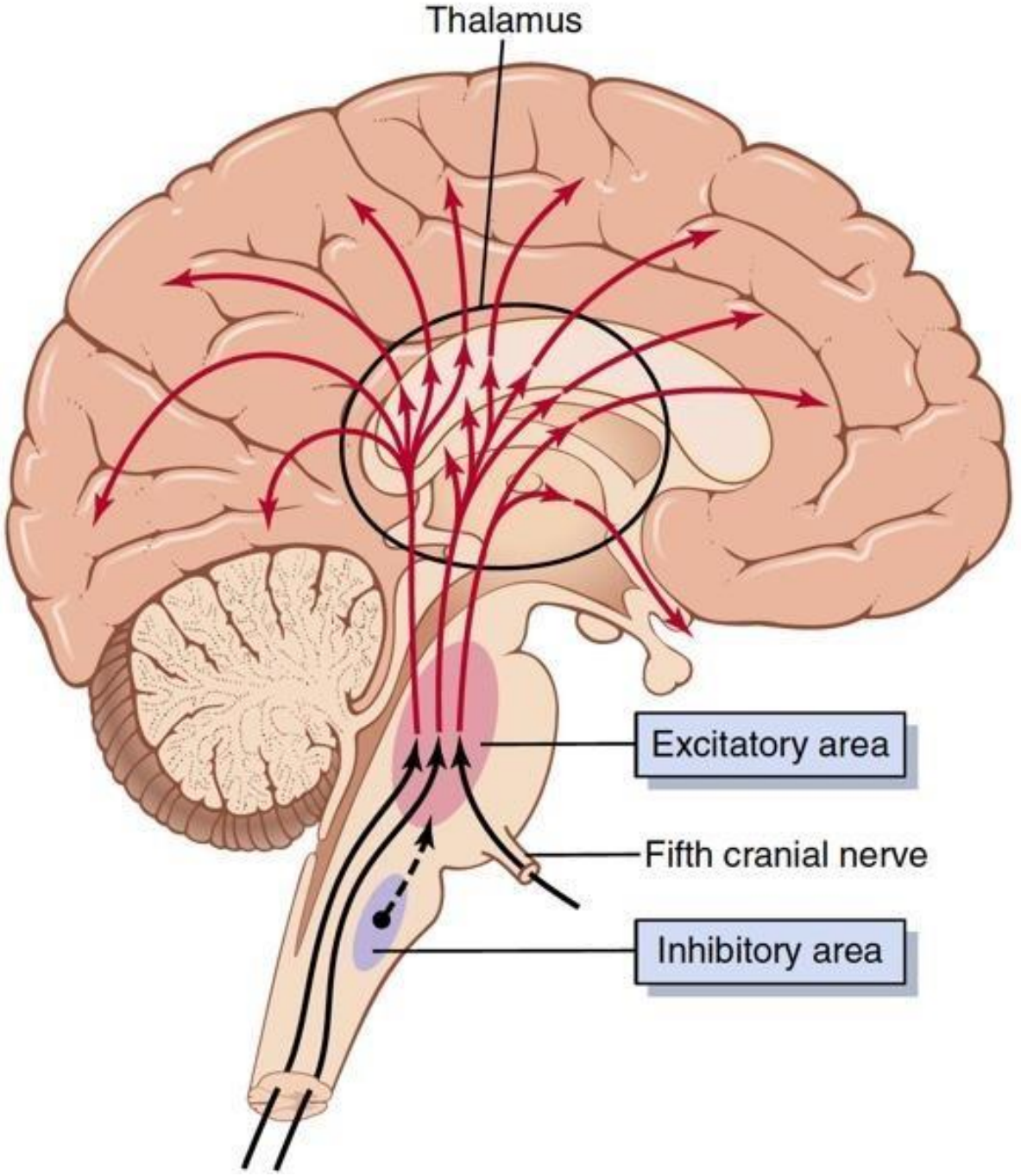
-It is called reticular formation because there is kind of integration between the wight and gray matter (they didn’t separate from each other).

-neuronal pathway come from Gigantocellular cells in the excitatory area of the reticular formation passing from the thalamus to widespread areas in the cerebral cortex (these excitatory neurons release Acetylcholine).

-the excitatory area in the reticular formation to send these excitatory neurons needs to be excited first by sensory signals from the periphery ,and the most sensory modality that stimulate this area is pain (you can't sleep with pain),the sensory modality that can't reach and stimulate this area is olfaction .

But why in movies they wake someone dizzy using onion or alcohol?

Actually, here the intense stimulus stimulates the pain receptors rather than olfactory receptors.



-So when the reticular stimulatory area get stimulated by sensory signals ,the excitatory neurons will arise from it, then they pass through thalamus ,each area in the thalamus will transmits signals to a specific area in the cerebral cortex .

-Then the stimulated cortical area send positive feedback signals to the reticular excitatory area to increase the stimulation again.
Just like when you are studying a physio lecture and try to understand (the stimulated cortical area of thought will send positive feedback signals to the reticular excitatory area to be more attentive).

-The excitatory area controlled by reticular inhibitory area by stimulation a serotonergic neurons (serotonin is inhibitory neurotransmitters) to inhibit the signals .

NOW, after you scanned the complete story , you can read the rest related slides to emphasize your information.

Reticular formation

- The central driving component is an excitatory area located in the reticular substance of the pons and mesencephalon. This area is also called the bulboreticular facilitory area.

- Most of the signals go first to the thalamus, where they excite a different set of neurons that transmit nerve signals to all regions of the cerebral cortex, as well as to multiple subcortical areas.

Reticular formation

- The level of activity of the reticular excitatory area in the brain stem, and therefore the level of activity of the entire brain, is determined to a great extent by the number and type of sensory signals that enter the brain from the periphery.

- Pain signals in particular increase activity in this excitatory area and therefore strongly excite the brain to attention.

Reticular formation

- feedback signals also return from the cerebral cortex back to this same area.
- Therefore, any time the cerebral cortex becomes activated by brain thought processes or by motor processes, signals are sent from the cortex to the brain stem excitatory area, which in turn sends still more excitatory signals to the cortex.
- This process helps to maintain the level of excitation of the cerebral cortex or even to enhance it.

Thalamus

- almost every area of the cerebral cortex connects with its own highly specific area in the thalamus.
- Therefore, electrical stimulation of a specific point in the thalamus generally activates its own specific small region of the cortex.
- Furthermore, signals regularly reverberate back and forth between the thalamus and the cerebral cortex

Reticular formation

- The reticular inhibitory area can inhibit the reticular facilitory area of the upper brain stem and thereby decrease activity in the superior portions of the brain.

- One of the mechanisms for this activity is to excite serotonergic neurons, which in turn secrete the inhibitory serotonin at crucial points in the brain.

Neurohormonal control of brain activity

(2) the second type of signaling that will stimulate the cerebrum is neurohormonal pathway :

- Often persist for minutes or hours and thereby provide long periods of control.

- These systems have different effects on levels of excitability in different parts of the brain.

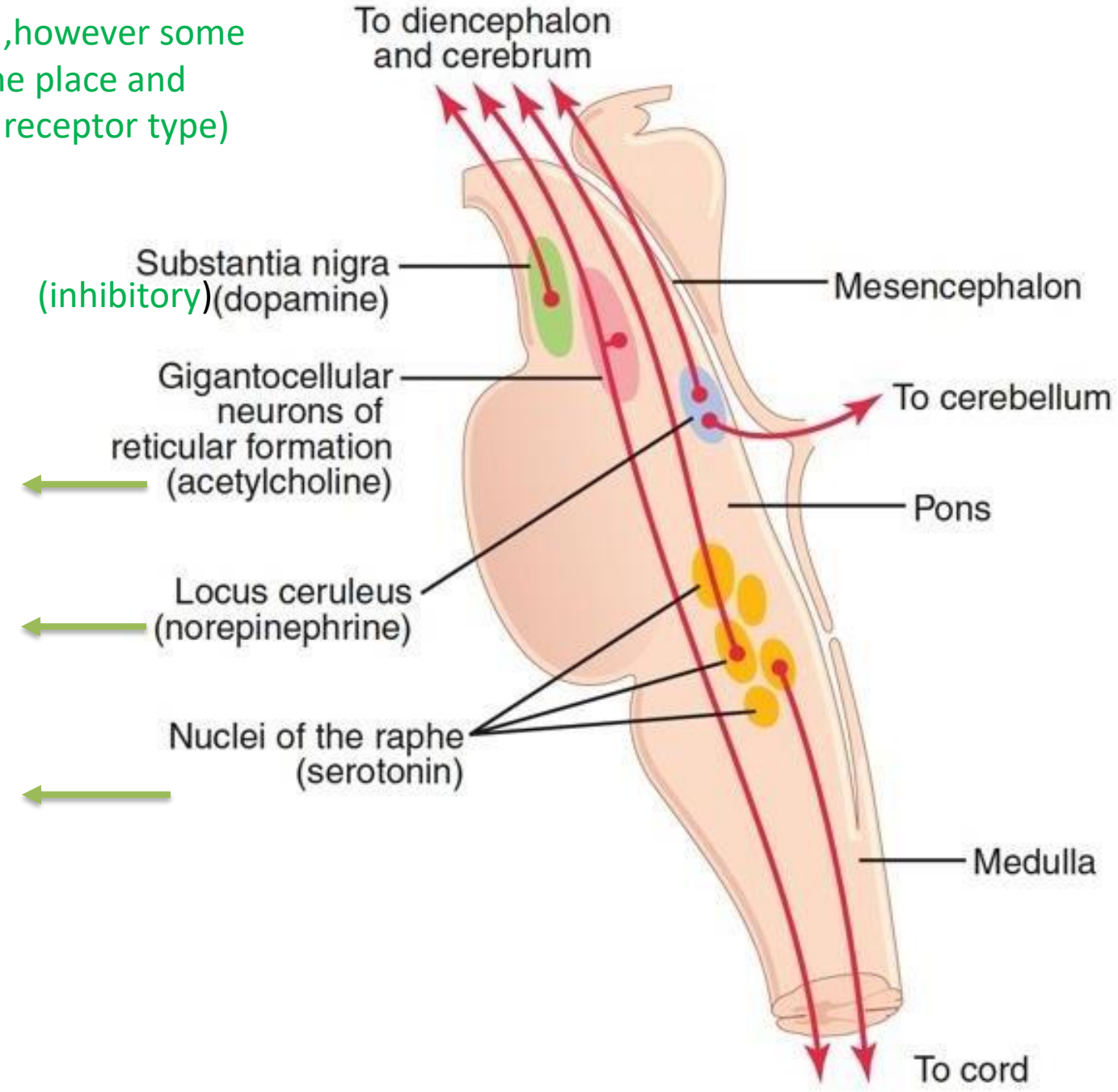
- there are multiple neurohormonal systems in the brain, the activation of each of which plays its own role in controlling a different quality of brain function.

- There are many neurotransmitters that release from different nuclei ,they can be excitatory or inhibitory ,however some neurotransmitters can be stimulatory in one place and inhibitory in another one (depends on the receptor type)
- Here some examples :

Mainly excitatory
and result in wakefulness

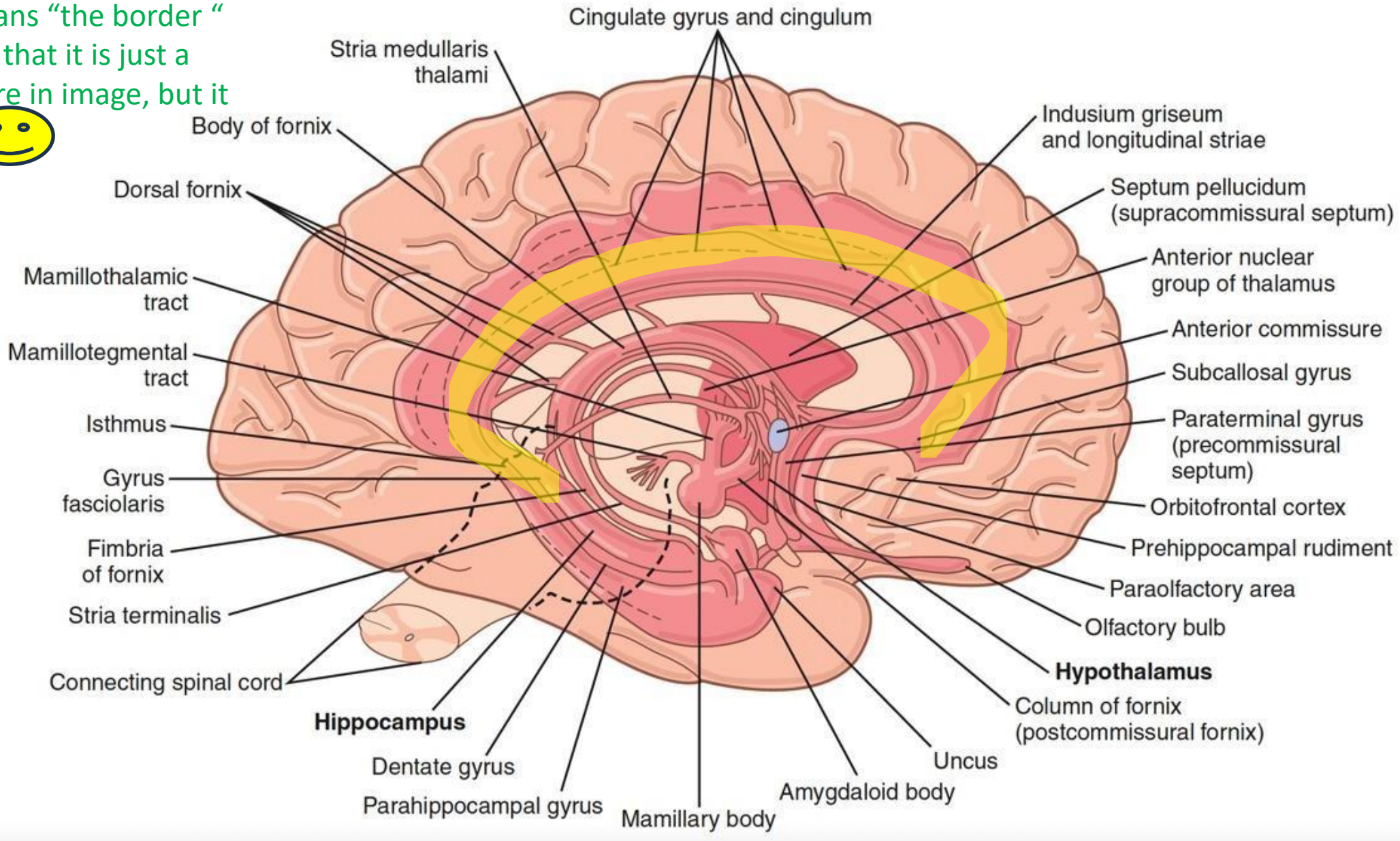
Mainly excitatory
dreaming

Mainly inhibitory
Suppress pain
Sleep



Let's talk about limbic system :

- Limbic system ,it means “the border “ because they thought that it is just a highlighted border here in image, but it is more than this .



Limbic system

The limbic system is :

- The entire neuronal circuitry that controls emotional behavior and motivational drives.
- they are an interconnected complex of basal brain elements.
- Located in the middle of all these structures is the extremely small hypothalamus.

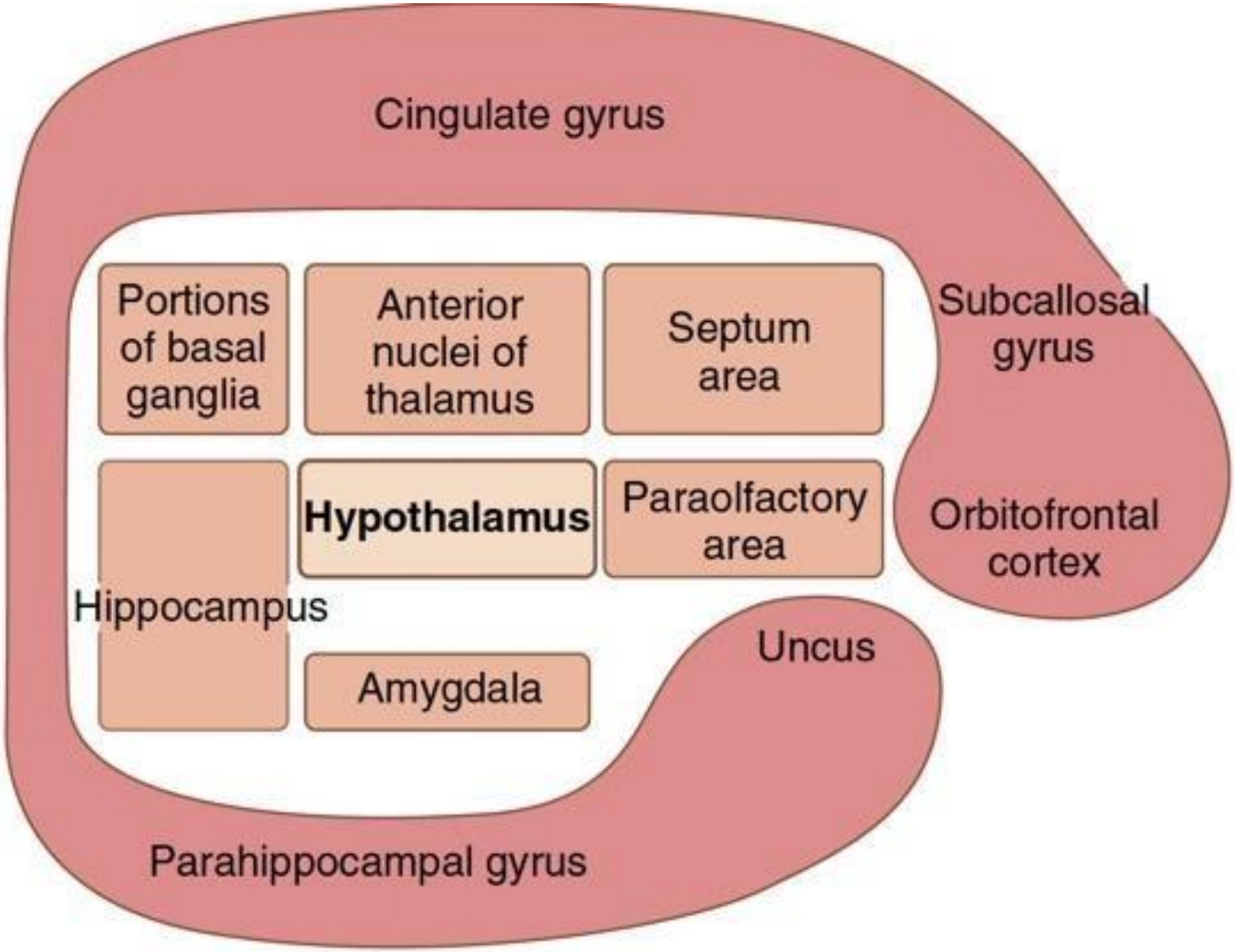
So any thing related to emotions , behavior or motivation will be related to these structures that are part of limbic system.

- the ring of limbic cortex functions as a two-way communication and association linkage between the neocortex and the lower limbic structures.

-The pink part is a limbic cortex (it is communicating part between the neocortex and subcortical area)

-the hypothalamus is the most important part because it has many connections with other parts .

The parts of limbic system :



Limbic system

- Many of the behavioral functions elicited from the hypothalamus and other limbic structures are also mediated through the reticular nuclei in the brain stem and their associated nuclei.

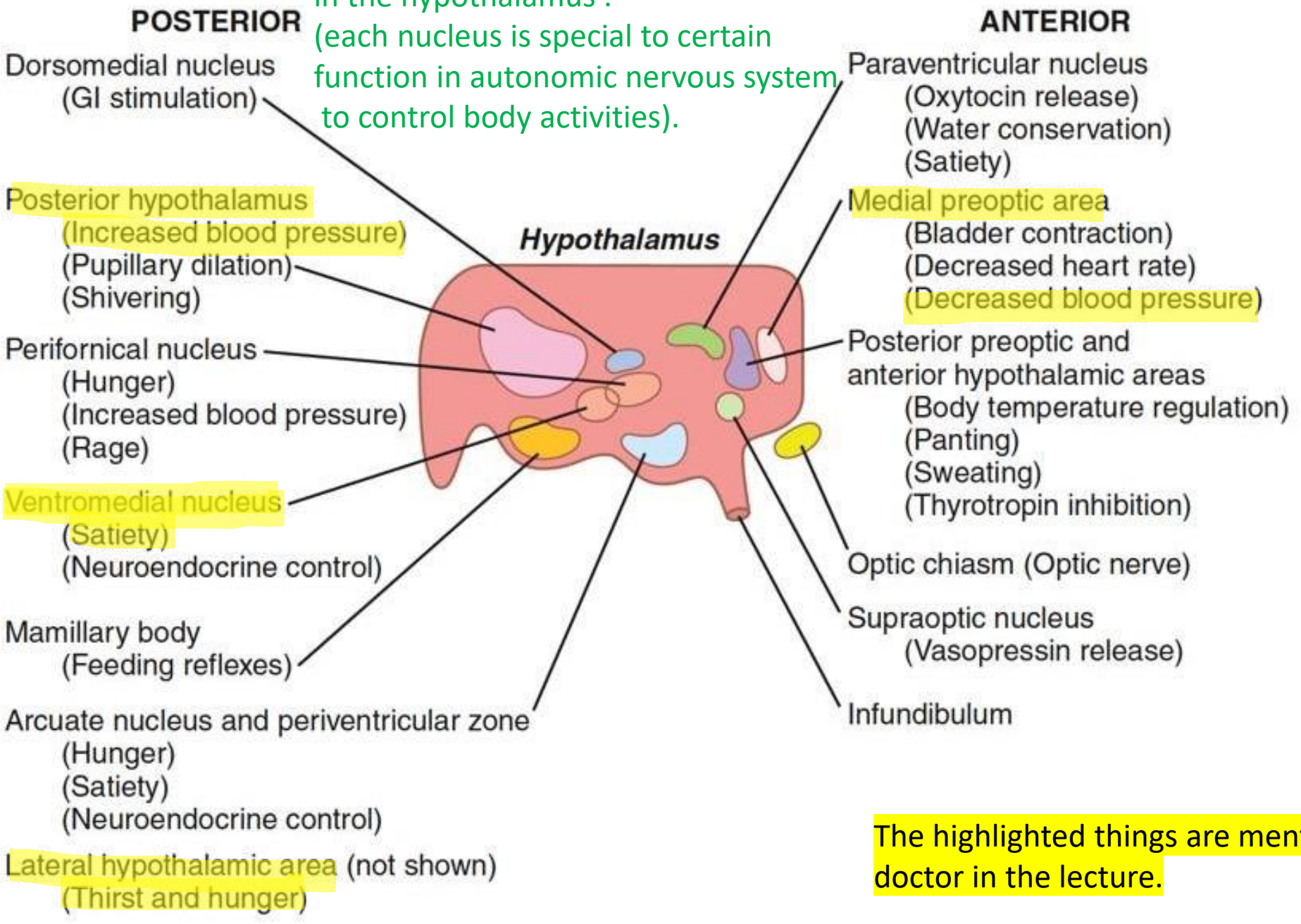
The Hypothalamus

- It controls most of the vegetative and endocrine functions of the body and many aspects of emotional behavior. (Have autonomic control)

- the hypothalamus sends output signals in three directions:

1. Reticular areas in the brain stem.
2. Anterior thalamus and limbic portions of the cerebral cortex.
3. Pituitary glands. (It controls anterior and posterior parts of pituitary glands in different ways)

This is a representation of different nuclei in the hypothalamus .
(each nucleus is special to certain function in autonomic nervous system to control body activities).



tranquility

Rage

The highlighted things are mentioned by doctor in the lecture.

-What is the correlation between the hypothalamus functions and the limbic system ?
They see when stimulate for example lateral hypothalamic area this will induce thirst and hunger sensations and these sensations are associated with rage behavior (they found the affective part of sensation)
On the other hand , when the ventromedial nucleus get stimulated which cause satiety then the person become quait and peaceful.

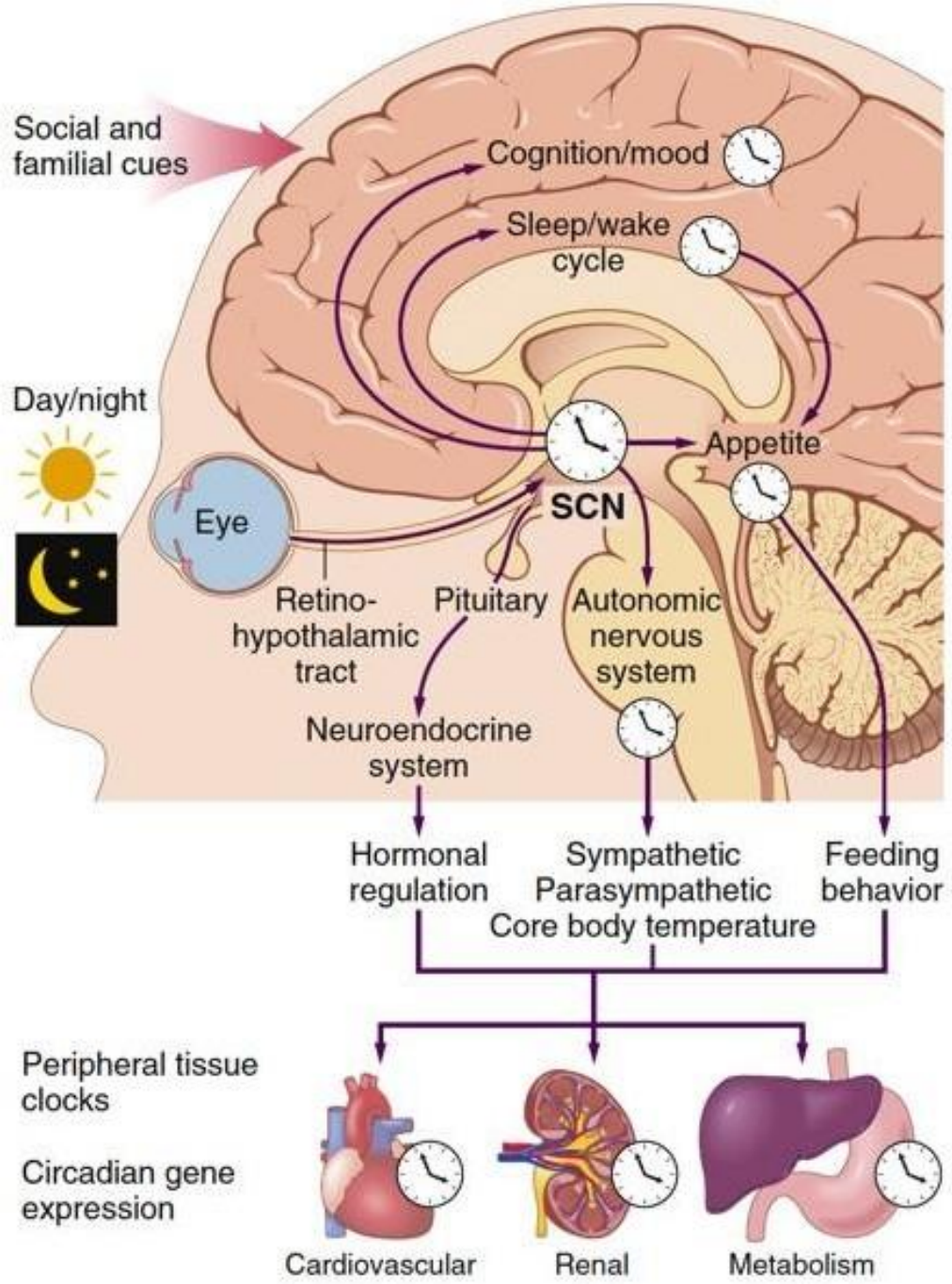
-to get it in simpler way just compare your situation before and after الفطور in Ramadan .

The Hypothalamus

One of the functions of the hypothalamus is controlling the circadian rhythm

- The suprachiasmatic nucleus (SCN) of the hypothalamus contains about 20,000 neurons and is located above the optic chiasm.
- biological clocks are found in nearly every tissue and organ of the body and capable of maintaining their own circadian rhythms, although their circadian rhythms are usually maintained for only a few days in the absence of signals from the SCN. We need the biological clocks to regulate different body functions.

SCN get stimulated by input come from retina in the eyes (from special ganglionic cells that have melanopsin pigment and they can sense the light and transmit signals to SCN through retinohypothalamic tract).



The Hypothalamus

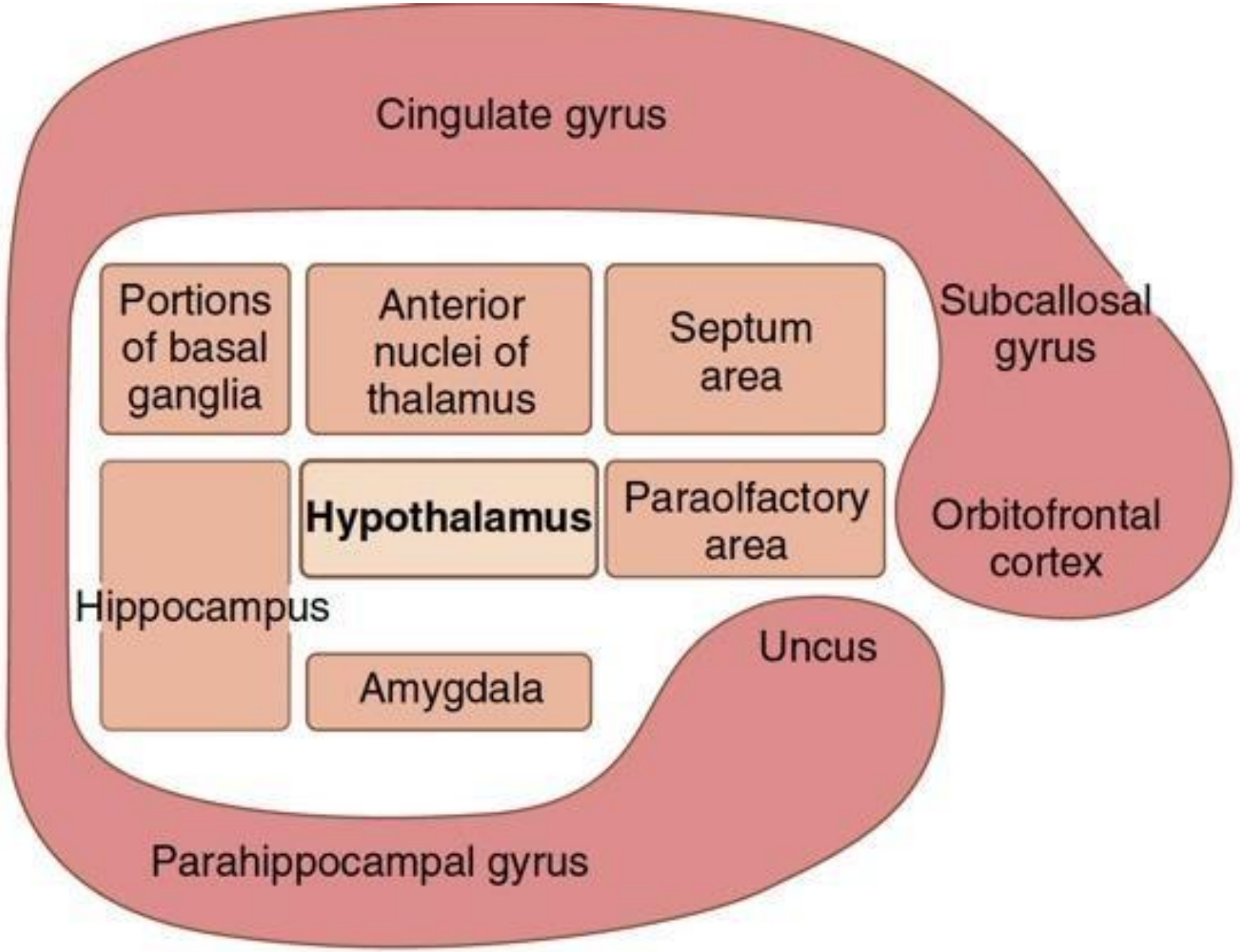
- Although the circadian rhythms of the SCN are endogenous and self-sustained, they are altered by environmental changes such as temperature and timing of the light-dark cycle.

  -Like people who travel a lot and have problems with sleep ,they give them melatonin (melatonin normally come from pineal gland) .

Reward or punishment

- Several limbic structures are particularly concerned with the affective nature of sensory sensations—that is, whether the sensations are pleasant or unpleasant.
- These affective qualities are also called reward or punishment, or satisfaction or aversion.

Because the limbic system is related to emotions and behaviors ,it has punishment & reward centers
Ex: areas in the hippocampus ,amygdala, hypothalamus (some nuclei in it).



Punishment centers

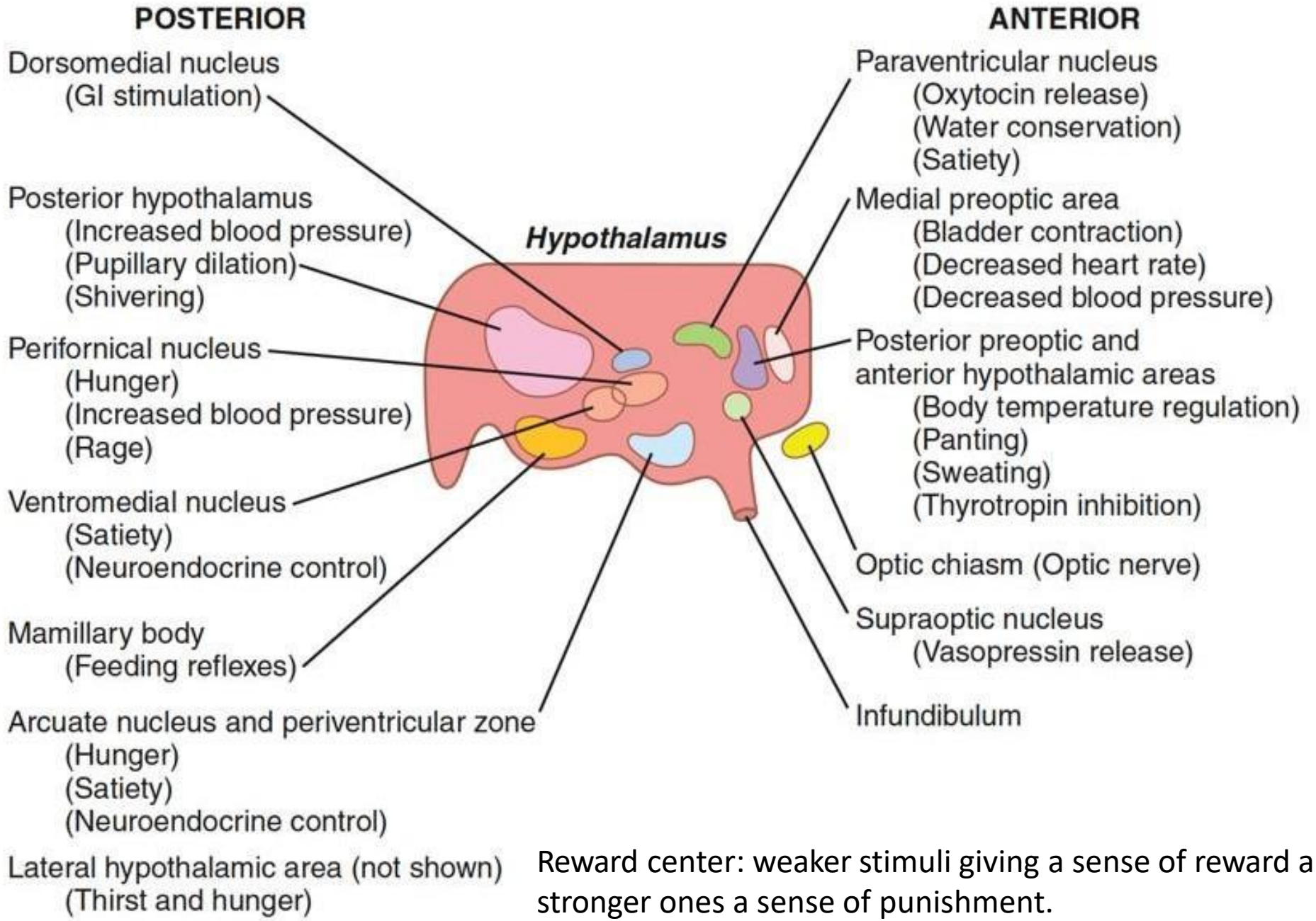
- Aquiduct of Sylvius.
- Periventricular area of hypothalamus.
- Less potent punishment areas are found in some locations in the amygdala and hippocampus.
- It is particularly interesting that stimulation in the punishment centers can frequently inhibit the reward and pleasure centers completely, demonstrating that punishment and fear can take precedence over pleasure and reward.

-That means ,if the punishment and reward centers both get stimulated ,the punishment centers will override the reward ones and that makes sense (like when you have good and bad news you will تنكد absolutely)

Punishment centers

- An emotional pattern that involves the punishment centers of the hypothalamus and other limbic structures and that has also been well characterized is the rage pattern.

- Normally, the rage phenomenon is held in check (الحمدلله)mainly by inhibitory signals from the ventromedial nuclei of the hypothalamus. In addition, portions of the hippocampi and anterior limbic cortex, help suppress the rage phenomenon.



tranquility

Rage

Reward center: weaker stimuli giving a sense of reward and stronger ones a sense of punishment.

Reward centers

- Exactly the opposite emotional behavior patterns occur when the reward centers are stimulated: placidity and tameness.

Reward and punishment

- Almost everything that we do is related in some way to reward and punishment.
- If we are doing something that is rewarding, we continue to do it; if it is punishing, we cease to do it.
- Therefore, the reward and punishment centers undoubtedly constitute one of the most important of all the controllers of our bodily activities, our drives, our aversions, and our motivations.

Role of reward and punishment in learning and memory

- Animal experiments have shown that a sensory experience that causes neither reward nor punishment is hardly remembered at all. For ex if you want to memorized something ,try to link it with a reward or punishment thing.

- Electrical recordings from the brain show that a newly experienced sensory stimulus almost always excites multiple areas in the cerebral cortex.

So the reward or punishment association is very important in memory or learning a new skills.

Habituation

- However, if the sensory experience does not elicit a sense of either reward or punishment, repetition of the stimulus over and over leads to almost complete extinction of the cerebral cortical response—that is, the animal becomes habituated to that specific sensory stimulus and thereafter ignores it.

-If any sensory signal doesn’t relate to either punishment or reward ,the CNS after will decrease the response to the same stimulus ,even if we repeat this stimulus (the CNS will ignore it).

-Like when you are focusing in the lecture with doctor to catch any information about exam ,your visual field just focuses with doctor (you aren’t see any thing else) and ignore the other things like السماعة السودة جنبها

Reinforcement

- If the stimulus does cause reward or punishment rather than indifference, the cerebral cortical response becomes progressively more and more intense during repeated stimulation instead of fading away, and the response is said to be reinforced.
- An animal builds up strong memory traces for sensations that are either rewarding or punishing but, conversely, develops complete habituation to indifferent sensory stimuli.

The Hippocampus

(Another part of limbic system)

- Almost any type of sensory experience causes activation of at least some part of the hippocampus, and the hippocampus in turn distributes many outgoing signals to the anterior thalamus, hypothalamus, and other parts of the limbic system, especially through the fornix, a major communicating pathway.
- Thus, the hippocampus is an additional channel through which incoming sensory signals can initiate behavioral reactions for different purposes.

The Hippocampus

- As in other limbic structures, stimulation of different areas in the hippocampus can cause almost any of the different behavioral patterns such as pleasure, rage, passivity, or excess sex drive.

The Hippocampus

- Another feature of the hippocampus is that it can become hyperexcitable.
- For example, weak electrical stimuli can cause focal epileptic seizures in small areas of the hippocampi.
- These seizures often persist for many seconds after the stimulation is over.
- During hippocampal seizures, the person experiences various psychomotor effects, including olfactory, visual, auditory, tactile, and other types of hallucinations that cannot be suppressed as long as the seizure persists.

However, he know that these hallucinations don't real at all.

The Hippocampus and memory

- Subjects with lesion in the hippocampus are capable of short-term memory for seconds up to a minute or two, although their ability to establish memories lasting longer than a few minutes is either completely or almost completely abolished. This phenomenon, called anterograde amnesia.

- Memory consolidation(the role of hippocampus in memory)：the conversion of short-term memory to long term memory.

Amygdala

- Olfaction amygdala is associated with olfactory sensations ,because they highly correlated with limbic system functions (emotions and behaviors).
- The amygdala receives neuronal signals from all portions of the limbic cortex, as well as from the neocortex of the temporal, parietal, and occipital lobes—especially from the auditory and visual association areas.

- Because of these multiple connections, the amygdala has been called the “window” through which the limbic system sees the place of the person in the world.

Amygdala

- In turn, the amygdala transmits signals (1) back into these same cortical areas, (2) into the hippocampus, (3) into the septum, (4) into the thalamus, and (5) especially into the hypothalamus.

- In general, stimulation in the amygdala can cause almost all the same effects as those elicited by direct stimulation of the hypothalamus, plus other effects.

Amygdala

- can also cause:
- Several types of involuntary movement.
- Sexual activities.
- Stimulation of certain amygdaloid nuclei can also cause a pattern of rage and punishment. Stimulation of other amygdaloid nuclei can give reactions of reward and pleasure.

Amygdala

When the amygdala get stimulated:

- the amygdala is believed to make the person's behavioral response appropriate for each occasion.

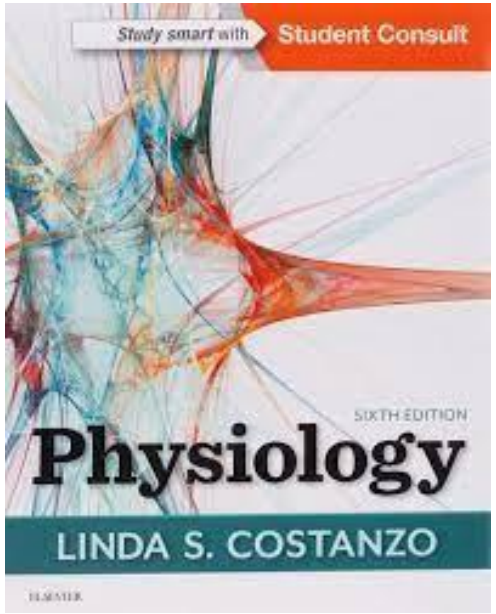
The limbic cortex

- the limbic cortex in effect functions as a cerebral association area for control of behavior.
- many behavioral patterns can be elicited by stimulation of specific portions of the limbic cortex. (because it connected with neocortex and subcortical areas which ingenerated different functions).

اللهُم كُن لأهل غزة عونا ونصيرا يا رب العالمين ، اللهم نستودعك أهالي غزّة وفلسطين وجميع المسلمين فانصرهم واحفظهم بعينك التي لا تنام، واربط على قلوبهم وأمدهم بجُندك وأنزل عليهم سكينتك وسخر لهم الأرض ومن عليها ، اللهم لا تخيب رجاءنا وأنت أرحم الراحمين.

Thank you

References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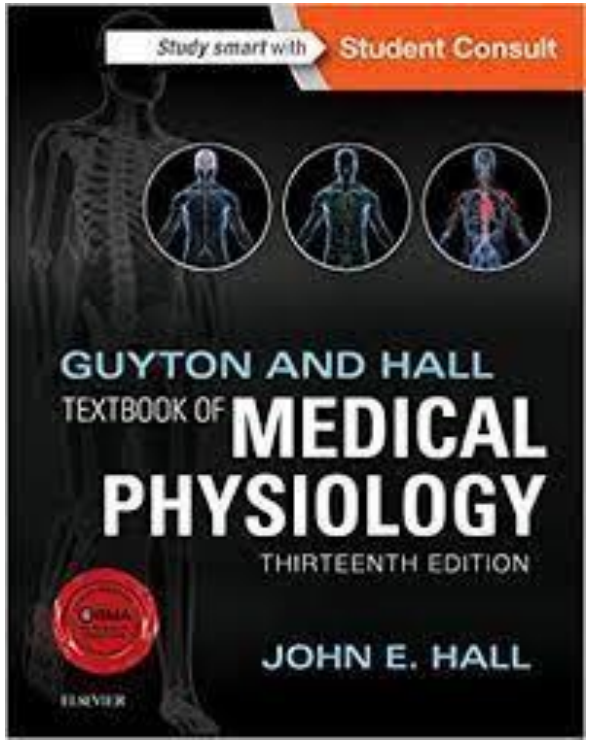
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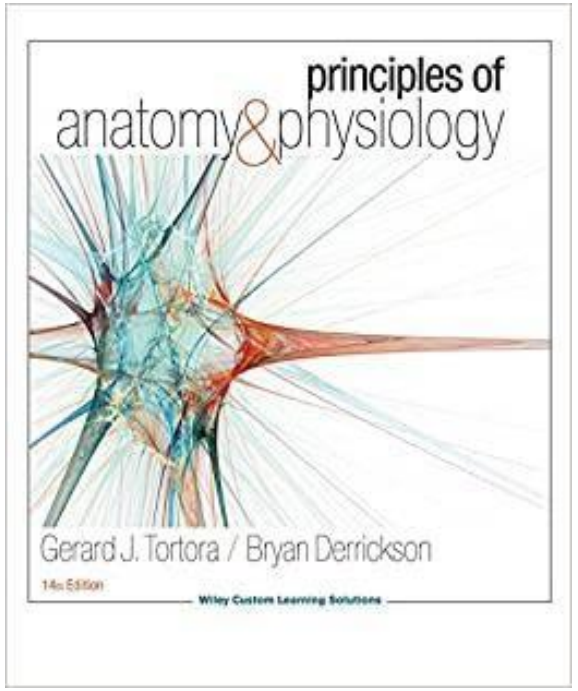
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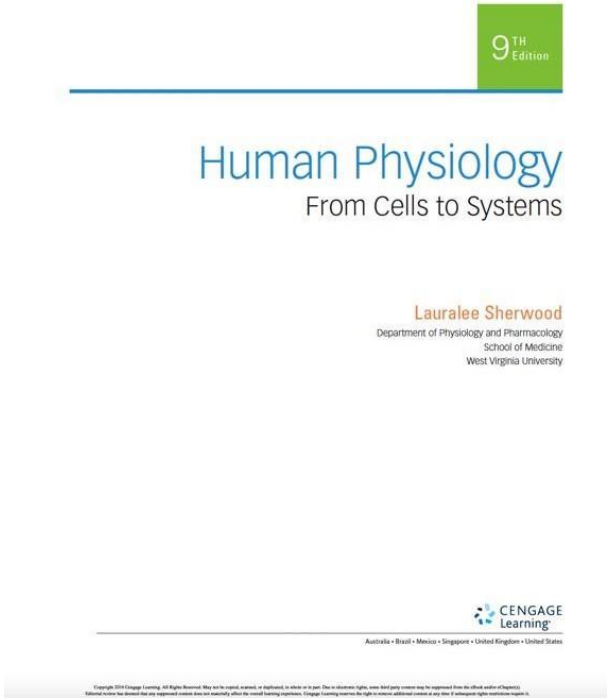
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