Limbic system (3 lectures) Behavioral and Motivational Mechanisms

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Human behavior

is the potential and expressed capacity (mentally, physically, and socially) of human individuals or groups to respond to internal and external stimuli throughout their life

Motivation

Motivation is **the desire to act in the service of a goal**.

It's the crucial element in setting and attaining our objectives.

Motivation is one of the driving forces behind human behavior. ... Motivation encompasses the desire to continue striving toward meaning, purpose, and a life worth living.

Consciousness

- Continuing stream of awareness of either our surroundings or our sequential thoughts

- Between stimulus and response there is a space. In that space is **our power to choose our response (Consciousness).**

Four aspect of human beings

Need vs behavior
Food – hunger, satiety ,GIT stimulation
Water – thirst ,water conservation
Sleep – sleep centers

Physical

Mental

Need vs behavior
Purpose – stress /anxiety

Spiritual

Connection with ALLAH, Love Service

emotional

Parameters or feedback mechanisms that allow you to know if your needs in other categories are met

Learning objectives

- Describe the principal components of the limbic system
- Describe Functions of limbic system
- Describe pathways connecting different components of limbic system
- Discuss the anatomy of memory and emotion in relation to the limbic system

THE LIMBIC SYSTEM

- The word “limbic” means “border.” Originally, the term “limbic” was used to describe the border structures around the basal regions of the cerebrum.
- The term *limbic system has been* expanded to mean the entire neuronal circuitry that controls emotional behavior and motivational drives.

Components

- Limbic lobe
- Components in diencephalon

Limbic lobe

1.Cingulate gyrus

2.Parahypocampal gyrus

Hippocampal formation

1. Dentate gyrus
2. Hippocampus

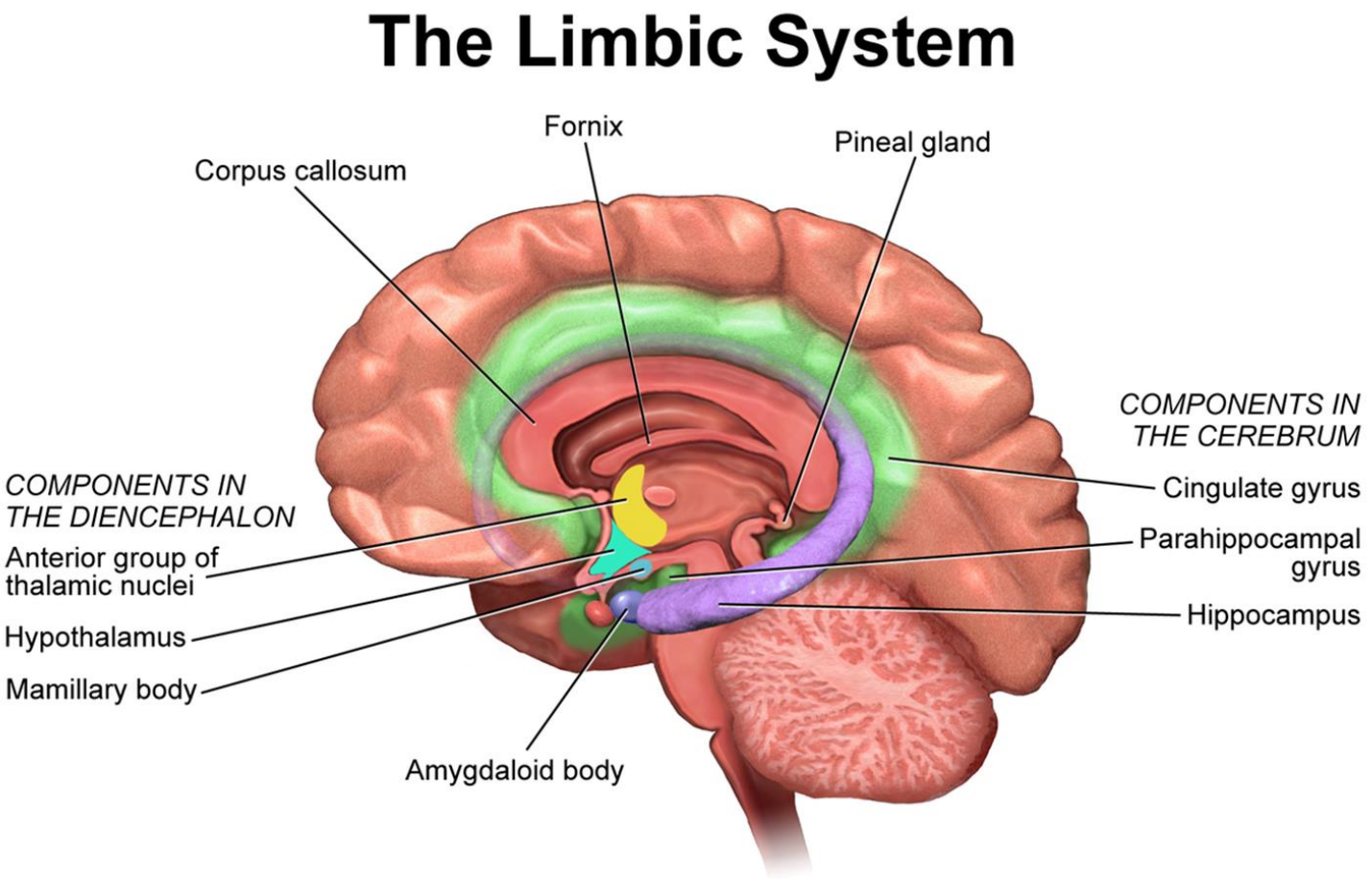
Amygdala

Medial nuclei

(Emotions related to smell)

Lateral

(other emotions)

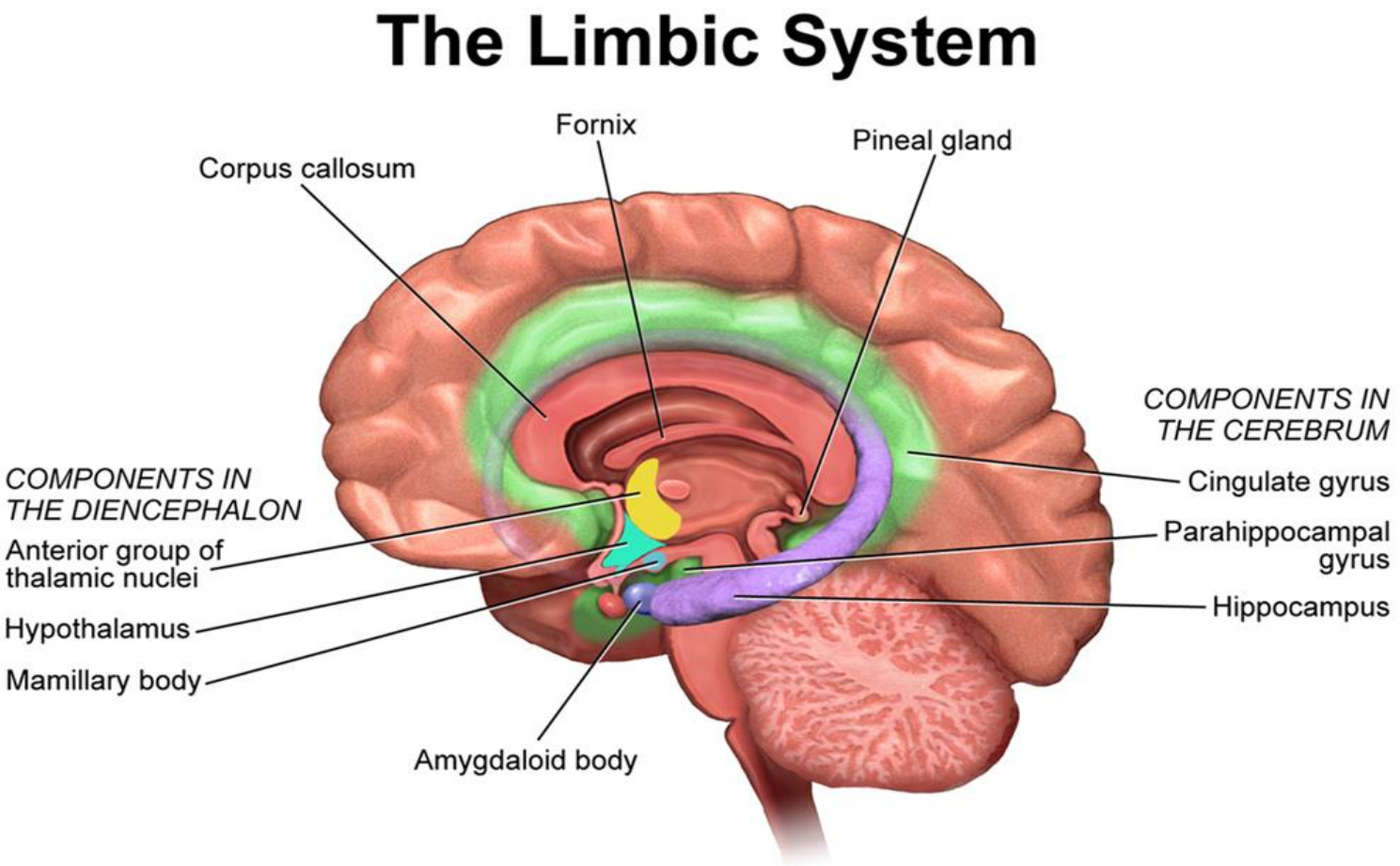


Components in diencephalon

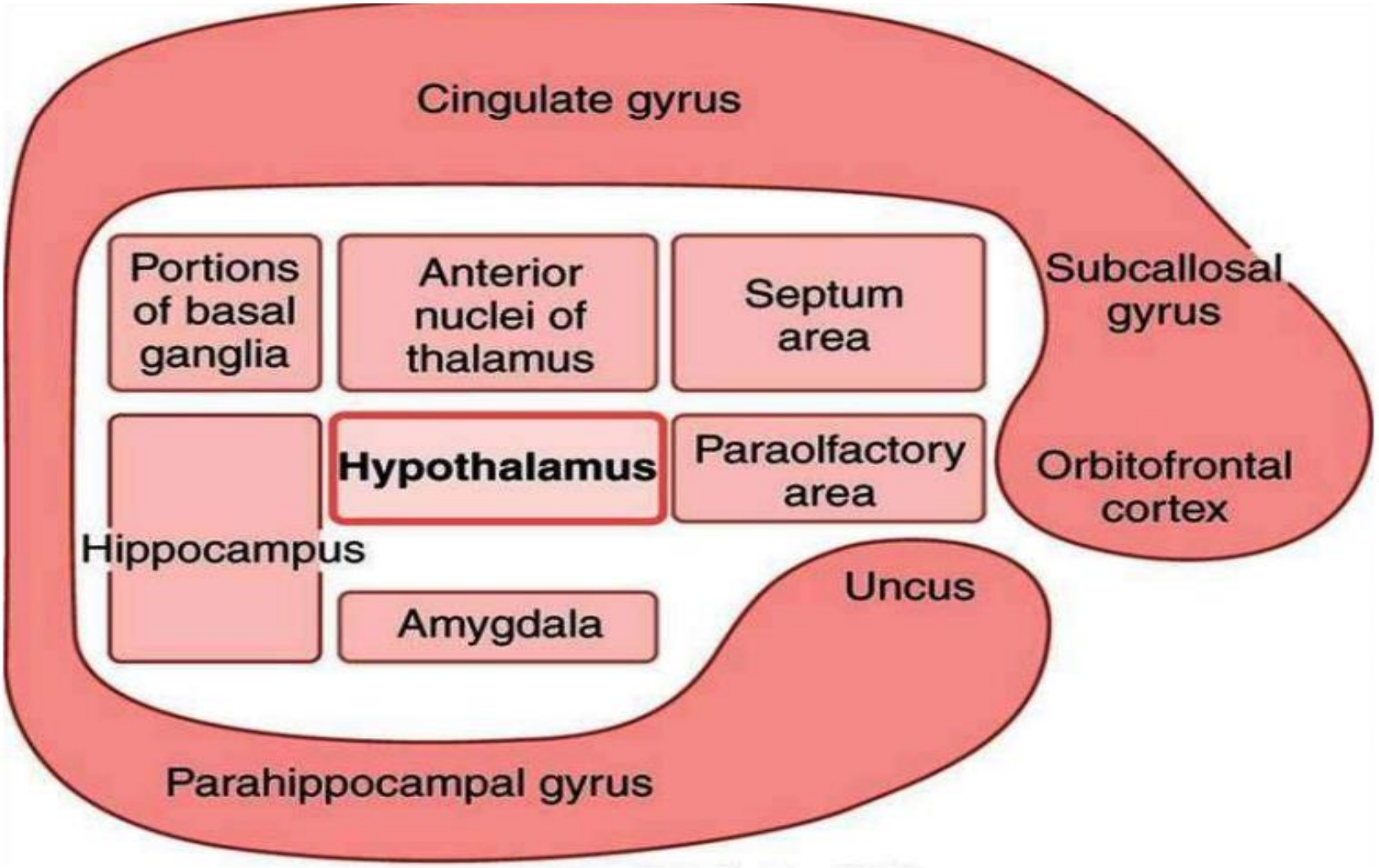
Thalamus (anterior nuclei, dorsomedial)

Hypothalamus mammillary body, autonomic nuclei

Septal nuclei



Limbic cortex ,central position of hypothalamus



Task ; Physical needs if not met leads to certain behaviors which are controlled from hypothalamus

Read page 754 –757, make a table Needs , behavior and hypothalamic center

Need vs behavior

Food – hunger, satiety ,GIT stimulation

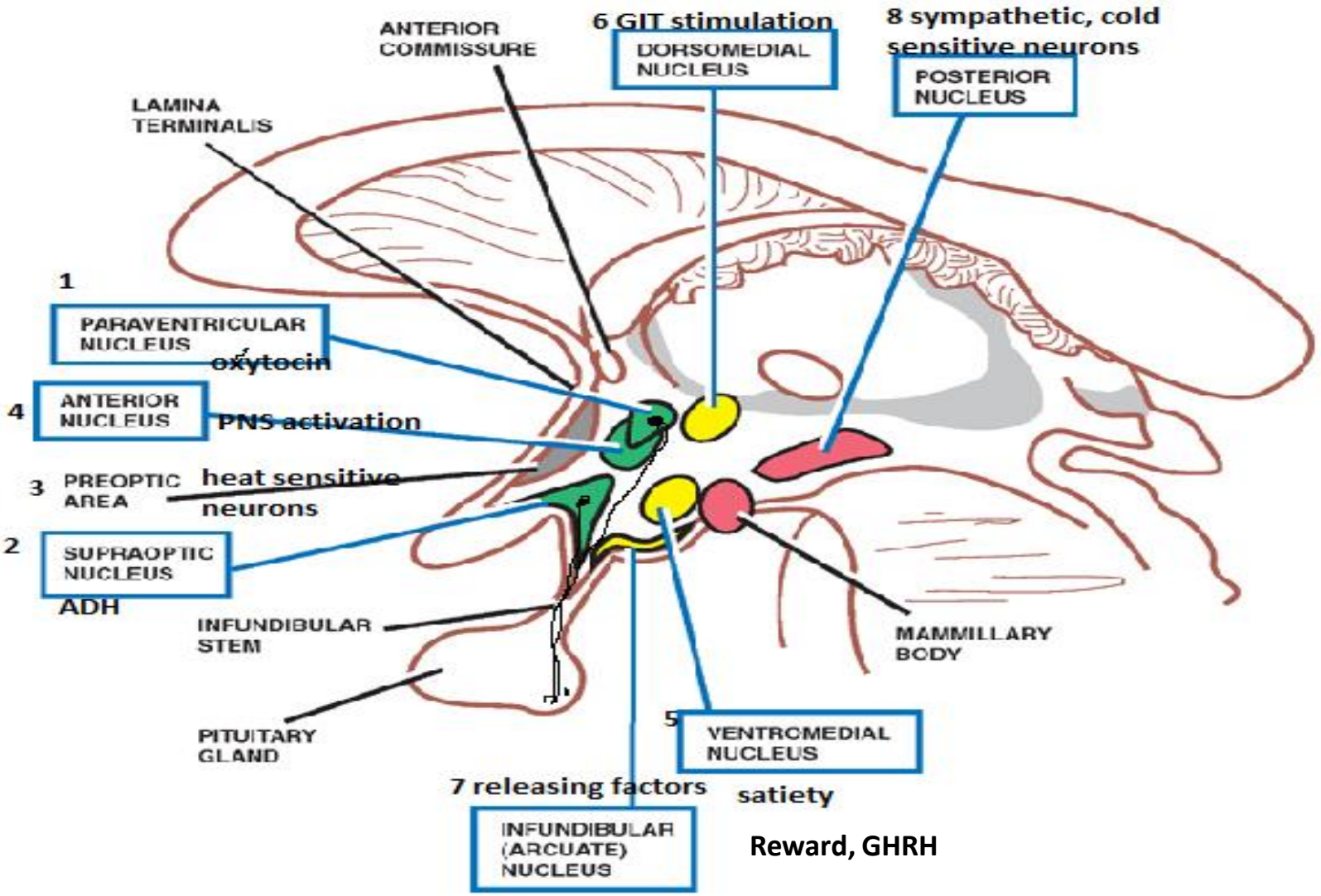
Water – thirst ,water conservation mechanisms

Sleep – sleep centers

Body temperature regulation – heat sensitive neurons (heat loss mechanisms) , cold sensitive neurons(heat gain mechanisms)

CVS regulation – sympathetic center , parasympathetic center

Divide hypothalamic nuclei into three groups and name them



Hypothalamus functions

- **Vegetative (**Vegetative functions are those bodily processes most directly concerned with maintenance of life. This category encompasses nutritional, metabolic, including eating, sleeping, menstruation, bowel function and sexual
- **Endocrine ,** releasing factors , oxytocin , ADH
- **Human behavior**, shaped by reward and punishment centers

Connections of limbic system

- conceptualized as the "feeling and reacting brain" that is interposed between the "thinking brain" and the output mechanisms of the nervous system.
-

WHAT DOES THIS IMPLY?

Connections of limbic system

1.Memory and learning

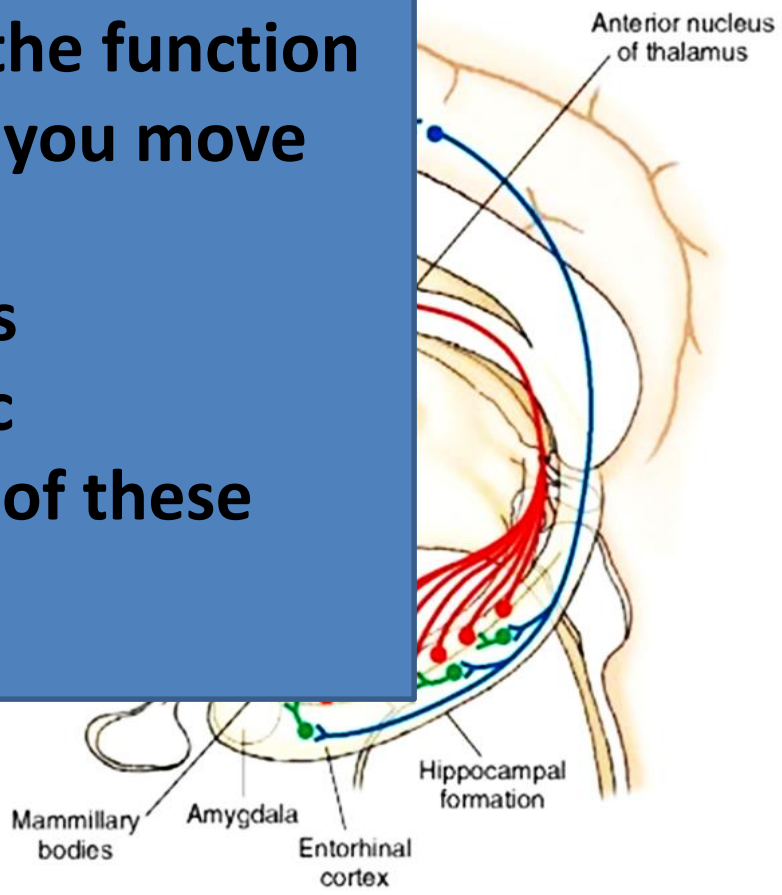
Papez circ

Hippocam
↔ mamr
↔ anter
thalamus
thalamic t

From here
transmitt
gyrus (CG
informati
directions ,one to Para hippocampal gyrus and hippocampus and secondly to prefrontal cortex

TASK

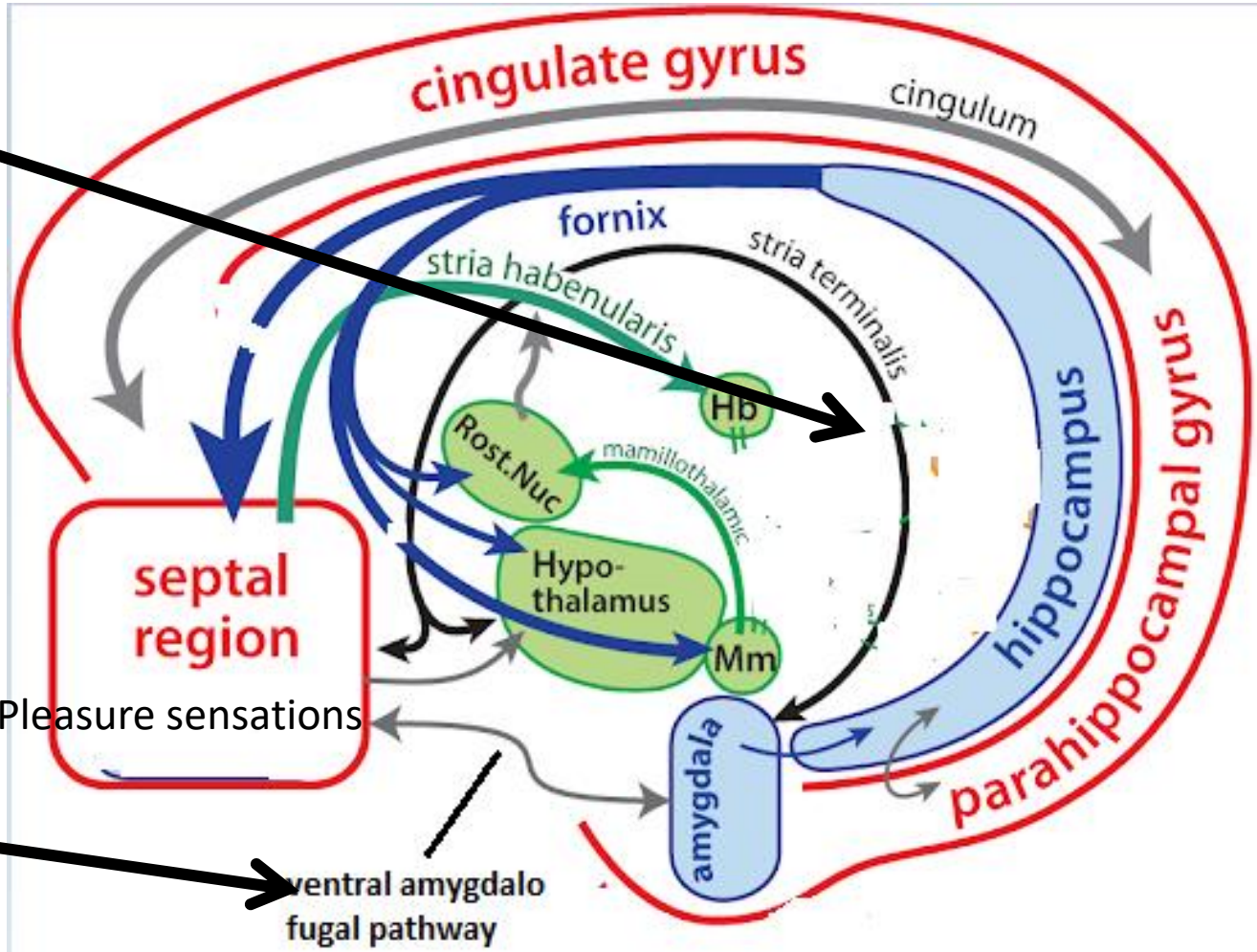
Draw pap circuit , state the function of each component as you move along e.g.
Hippocampus
Amygdala etc
And make sense out of these connections



2. Amygdala (2 pathways)

a)Stria terminalis runs dorsally (to septal nuclei and lateral hypothalamus)

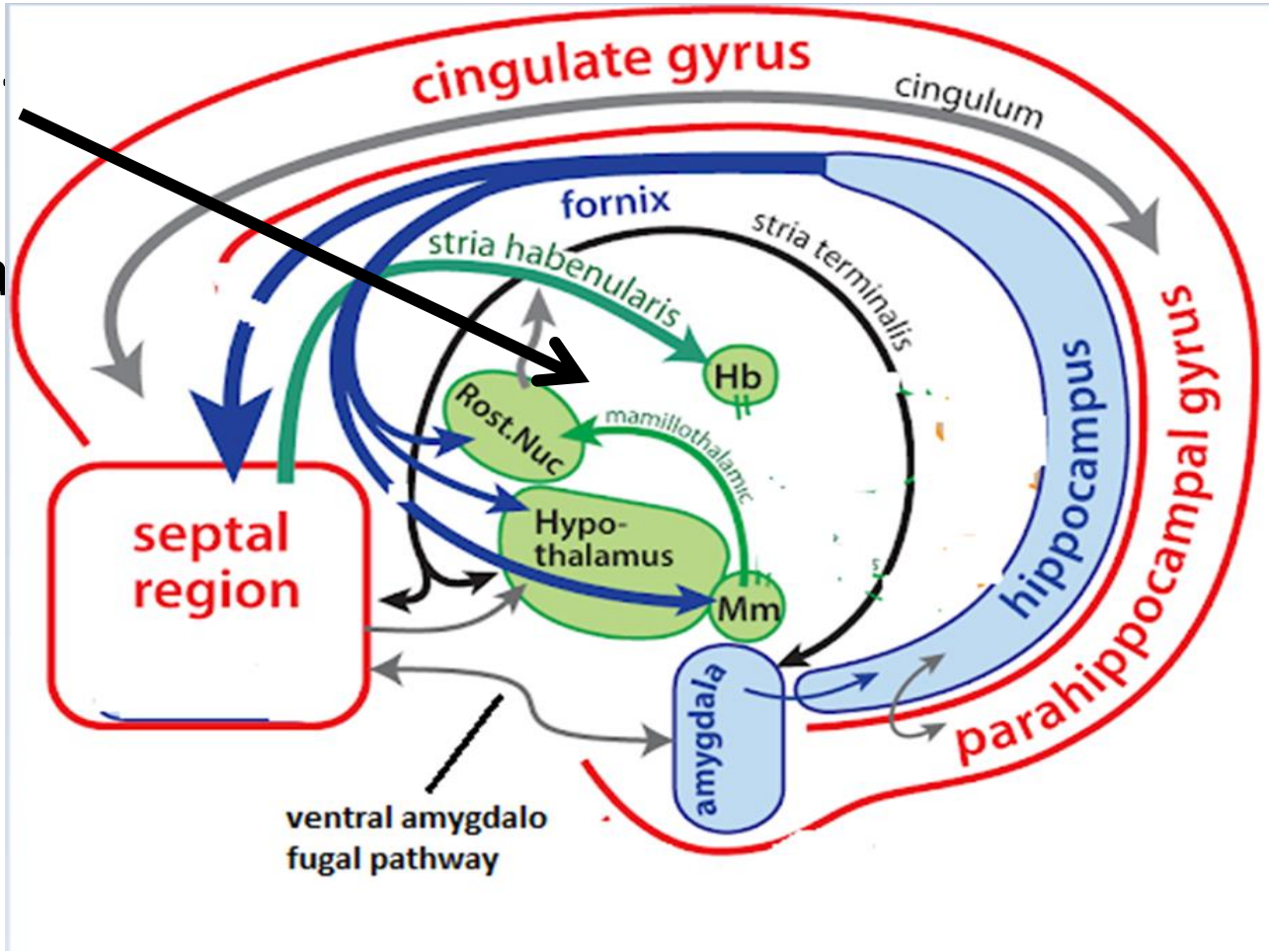
b) Ventrally is ventral **amygdalo fugal** pathway feeding,fear,rage



Mammillo thalamic tract

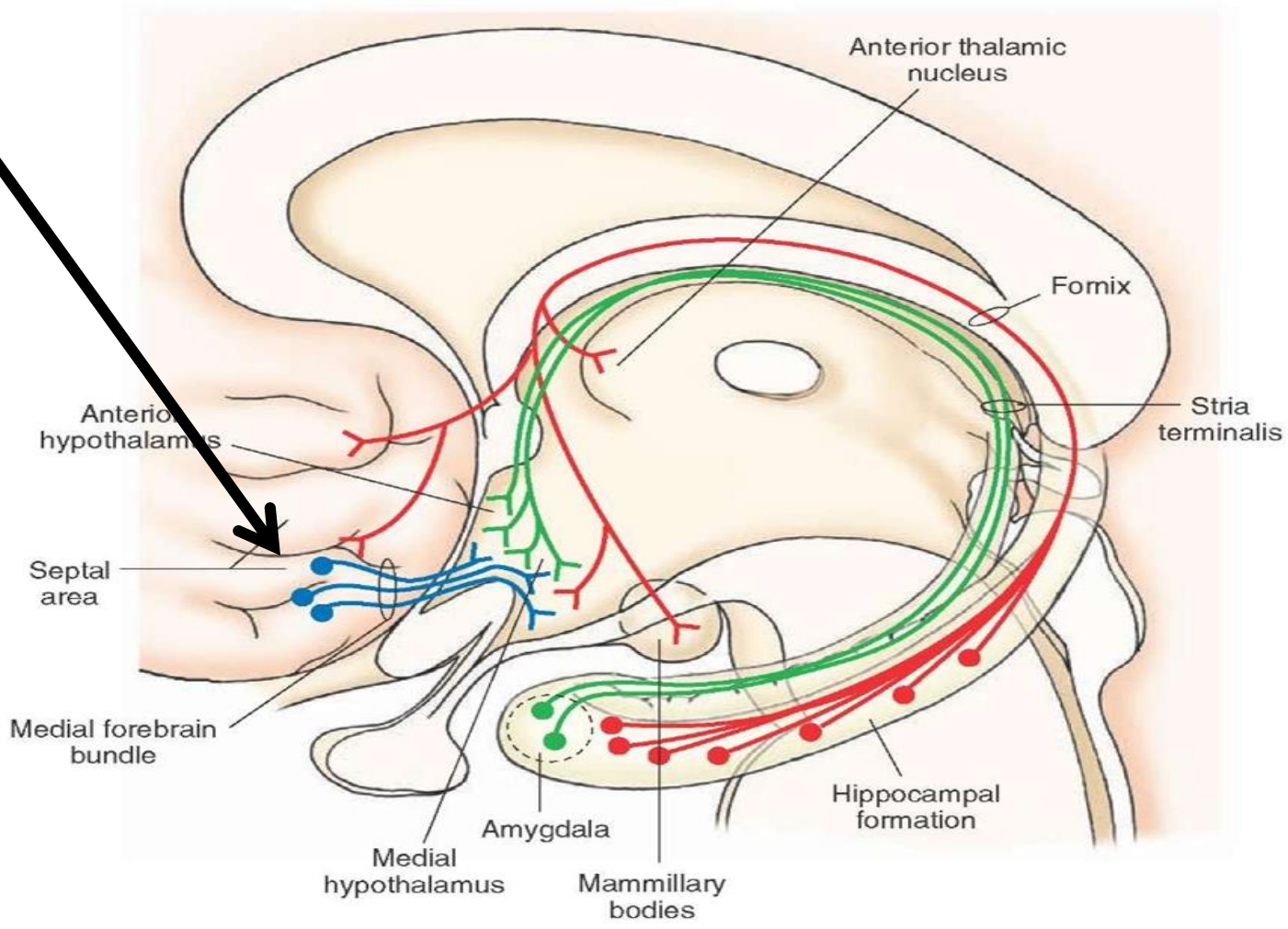
3. Mammillary body to anterior nuclei of thalamus **(mammilo-thalamic** tract

(spatial memory is a form of memory responsible for the recording of information about one's environment and spatial orientation and location)

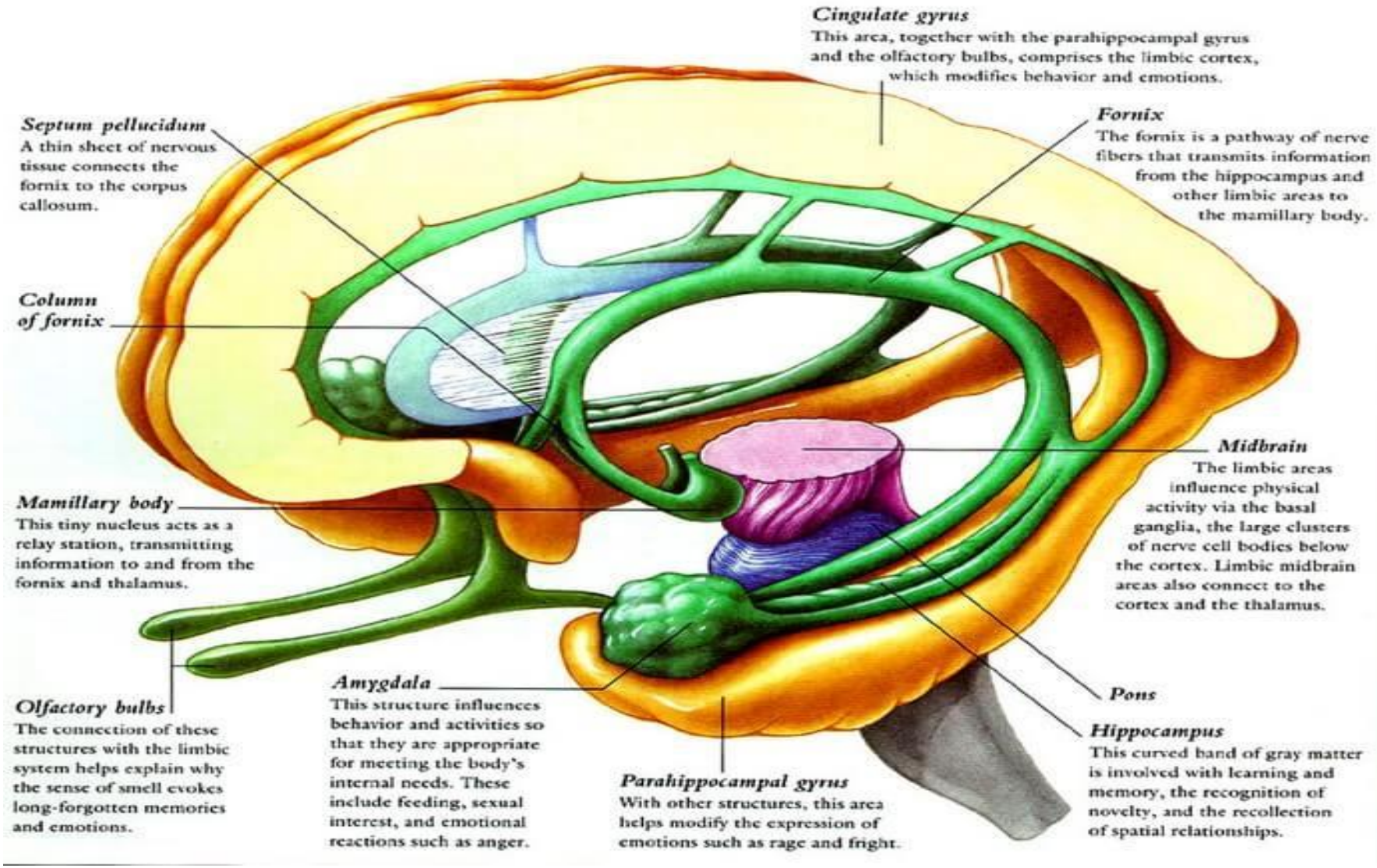


Medial forebrain bundle(reward pathway)

4.From septal, orbitofrontal, nucleus accumbance (a region in basal forebrain) and prefrontal cortex through middle of hypothalamus to reticular formation, ventral tegmental area(dopamin ergic neurons)



Functions of limbic system

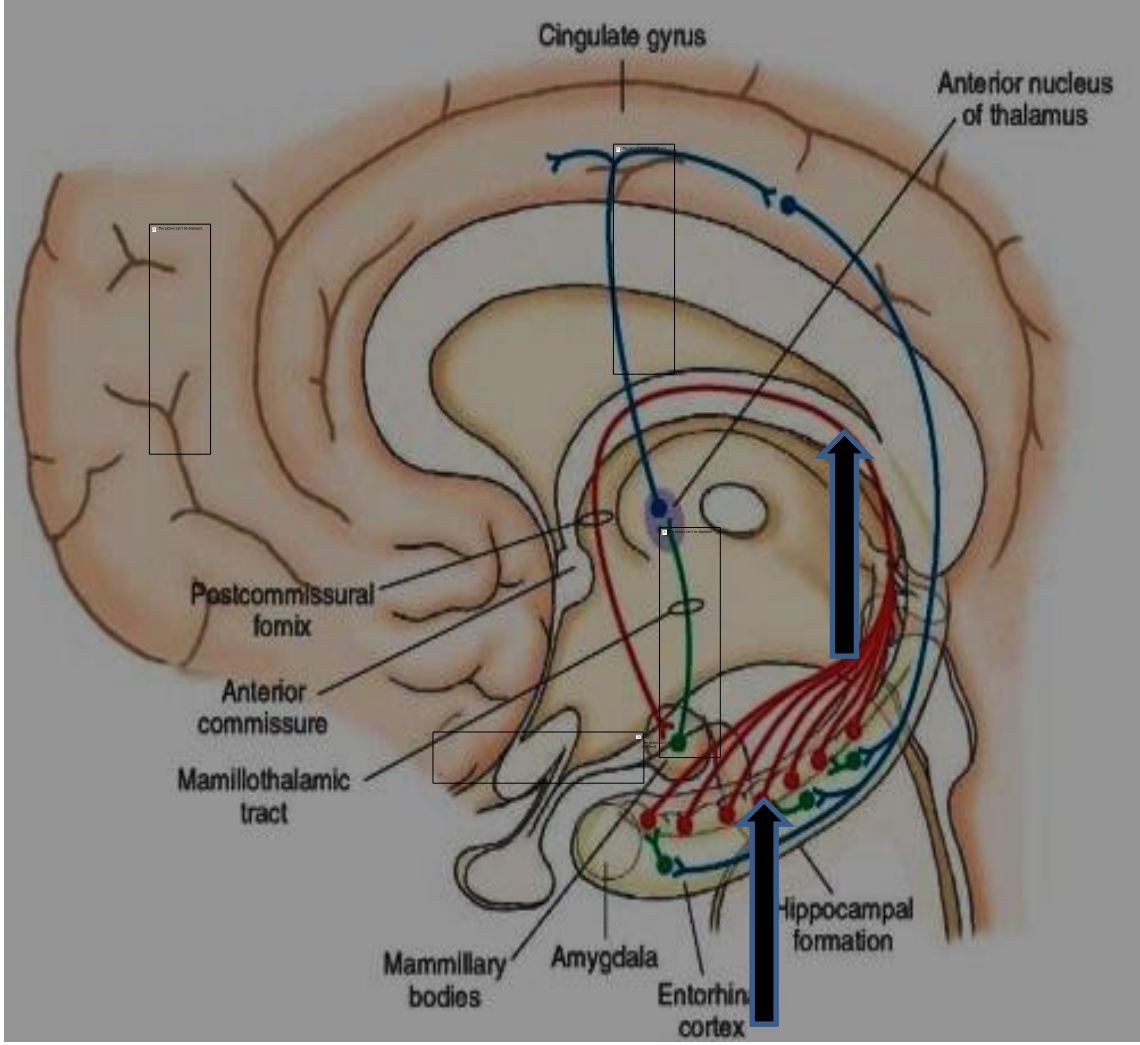


1.Memory and learning

Papez circuit

Hippocampus↔fornix ↔ mammillary body ↔ anterior nucleus of thalamus (mammilo-thalamic tract)

From here signals are transmitted to cingulate gyrus (CG). CG send information in two directions ,one to Para hippocampal gyrus and hippocampus and secondly to prefrontal cortex



Prefrontal cortex functions in focusing attention ,decision making, personality expression, moderating social behavior

Sensory stimuli or thoughts that cause pain or aversion excite the **limbic punishment centers**, and stimuli that cause pleasure, happiness, or sense of reward excite the **limbic reward centers(dopaminergic neurons in tegmentum** .

All these together provide the background mood and motivations of the person. Among these motivations is the drive in the brain to remember those experiences and thoughts that are either pleasant or unpleasant. The **hippocampi** especially and to a lesser degree **the dorsal medial nuclei of the thalamus**, make the decision about which of our thoughts are important enough on a basis of reward or punishment to be worthy of memory

Functions of limbic system

2. Olfaction

Olfactory tract (medial and lateral)

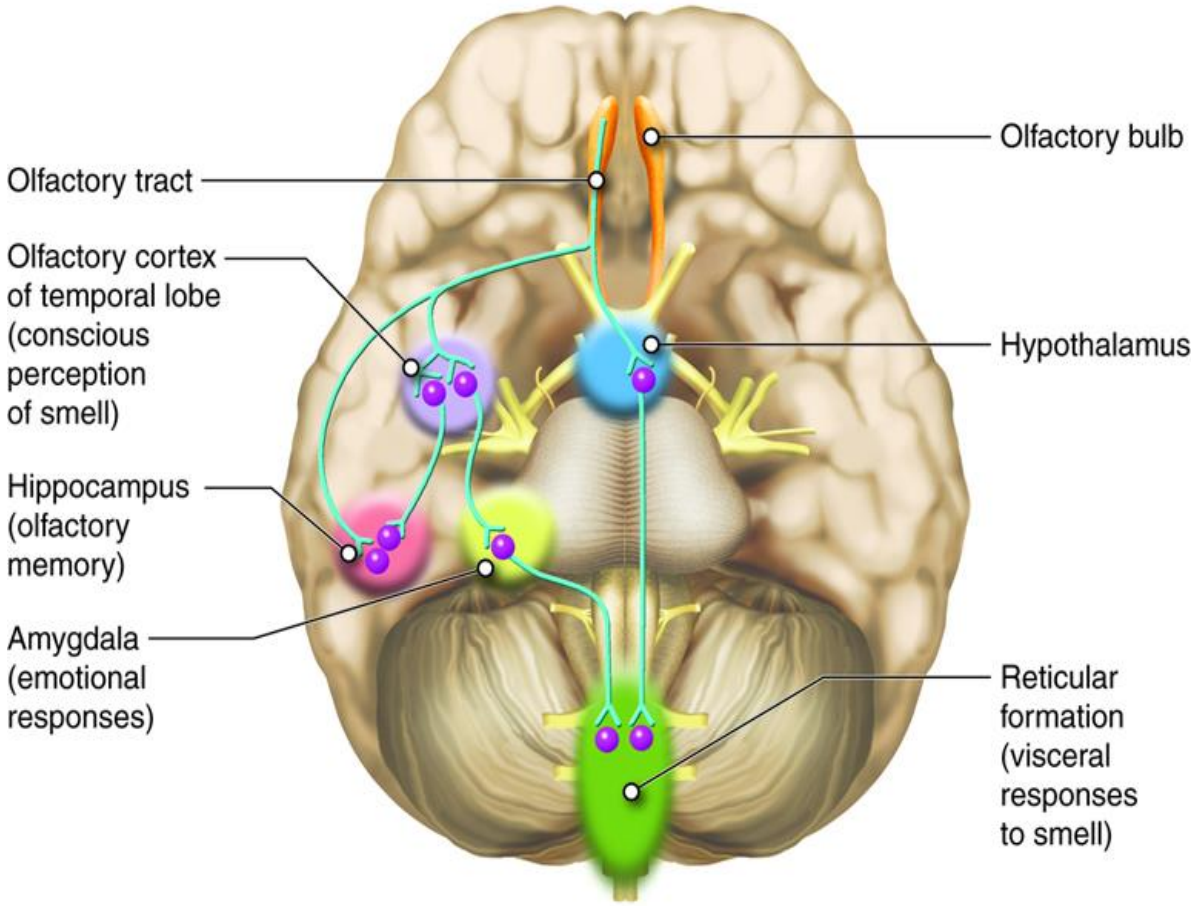
Lateral

to hippocampus

(memory of smells)

To amygdala

(emotions related to smell)

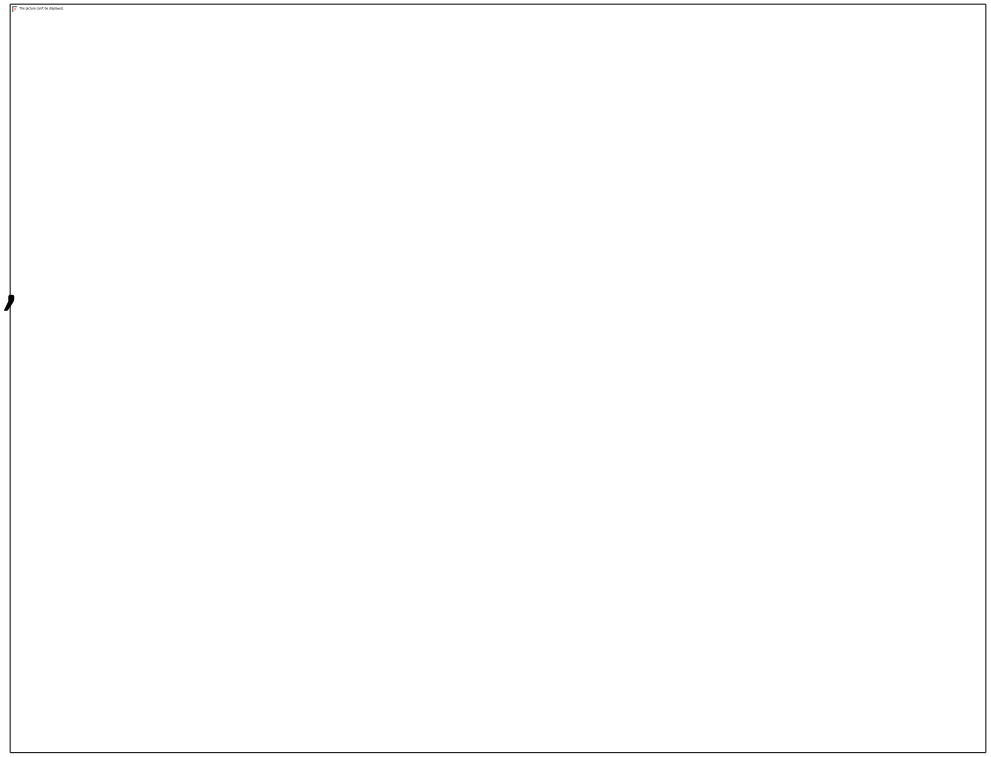


3. Emotional responses (role of amygdala)

Emotions are complex psychological state that involves three distinct components:

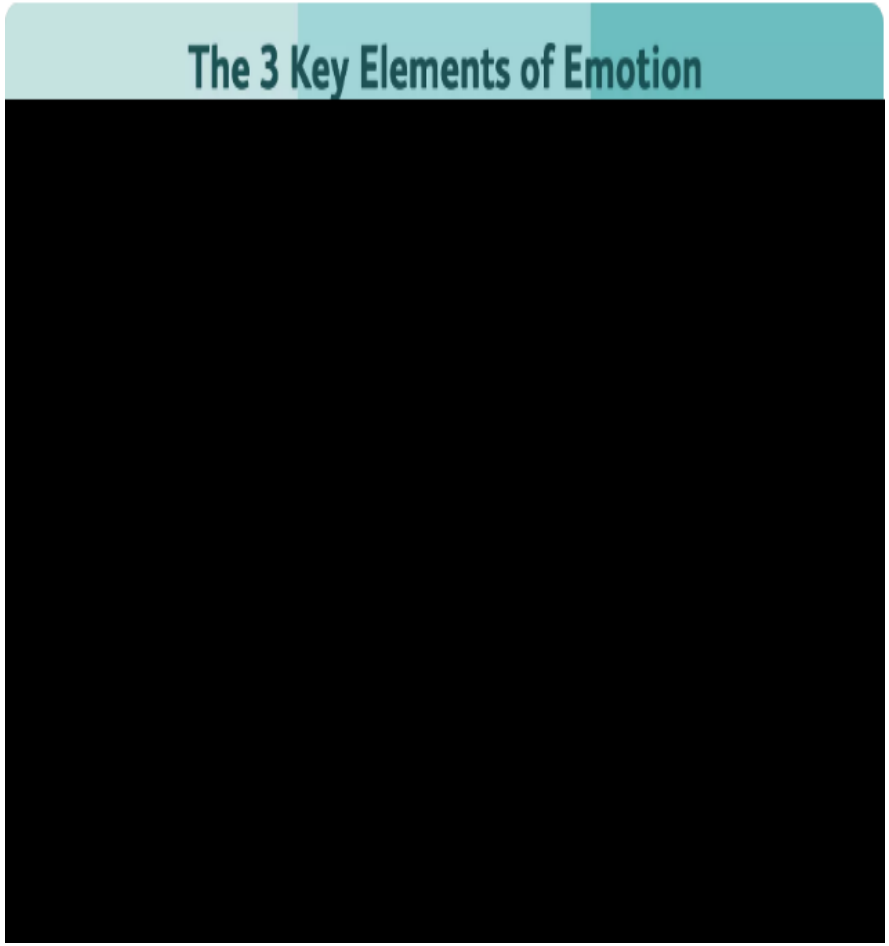
1. subjective experience,
2. physiological response,
3. behavioral or expressive response

six basic emotions that are universal throughout human cultures**: fear, disgust, anger, surprise, happiness, and sadness**



Subjective experience

- Consider anger, for example. Is all anger the same? Your own experience might range from mild annoyance to blinding rage.so feelings are subjective



Physiological response (Role of Hypothalamus)

Hypothalamus in the limbic system governs the *involuntary internal responses* of various body systems in preparation for appropriate action to accompany a particular emotional state.

Anterior portion =parasympathetic(↓HR, ↓BP)

(sweating i.e, heat loss mechanisms)

Posterior = sympathetic(↑HR, ↑BP)

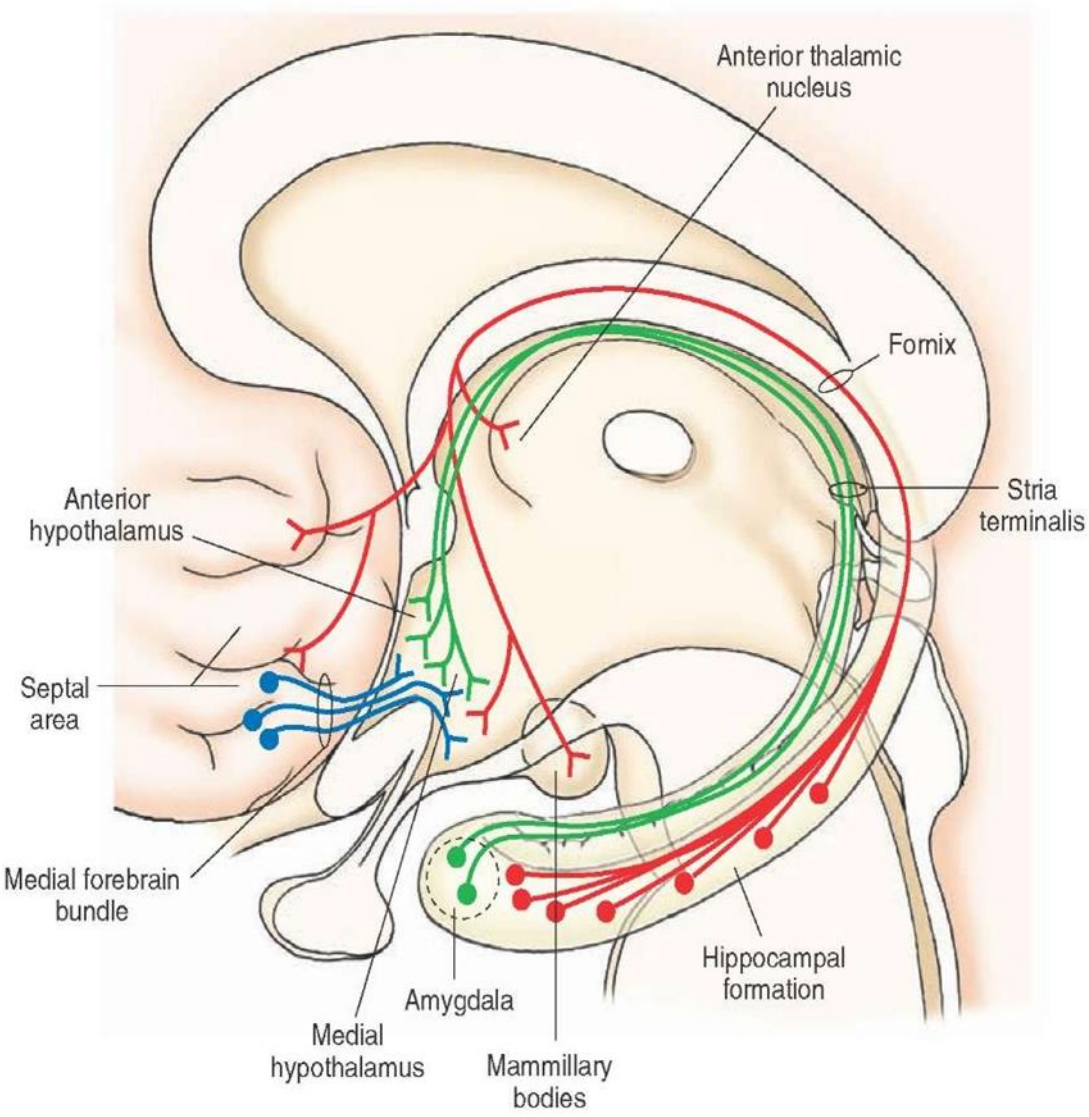
(shivering i.e. heat producing mechanisms)

Quiz Time

Area of hypothalamus	Effect of stimulation	Effect of lesion
lateral		
Ventromedial		
paraventricular		

Role of amygdala

Amygdala has communication with widespread areas of the cerebral cortex , Via mammillo thalamic tract amygdala is connected to anterior thalamic nuclei (memory) and **hypothalamus**



Task

- Read page 760
- Topic = function of amygdala

Question

1. Explain how the amygdala is the window through which limbic system sees the place of the person in the world

2. List the effects of bilateral ablation of Amygdala

Effects of Bilateral Ablation of the Amygdala—The Klüver-Bucy Syndrome.

1) is not afraid of anything,

(2) has extreme curiosity about everything,

(3) forgets rapidly,

(4) has a tendency to place everything in its mouth and sometimes even tries to eat solid objects, and

(5) often has a sex drive so strong


Thank You
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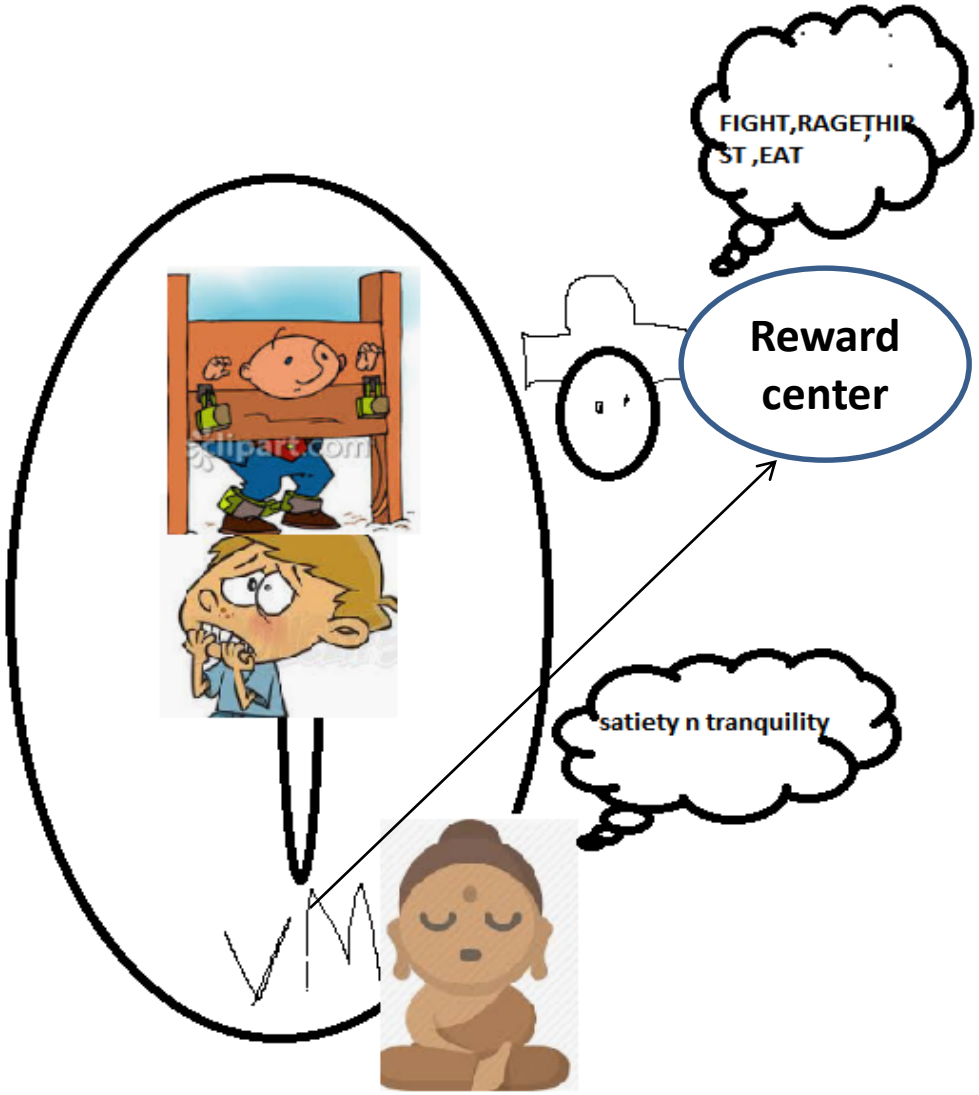
Non vegetative functions of hypothamus(centers)

Reward centers are also located in Septum ,amygdala Basal ganglia (tegmentum ,dopamin

Punishment centers Periventricular zones Of hypothalamus



Some important areas in hypothalamus

Lateral = thirst, hunger, rage, fight, emotions

Posterior and lateral

Sympathetic center(↑BP,HR)

Ventromedial= satiety, tranquility

Anterior

parasympathetic

Periventricular=

Fear , punishment

anterior

Physiological response

- Autonomic nervous system
- Limbic system

Behavioral response

- actual expression of emotion

Physiological component

- Brain activation
- Neurotransmitter release
- Autonomic ns activation

1)Emotions (**amygdala periventricular area)**

Stimulating specific regions of the limbic system during brain surgery produces vague subjective sensations

amygdala is especially important in processing inputs that give rise to the sensation of fear and anxiety.

2)Basic behavioral patterns (lateral hypothalamus, cerebrum)

include those aimed at individual

- survival(eating , thirst)
- attack, fight
- searching for food and
- those directed toward perpetuating the species

Role of hypothalamus and cerebral cortex

Higher cortical mechanisms are called into play to connect the limbic system and hypothalamus

with the outer world so that appropriate overt behaviors are manifested.

3)Motivation

- is the ability to direct behavior toward specific goals.
- **Homeostatic drives** represent the subjective urges associated with specific bodily need
- **Non Homeostatic drives** influenced by experience, learning, and habit, shaped in a complex framework of unique personal gratifications blended with cultural expectations.

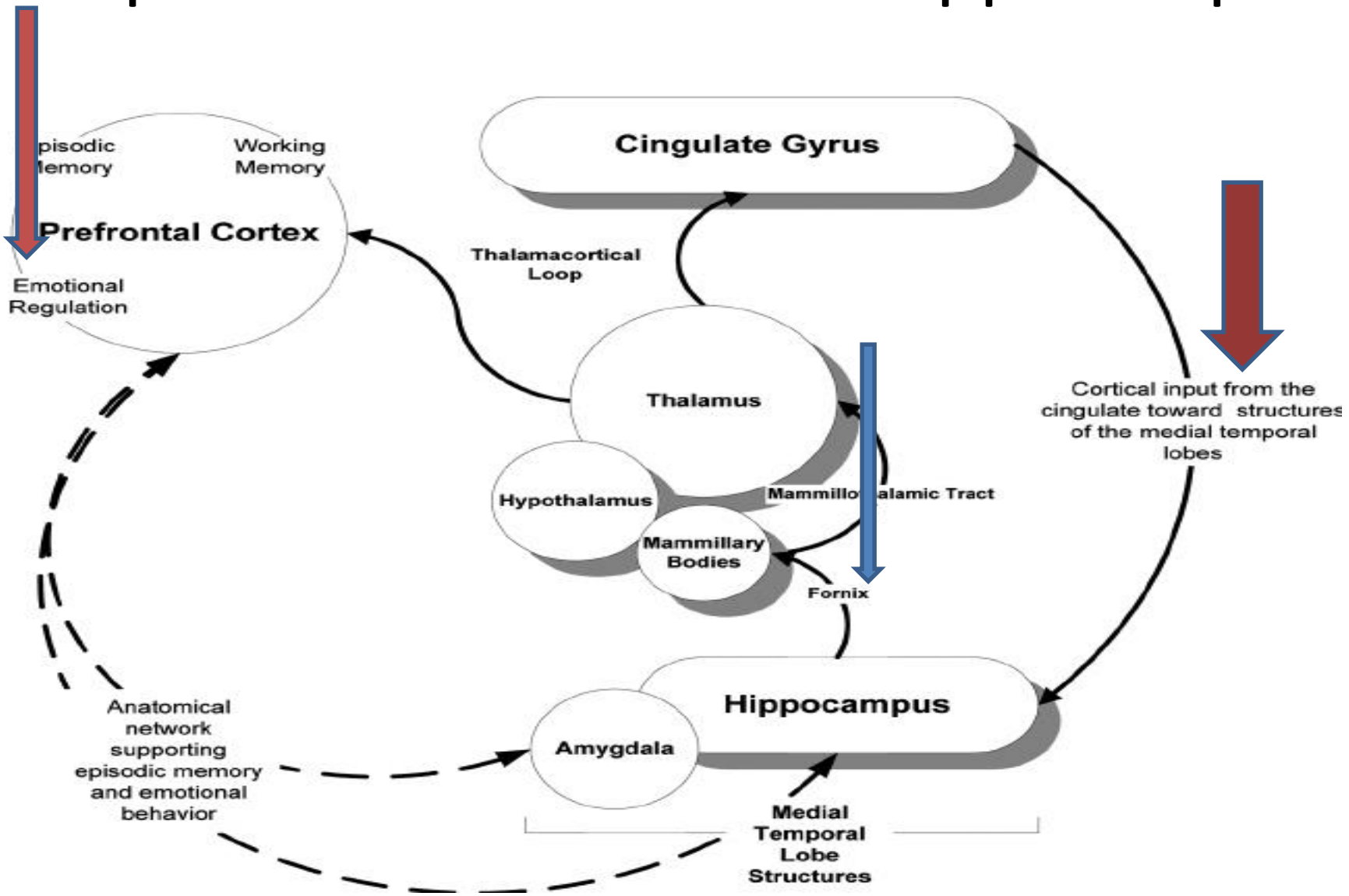
Motivation
(**reward”** and **“punishment” centers)**

- An individual tends to reinforce behaviors that have proved gratifying and to suppress behaviors that have been associated with unpleasant experiences.
-
- Certain regions of the limbic system have been designated as **“reward”(lateral and ventromedial hypothalamus)** and **“punishment” centers(periventricular)**
- because stimulation in these respective areas gives rise to pleasant or unpleasant sensations.

4)Learning and memory (hippocampus)

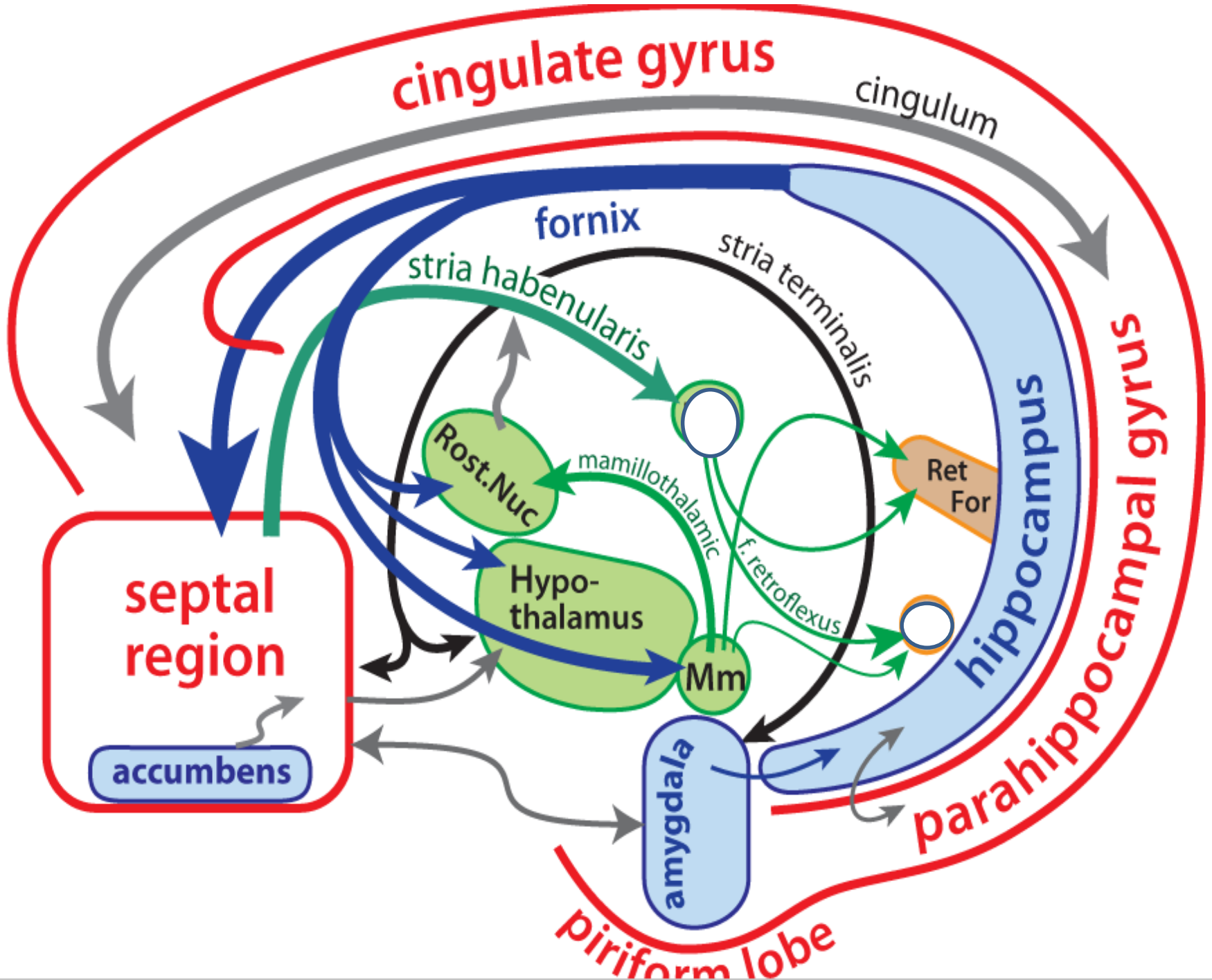
- **Learning** is the acquisition of knowledge or skills as a consequence of experience, instruction, or both.
- Rewards and punishments are integral parts of many types of learning.
- When behavioral responses that give rise to pleasure are reinforced or those accompanied by punishment are avoided, learning has taken place

1.Cortical input- hippocampus
2.prefrontal cortex and hippocampus



prefrontal cortex

- The prefrontal cortex is anterior to the premotor cortex.
- This part of the cortex is extremely well-developed in humans and is critical to judgment, insight, motivation and mood.
- It is also important for conditioned emotional reactions.
- The prefrontal cortex receives input from the other areas of limbic cortex, from the amygdala and from septal nuclei and has reciprocal connections with each of these areas and with the dorsomedial nucleus of the thalamus.


cingulate gyrus
cingulum
fornix
stria habenularis
stria terminalis
Rost.Nuc
mamillothalamic
Ret For
f. retroflexus
Hypo-
thalamus
Mm
hippocampus
septal
region
accumbens
amygdala
parahippocampal gyrus
piriform lobe

Stay blessed

Lecture 2

At the end of lecture students of 2nd year MBBS should be able to

1. Describe functions of hypothalamus

2. Describe the connection of hypothalamus with different areas of brain.
3. Describe hypothalamic control of behaviors

several types of inputs to hypothalamus.

- 1) receiving direct sensory inputs from the smell, taste, visual, and somatosensory systems.
- 2) internal sensors for temperature, osmolarity, glucose and sodium concentration and a variety of hormones.
- 3) inputs from forebrain areas including the hippocampus, amygdala, and cingulate cortex(limbic system)which receives highly processed sensory information from throughout the cerebral cortex, and determines personal importance for the individual.

Outputs from hypothalamus

in three directions:
(**1)Autonomic controle** backward and downward to the brain stem, mainly into the reticular areas of the mesencephalon, pons, and medulla and from these areas into the peripheral nerves of the autonomic nervous system;
(2)**Emotional ,behavioral controle** upward toward many higher areas of the diencephalon and cerebrum, especially to the anterior thalamus and limbic portions of the cerebral cortex; and
(3)**endocrine controle** into the hypothalamic infundibulum to control or partially control most of the secretory functions of both the posterior and the anterior pituitary glands.

functions

1) homeostasis (Greek for “staying the same”)

2) responding to urgent external events,

3) helps anticipate daily events that are triggered by the external day-night cycle.

predictable times for feeding, drinking, sleeping, and sexual behavior. wakefulness and eg cortisol levels peaks at the time of day

Hypothalamic control of *behavior* is mediated in several ways

1. the lateral hypothalamic area play a major role in determining the overall level of wakefulness or arousal
2. hypothalamic inputs to various motor pattern generators may increase the probability of specific behaviors. hypothalamus may reduce the threshold for activating motor pattern generators for locomotion, and for sniffing and oral behaviors that are involved in ingestion of food.
3. there are hypothalamic descending outputs to sensory systems that may sensitize them (e.g., when hungry, food tastes better)
4. hypothalamic control of autonomic responses may cause signals (stomach grumbling when hungry; dry mouth when thirsty) that reach conscious appreciation in higher cognitive systems as a need to engage in a behavior (in this case, eat or drink).
5. hypothalamic regulation of endocrine systems may feed back on the brain. For example, many neurons in the brain have receptors for steroid hormones involved in reproduction, stress responses, or salt depletion, and changes in these hormones may alter the likelihood of various complex behaviors regulated by those neuronal systems.

amygdala

stimulation in the amygdala can cause almost all the same effects as those elicited by direct stimulation of the hypothalamus,plus other effects. Effects initiated from the amygdala and then sent through the hypothalamus include

(1) increases or decreases in arterial pressure;

2) Increases or decreases in heart rate;

(3) increases or decreases in gastrointestinal motility and secretion;

(4) defecation or micturition;

(5) pupillary dilation or, rarely, constriction;

(6) piloerection; and

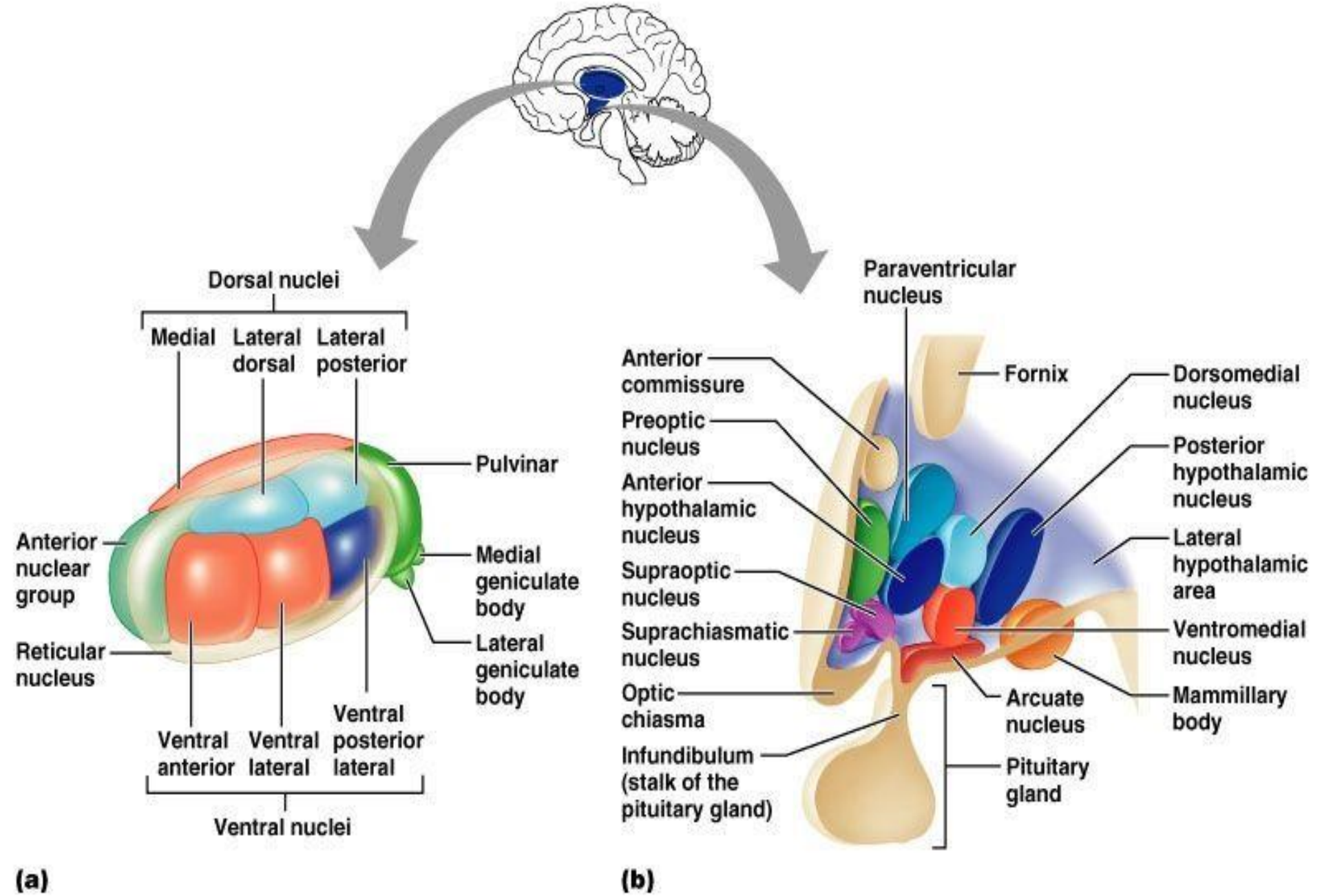
(7) secretion of various anterior pituitary hormones, especially the gonadotropins and adrenocorticotropic

hippocampus

Hippocampal neurons have been studied extensively in terms of long-term potentiation. This requires activation of glutamate receptors and results in long-term changes in neuronal excitability by way of calcium mediated physiologic effects.

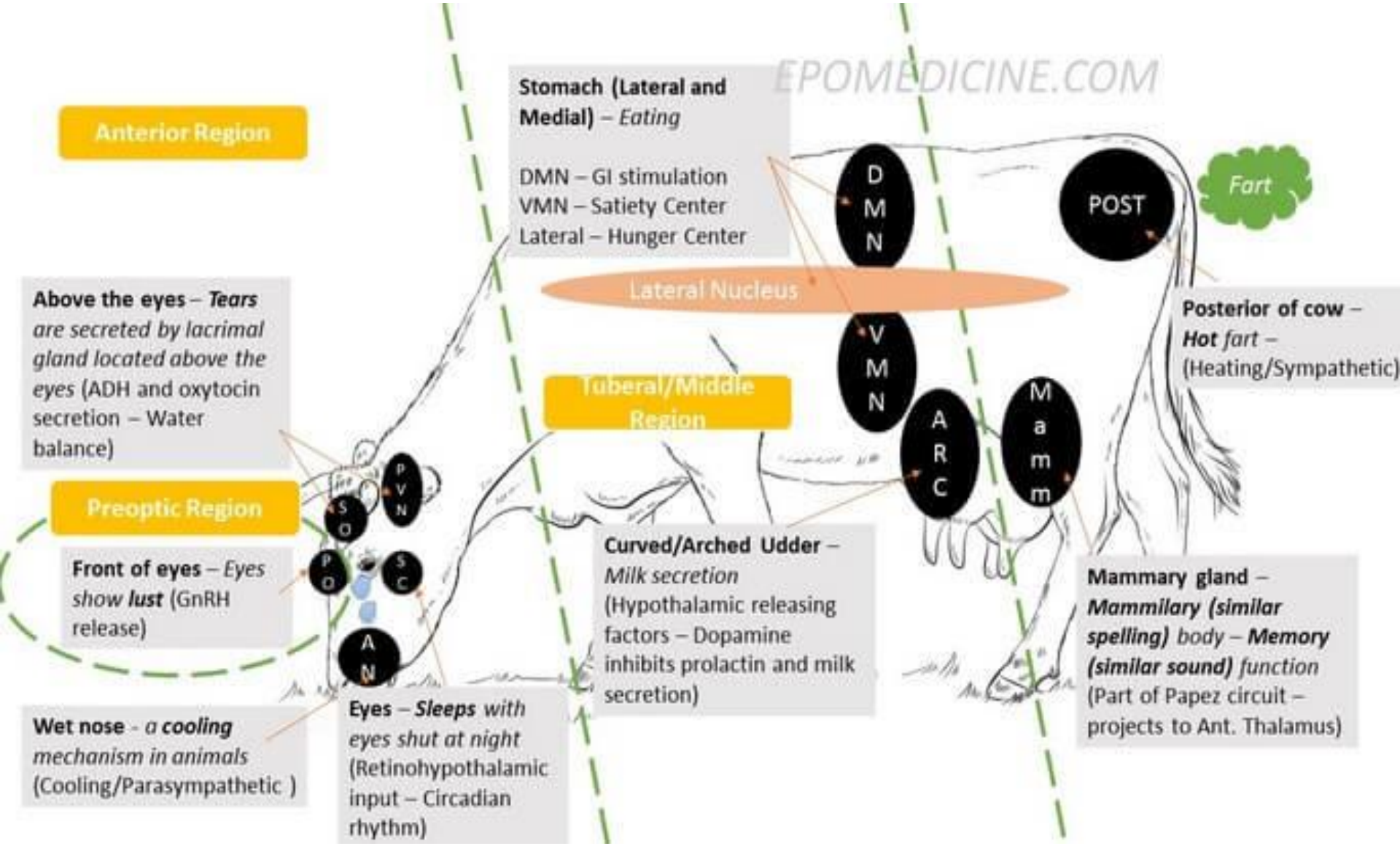
- Damage to the prefrontal area produces difficulties with abstract reasoning, judgment moods and puzzle solving

Ablation of the Anterior Temporal Cortex	Klüver-Bucy syndrome
Ablation of the Posterior Orbital Frontal Cortex	insomnia associated with intense motor restlessness
Ablation of the Anterior Cingulate Gyri and Subcallosal Gyri.	releases the rage centers of the septum and hypothalamus from prefrontal inhibitory influence. vicious and much more subject to fits of rage



Region	Medial area	Lateral area
Supraoptic	Supraoptic nucleus Paraventricular nucleus Anterior nucleus Suprachiasmatic nucleus	Lateral nucleus Part of Supraoptic nucleus
Tuberal	Dorsomedial nucleus Ventomedial nucleus Arcuate nucleus	Lateral nucleus Lateral tuberal nuclei
Mamillary	Mamillary body Posterior nucleus	Lateral nucleus

Easy way to memorize



THANKS