

Sleep



Why Do We Need Sleep?

Adaptive Evolutionary Function

- safety
- energy conservation/ efficiency

Restorative Function

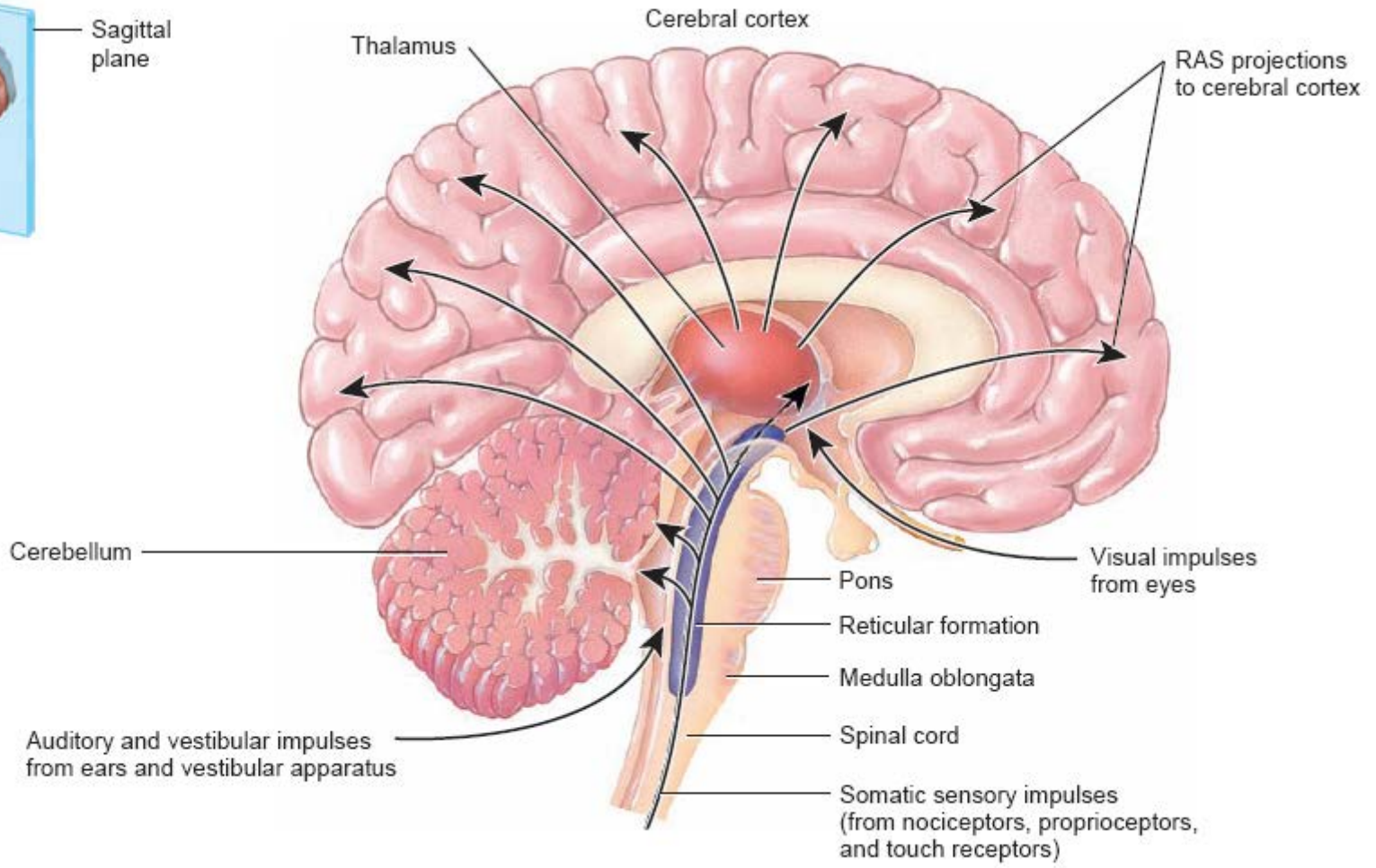
- body rejuvenation & growth

Brain Plasticity

- enhances synaptic connections
- memory consolidation



Sagittal plane



Cerebral cortex

Thalamus

RAS projections to cerebral cortex

Cerebellum

Visual impulses from eyes

Pons

Reticular formation

Medulla oblongata

Spinal cord

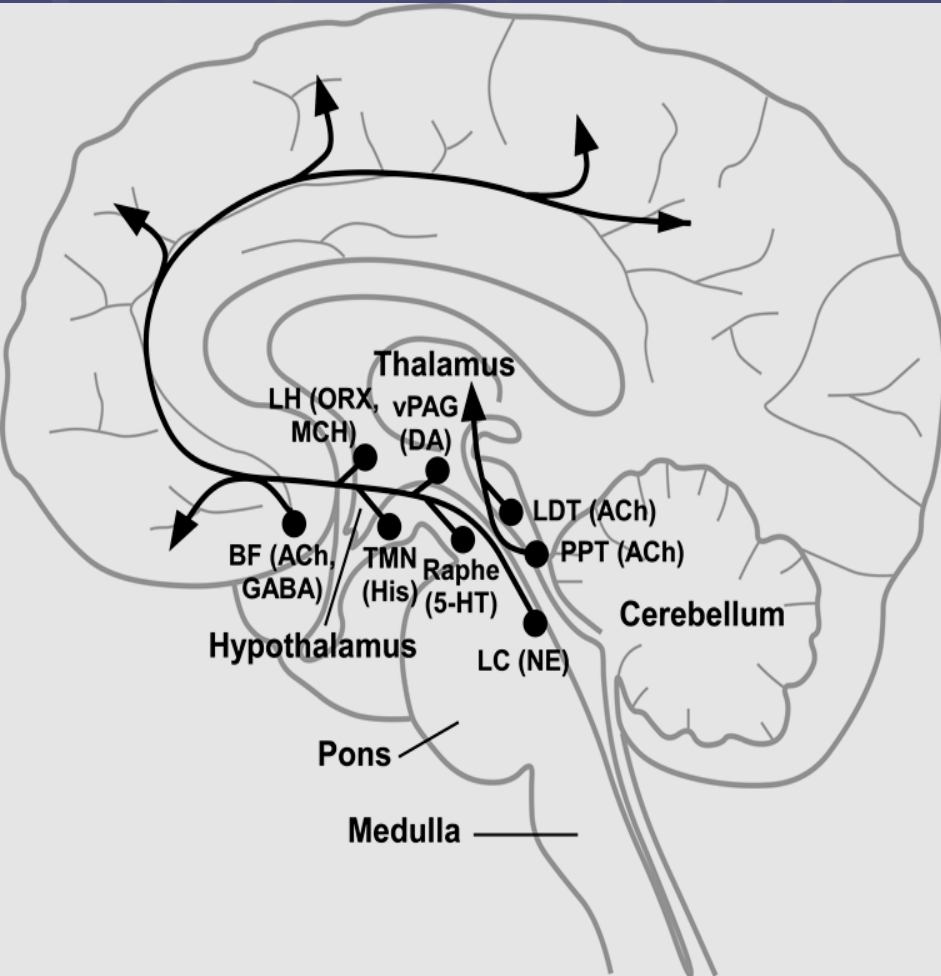
Auditory and vestibular impulses from ears and vestibular apparatus

Somatic sensory impulses (from nociceptors, proprioceptors, and touch receptors)

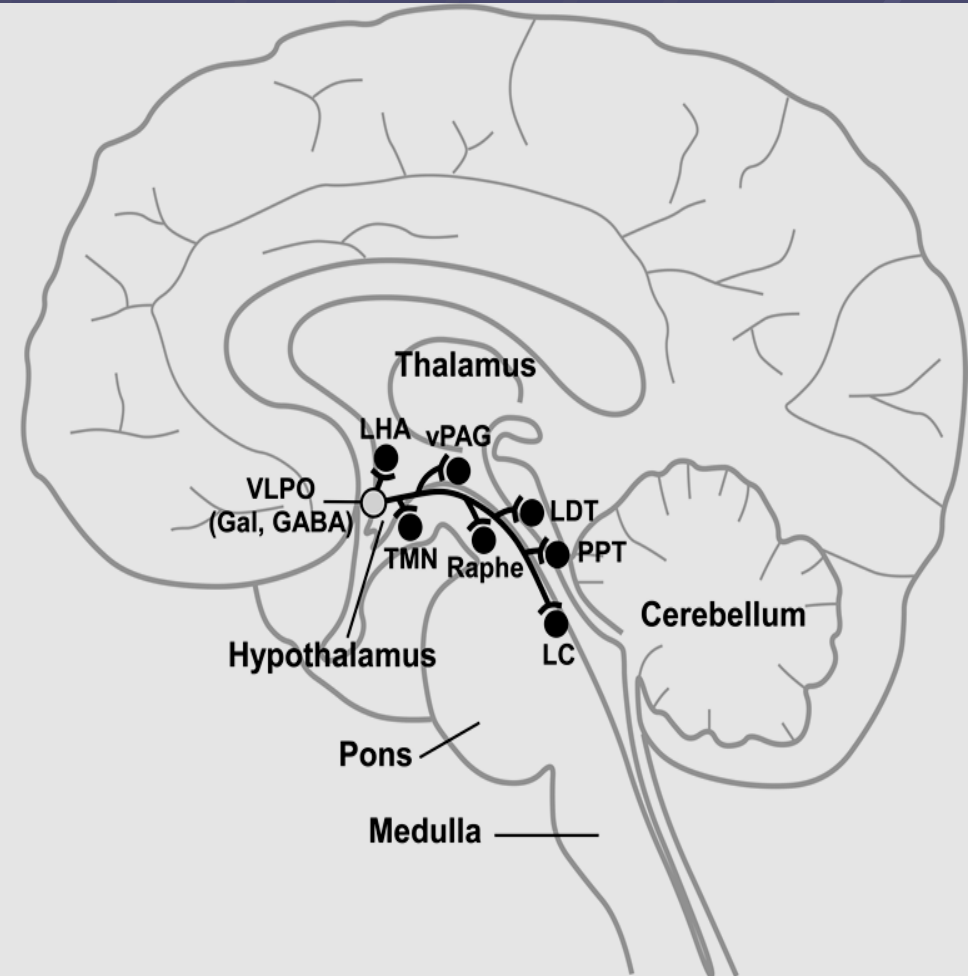
Sagittal section through brain and spinal cord

The ascending arousal system promotes wake

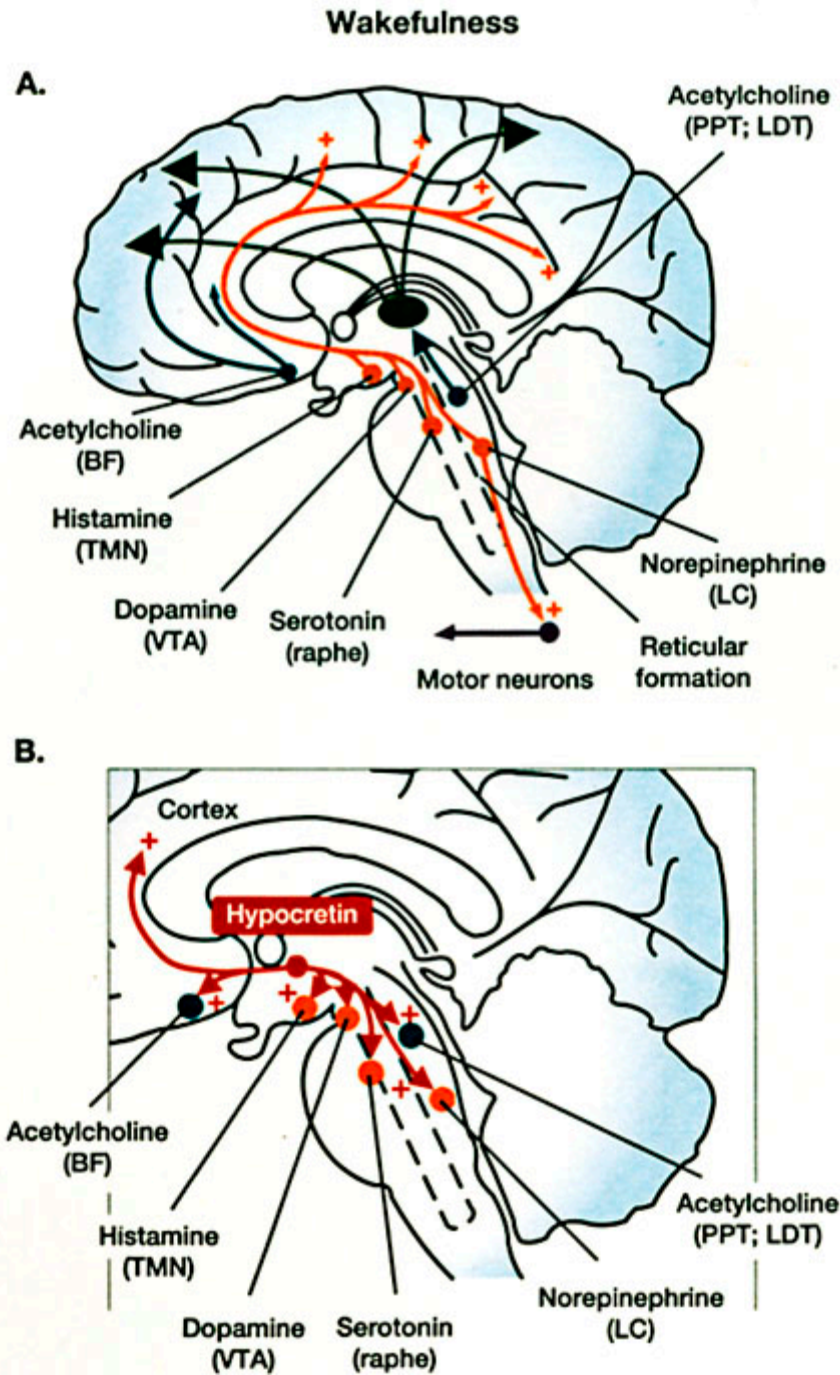
A.

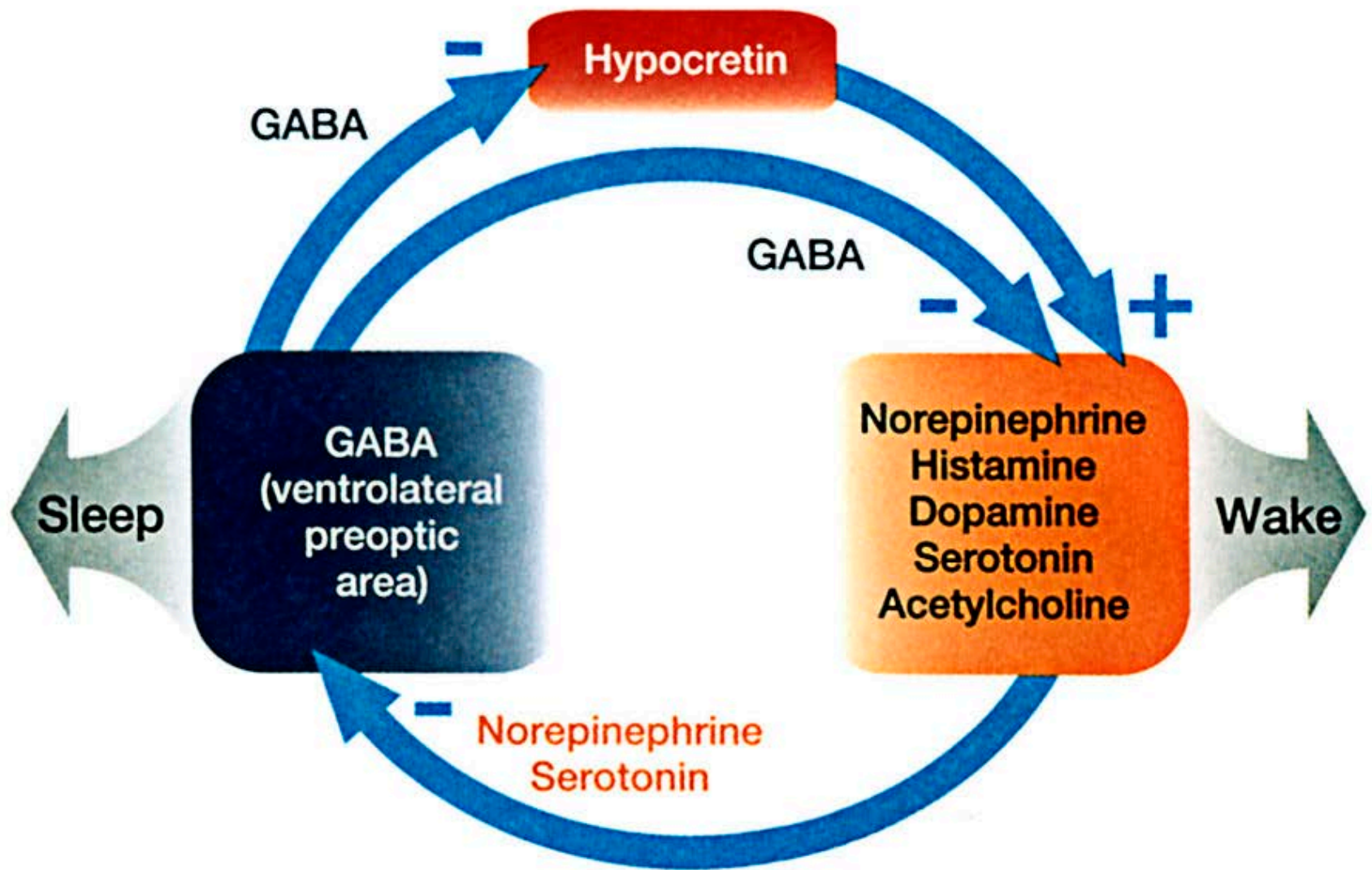


B.



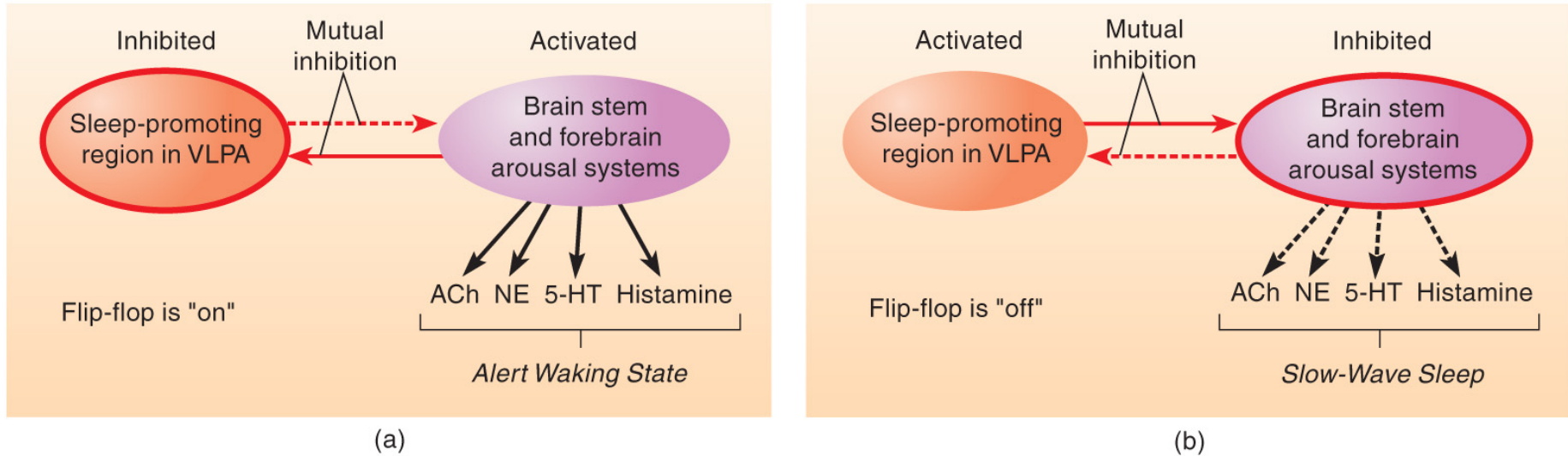
Hypocretin (orexin)





Sleep/Waking “Flip-Flop”

C7B08F11.eps



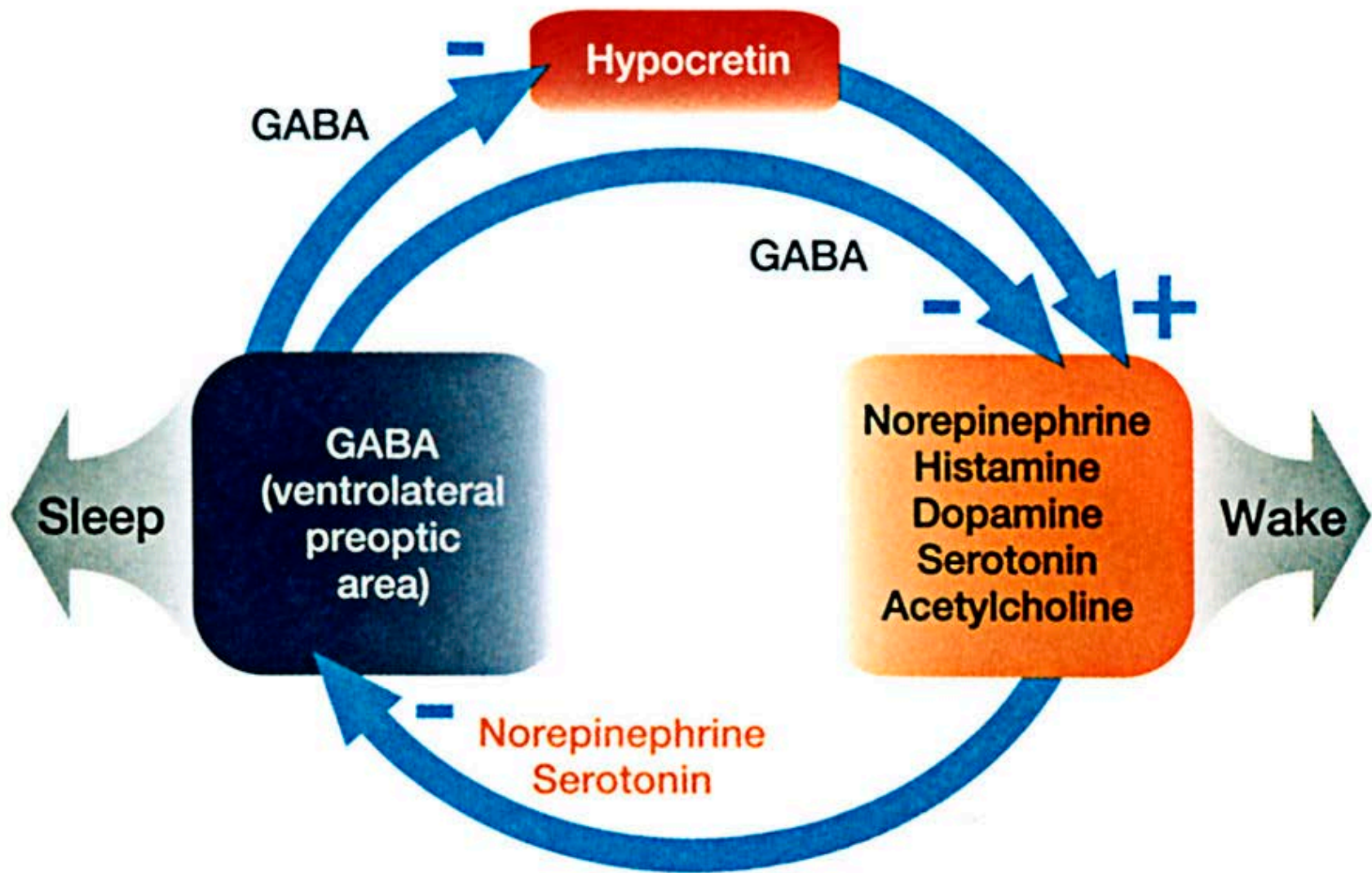
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VLPOA = ventrolateral preoptic area

ACh = acetylcholine

NE = norepinephrine

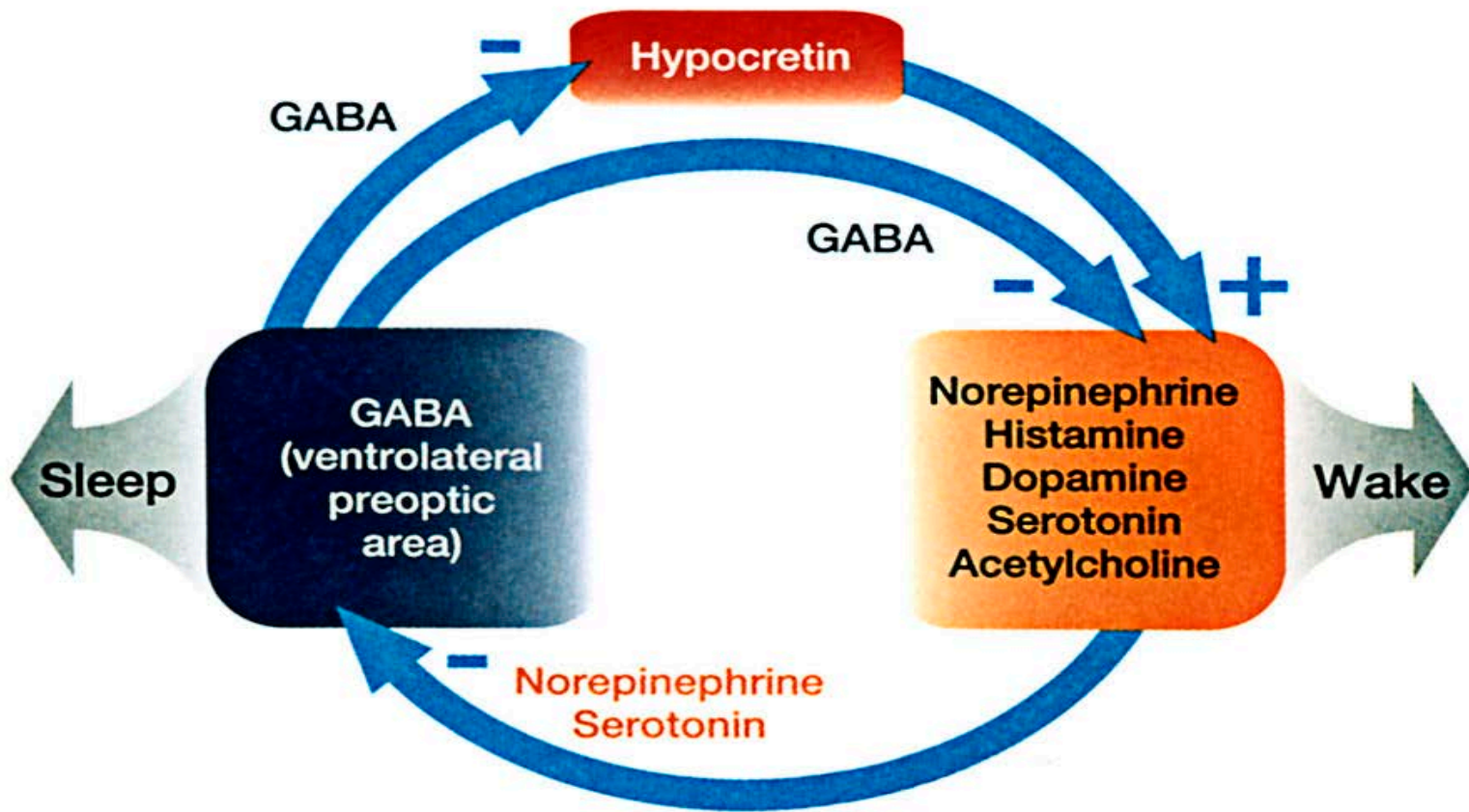
5-HT = serotonin



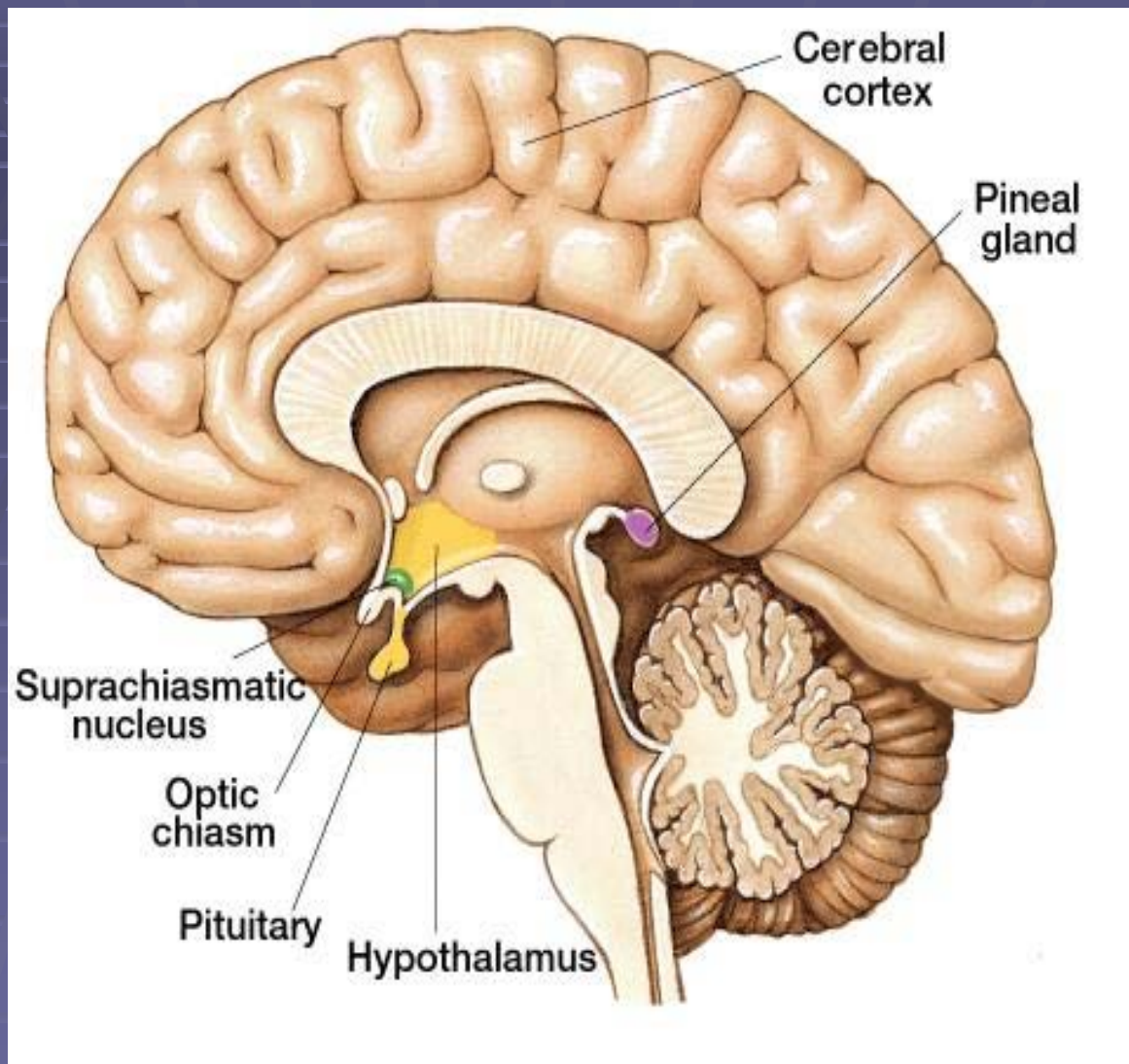
Narcolepsy

VS

Insomnia



Melatonin: Produced by pineal gland, released at night-inhibited during the day (circadian regulation); initiates and maintain sleep; treat symptoms of jet lag and insomnia



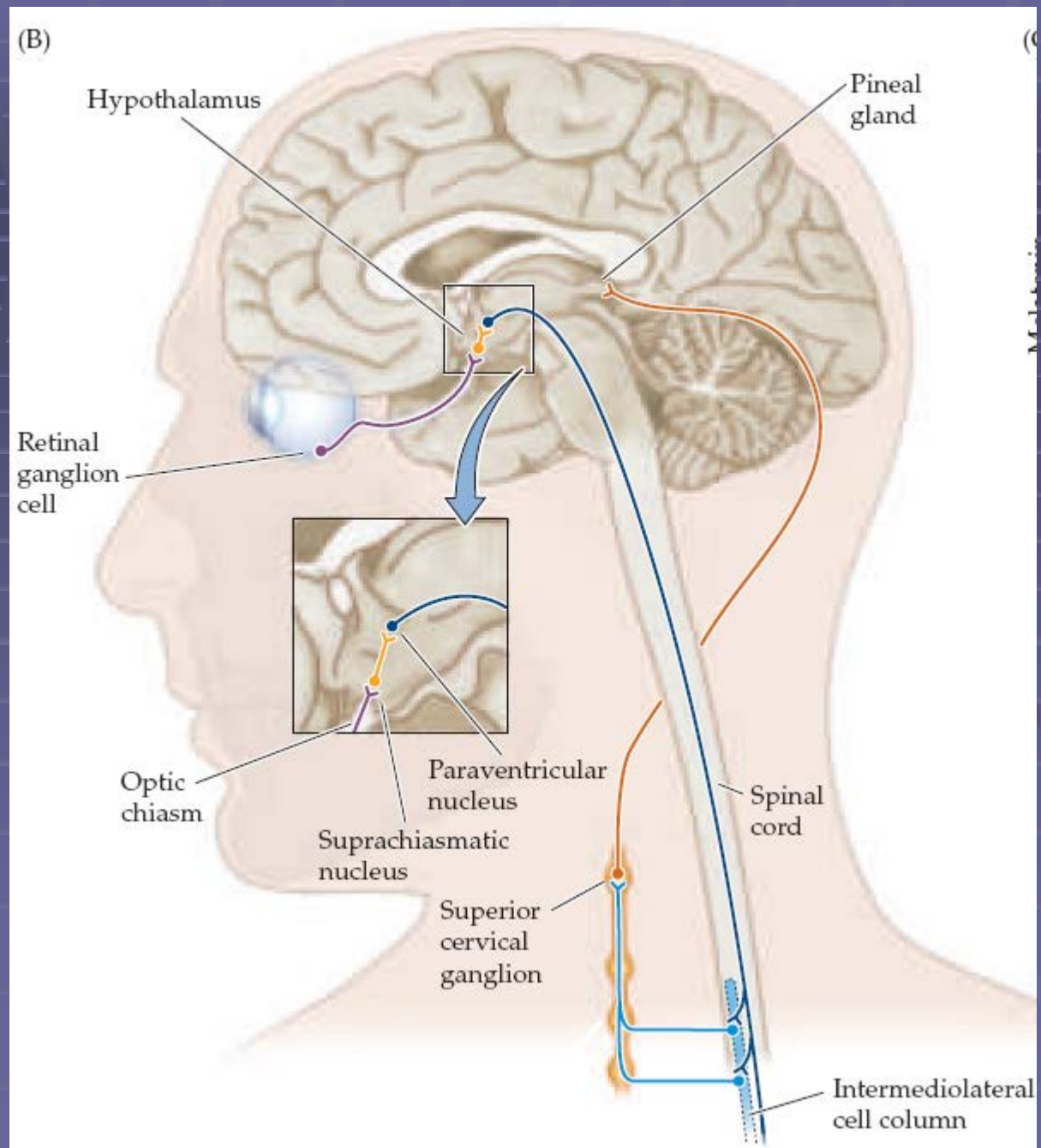
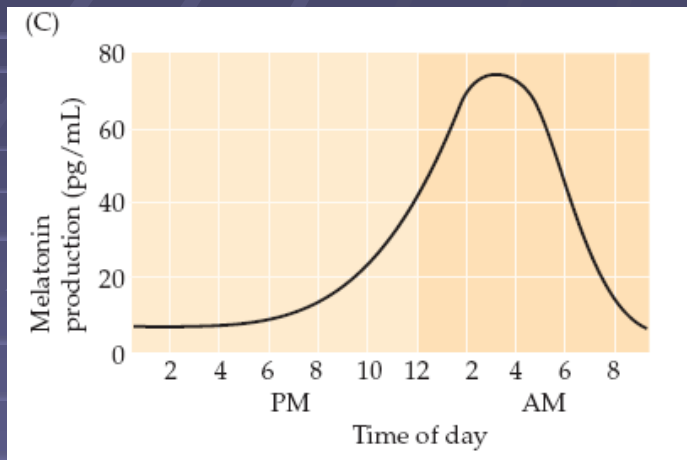
Biological Clocks

- Suprachiasmatic nucleus

- A nucleus situated atop the optic chiasm responsible for organizing circadian rhythms.

- Pineal gland

- A gland attached to the dorsal tectum; produces melatonin and plays a role in circadian and seasonal rhythms.



Coffee



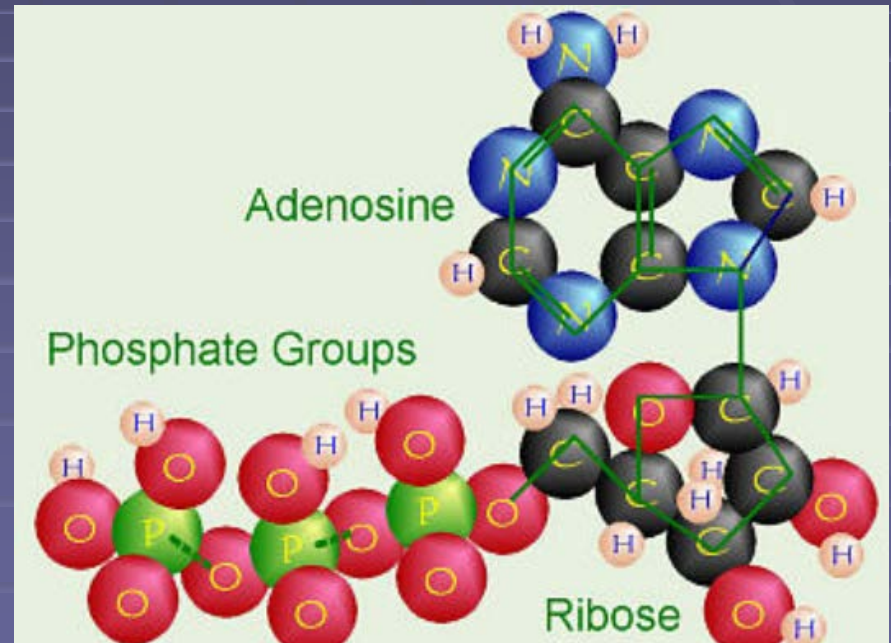
**DRINK
COFFEE**

*Do Stupid
Things
Faster
with More
Energy*



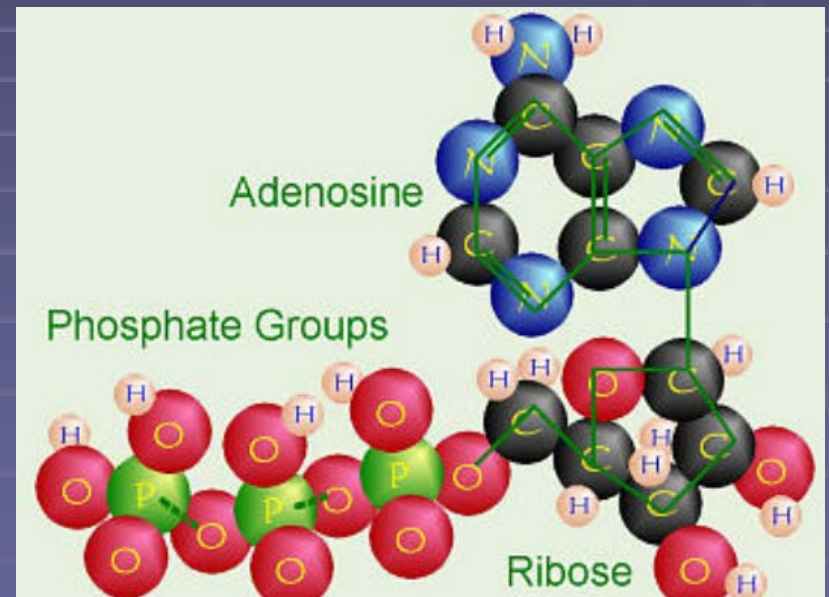
Coffee

- During waking, brain consume ATP




Coffee

- During waking, brain consume ATP
- ↑ adenosine



Coffee

- During waking, brain consume ATP
-  adenosine
- Adenosine bind to A1 receptor
- Inhibit acetylcholine neurons

Coffee

- During waking, brain consume ATP
- ↑ adenosine
- Adenosine bind to A1 receptor
- Inhibit acetylcholine neurons
- Caffeine and Theophylline are A1 antagonist

Sleep stages

- **Awake**

- ***Stage 1***

- ***Stage 2***

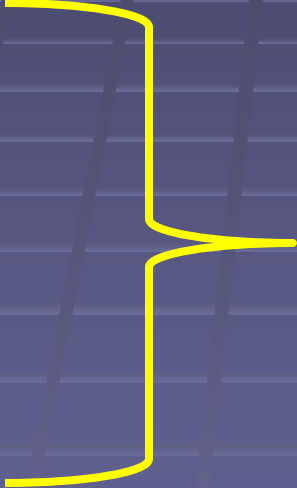
- ***Stage 3***

- ***Stage 4***



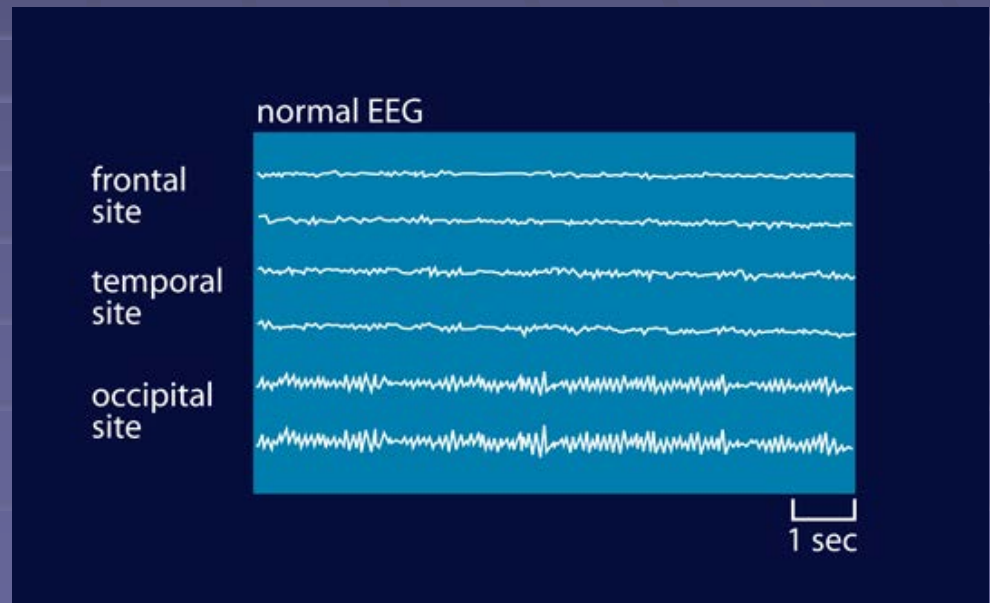
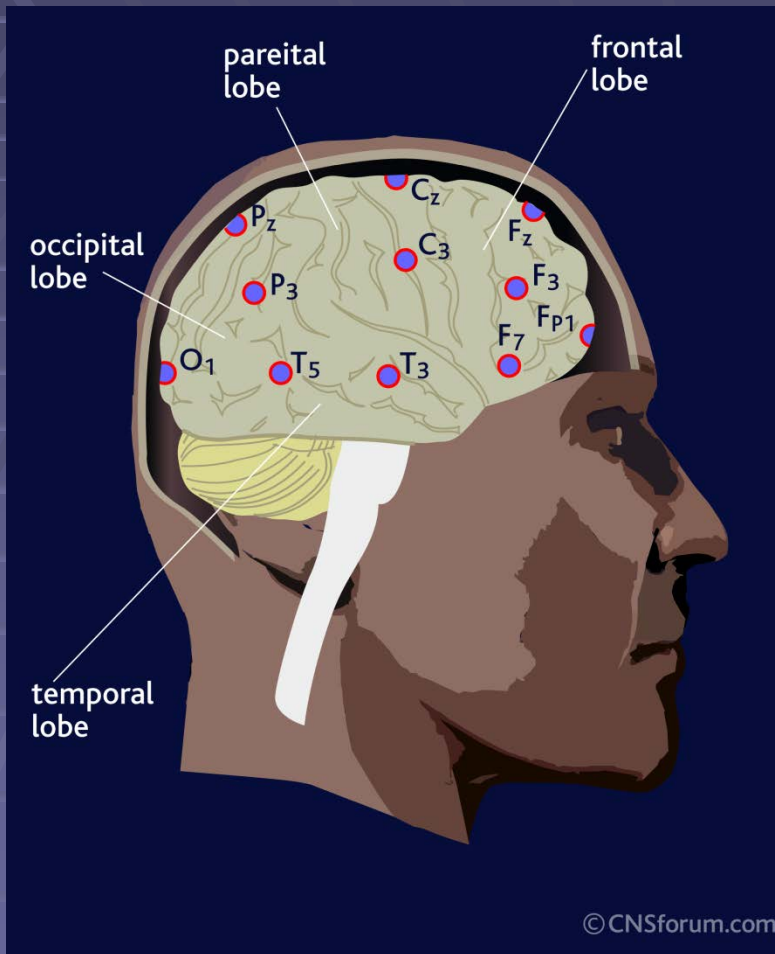
Slow wave sleep

Sleep stages

- **Awake**
 - ***Stage 1***
 - ***Stage 2***
 - ***Stage 3***
 - ***Stage 4***
 - **Rapid eye movement sleep (REM)**
- Slow wave sleep (NREM)
- 

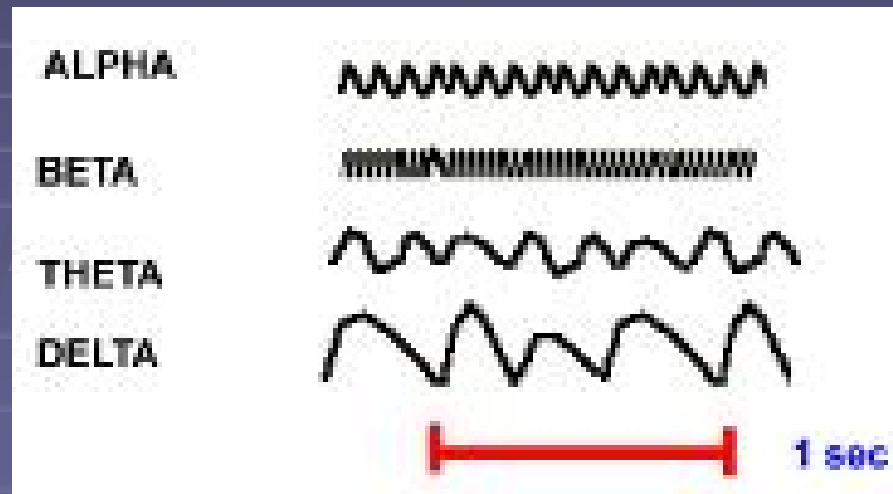
EEG waves

EEG Electrode Placement



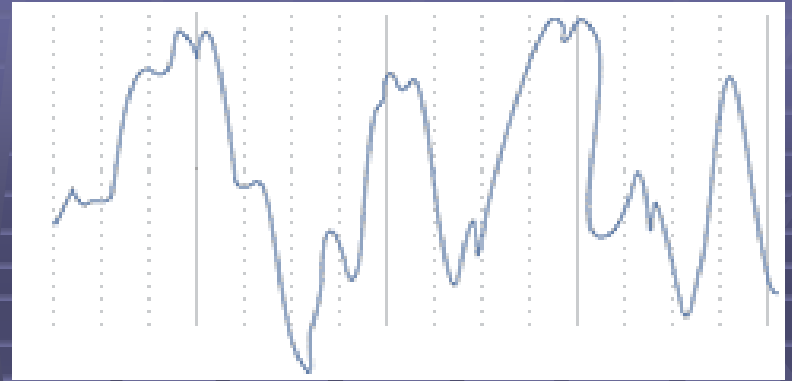
Classifying EEG brain waves

- **Frequency**: the number of oscillations/waves per second, measured in Hertz (Hz)
 - reflects the firing rate of neurons
 - alpha, beta, theta, delta



- **Amplitude**: the magnitude of brain waves, measured in millivolts (mV), gives an indication of the wave's "power".
 - The number of neurons firing in synchrony & the distance between the neurons and the recording electrode

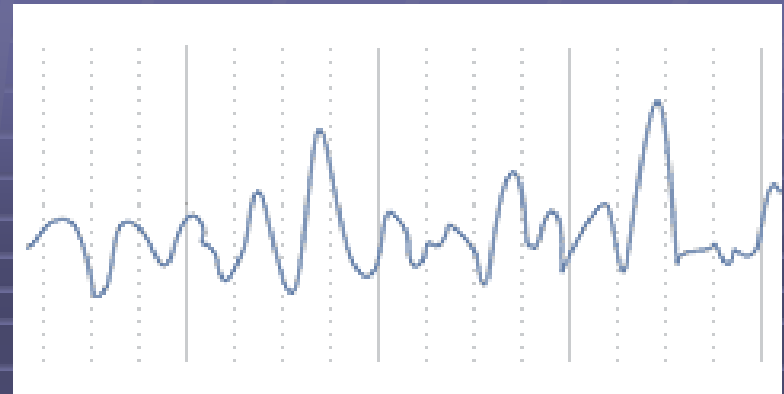
Delta Waves



- Slowest frequency waves: 1 – 3 Hz
- Associated tasks & behaviors:
 - deep, dreamless sleep, not moving, not attentive, sleeping



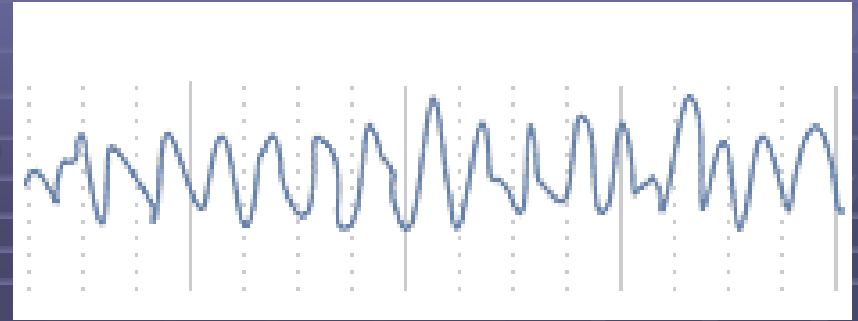
Theta Waves



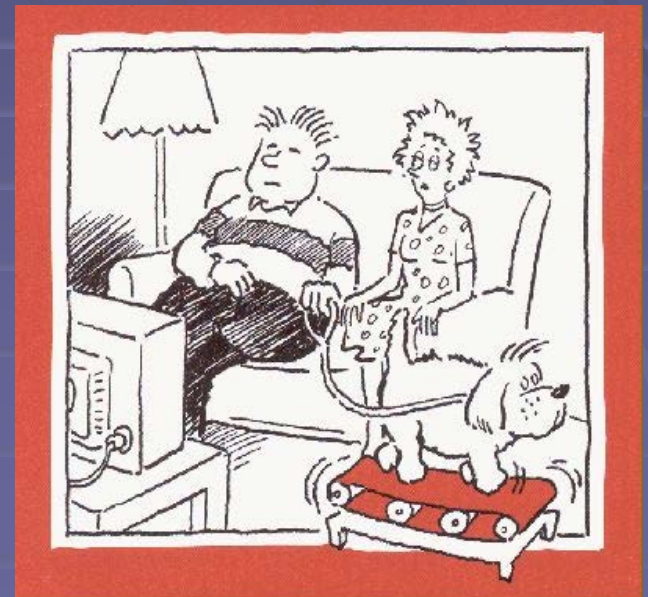
- Slow wave frequency: 4 – 8 Hz
- Associated tasks & behaviors:
 - State between wakefulness and sleep
“Drowsy”
 - during sleep, meditation, internal focus, and prayer; subconsciousness.



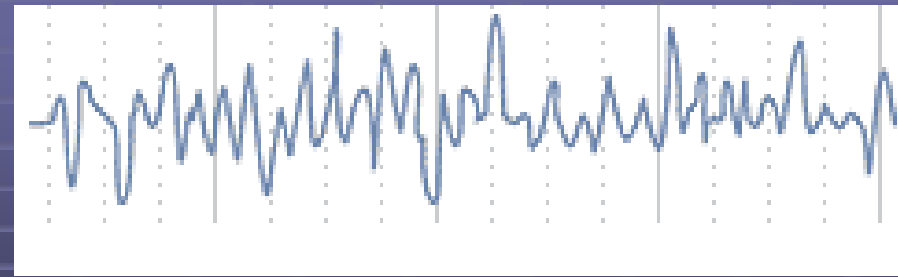
Alpha Waves



- Mid wave frequency: 8 - 13 Hz
- Parietal and occipital lobes
- Associated tasks & behaviors:
 - Relaxing, watching television, light reading (e.g., novel), eyes closed.



Beta Waves



- High wave frequency: 12 - 35 Hz

- The “normal” dominant rhythm \
- mostly on temporal and frontal lobe

- Associated tasks & behaviors:

- listening and thinking during analytical problem solving, judgment, decision making, processing information,

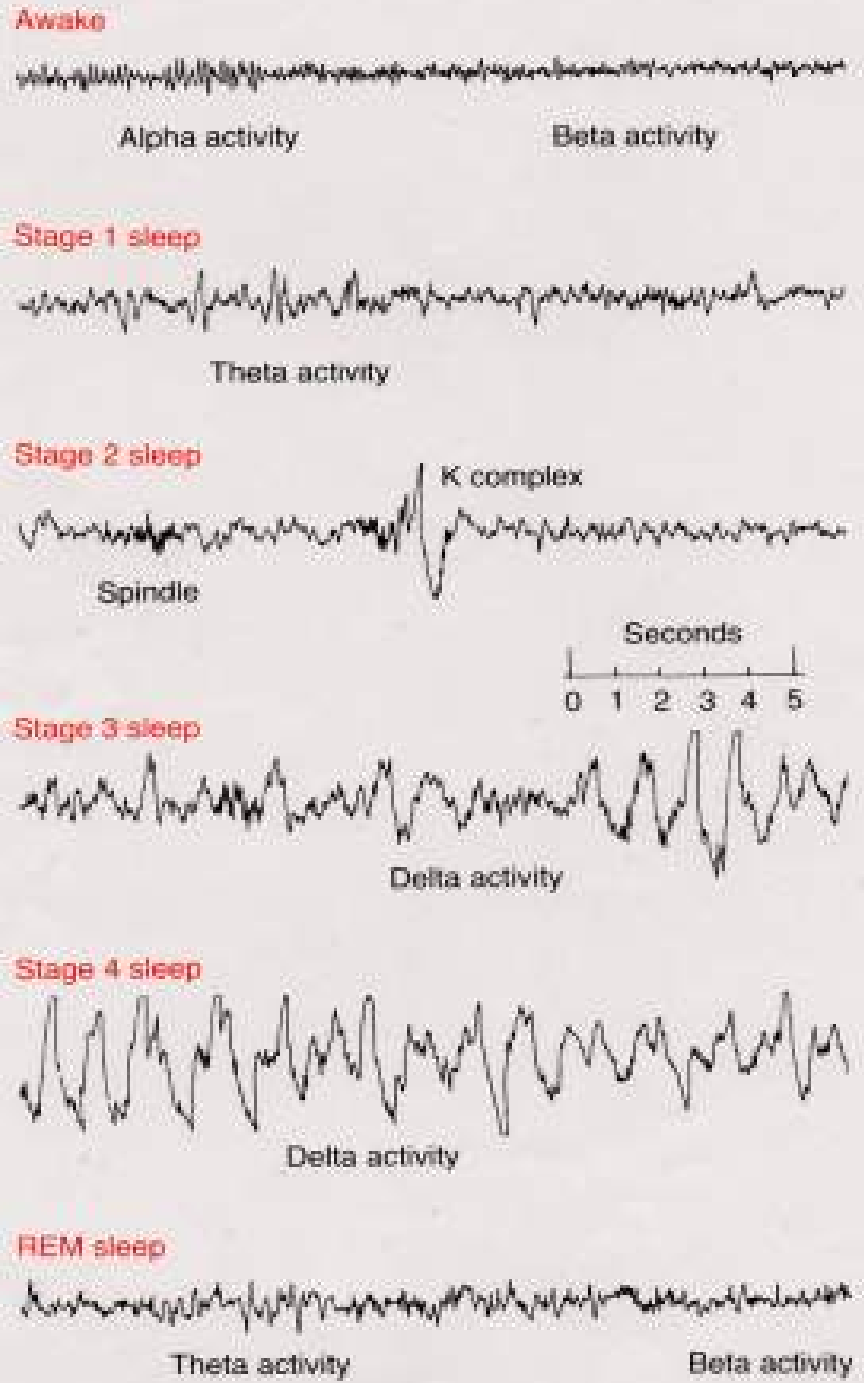


EEG Waveforms

- Alpha
 - 8-13 Hz
 - Parietal and occipital prominent
 - Relaxed wakeful
- Beta
 - 13-30 Hz
 - Frontal prominent
 - Intense mental activity
- Delta
 - 0.5-4 Hz
 - Drowsiness/early SWS
- Theta
 - 4-7 Hz
 - Drowsiness/early SWS

Types and Stages of Sleep: NREM

- Stage 1 – eyes are closed and relaxation begins; the EEG shows alpha waves; one can be easily aroused
- Stage 2 – EEG pattern is irregular with sleep spindles (high-voltage wave bursts); arousal is more difficult



–Stage 3 – sleep deepens;; theta and delta waves appear; vital signs decline; dreaming is common

–Stage 4 – EEG pattern is dominated by delta waves; skeletal muscles are relaxed; arousal is difficult

Awake



Alpha activity

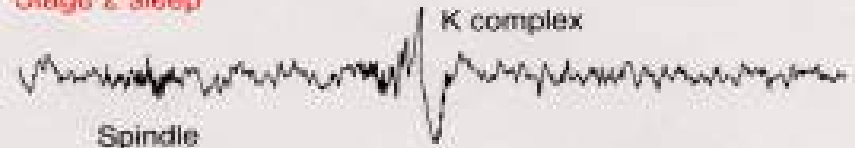
Beta activity

Stage 1 sleep



Theta activity

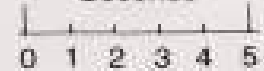
Stage 2 sleep



Spindle

K complex

Seconds



Stage 3 sleep



Delta activity

Stage 4 sleep



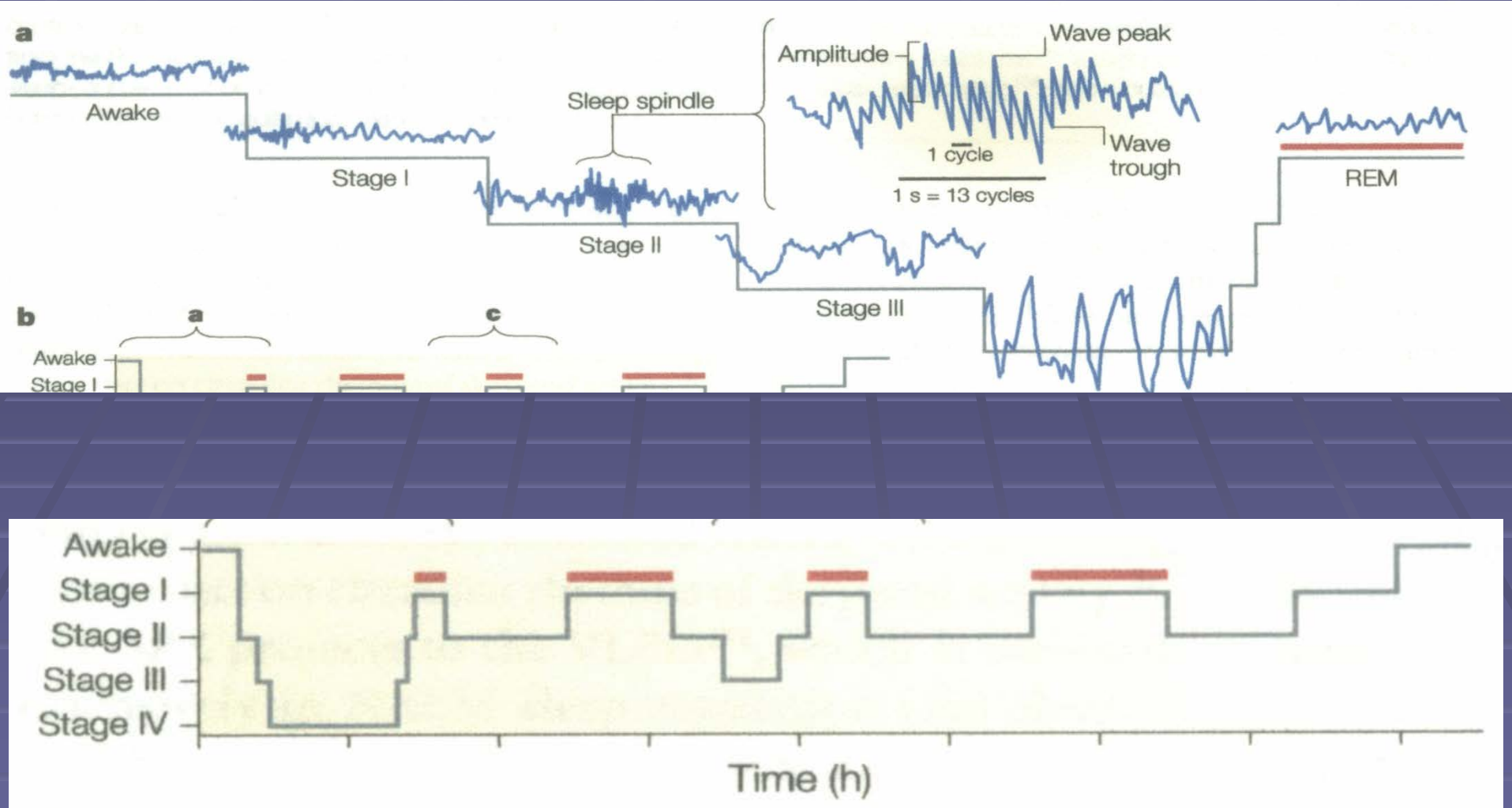
Delta activity

REM sleep



Theta activity

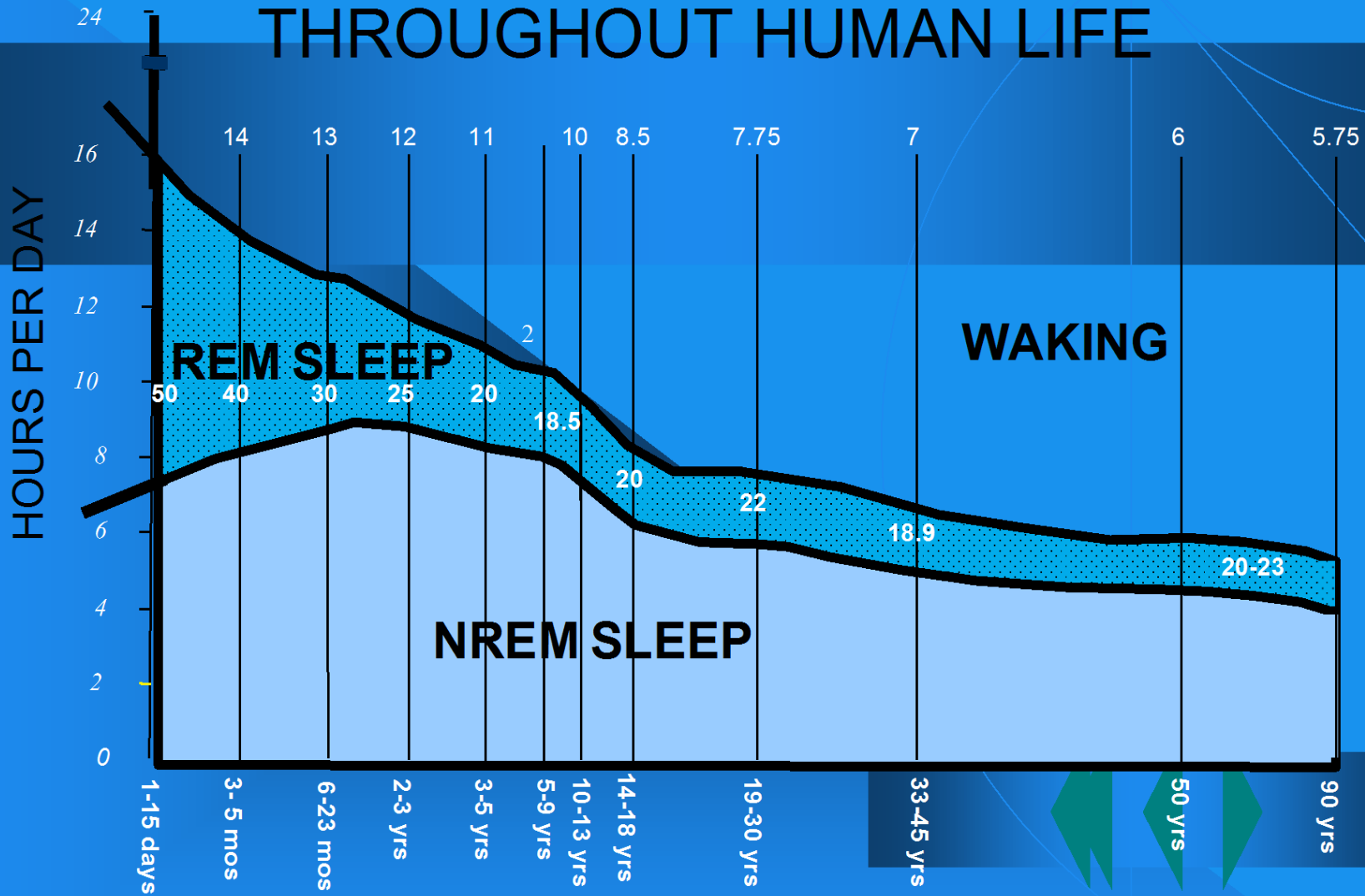
Beta activity



REM Sleep

- Presence of beta activity (desynchronized EEG pattern)
- Physiological arousal threshold increases
 - Heart-rate quickens
 - Breathing more irregular and rapid
 - Brainwave activity resembles wakefulness
 - Genital arousal
- Loss of muscle tone (paralysis)
- Vivid, emotional dreams
- May be involved in memory consolidation

SLEEP AND WAKE THROUGHOUT HUMAN LIFE



AFTER ROFFWARG , MUZIO & DEMEMT, *Science* (1966).

REM Dreaming

NREM Dreaming

“vivid and exciting”

~3 per night

- Longer, more detailed
- Fantasy world
- nightmares

● “just thinking”

Shorter, less active

- Logical, realistic

Dream theories

- Activation synthesis theory
 - Sensory experiences are fabricated by the cortex as a means of interpreting signals from the PGO activity.
- Continual activation theory
 - Encoding of short term into long-term memories.
 - NREM sleep processes the conscious-related memory (declarative memory),
 - REM sleep processes the unconscious related memory (procedural memory).

Sleep Disorders

- insomnia
- sleep walking, talking, and eating
- nightmares and night terrors
- narcolepsy
- sleep apnea

Sleep Disorders

- **Insomnia:** persistent problems in falling asleep, staying asleep, or awakening too early
- **Sleep Apnea:** repeated interruption of breathing during sleep
- **Narcolepsy:** sudden and irresistible onsets of sleep during normal waking hours



Sleep disorders



- **Nightmares:** anxiety-arousing dreams occurring near the end of sleep, during REM sleep
- **Night Terrors:** abrupt awakenings from NREM sleep accompanied by intense physiological arousal and feelings of panic

Sleep Disorders

- **Somnambulism...sleepwalking**
 - 40% of children will have an episode, peaking at between 11-12 years of age;
 - Can be induced if arouse children during NREM;
 - associated with complete amnesia,
 - Occurs within 2 hours of falling asleep.. EEG..reveals both waking and sleep signals. Considered benign.

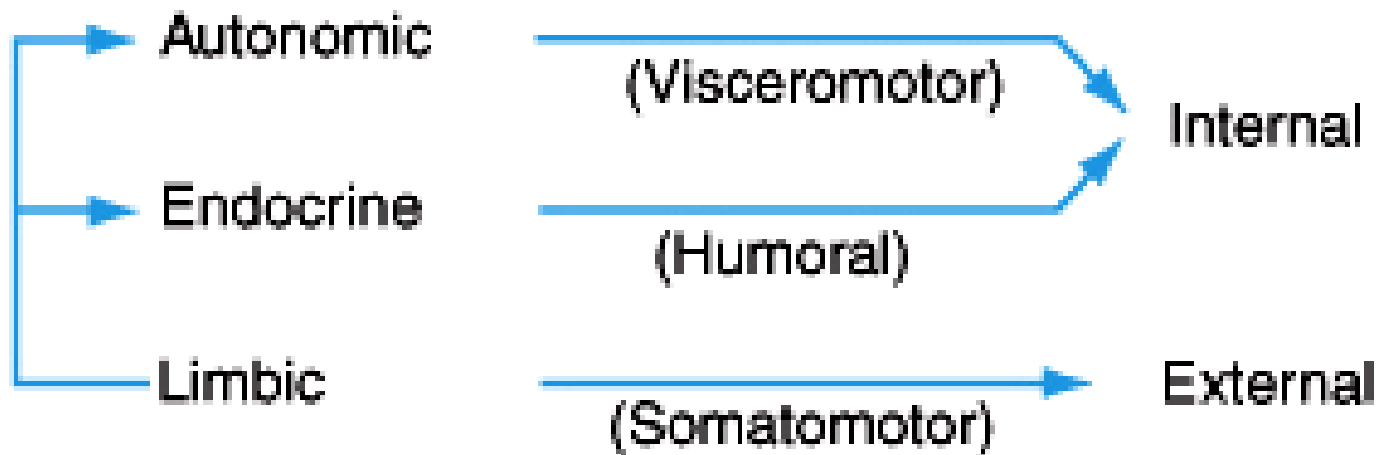
Coma & Brain death

- Definition:
 - Greek in origin – “deep sleep or trance”
 - It refers to an unconscious state characterised by a lack of both arousal and responsiveness

The Hypothalamus

SYSTEMS:

ENVIRONMENT:

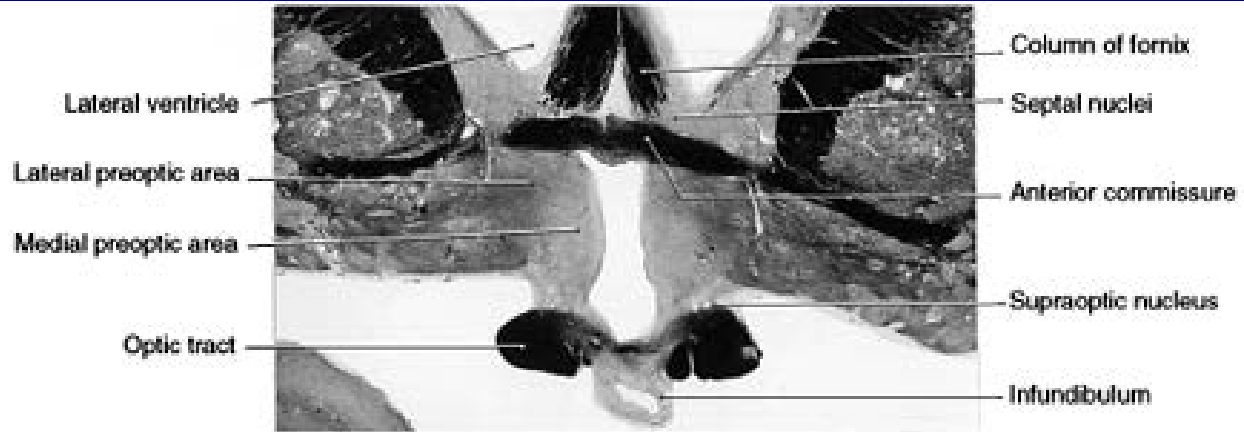


Functions of hypothalamus

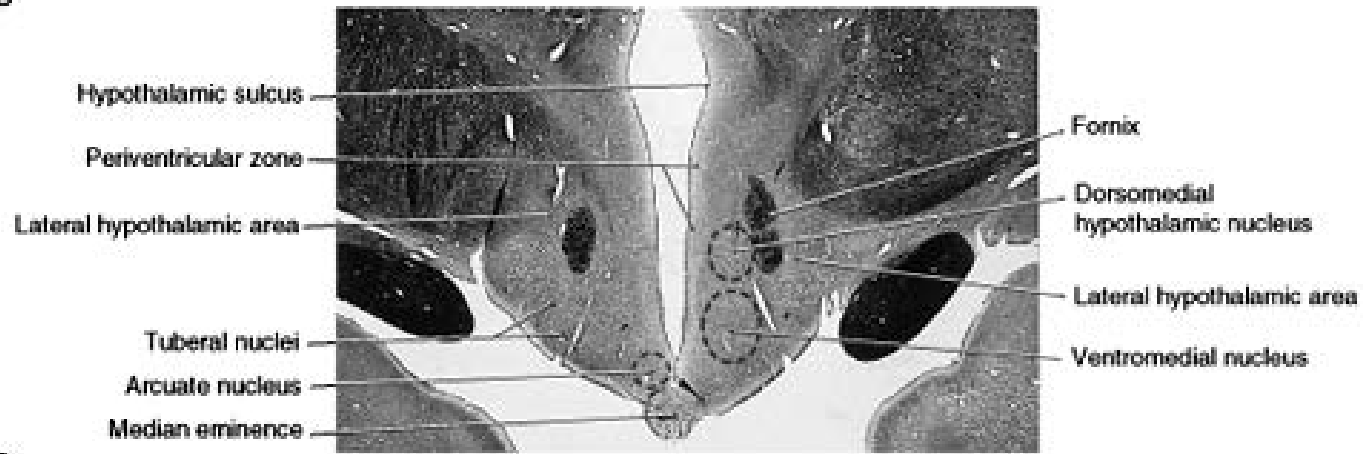
- Endocrine function
- Caloric balance
- Osmolarity balance
- Thermal regulation
- Autonomic balance
- Sleep
- Affective behavior
- Memory
- Somatic movements



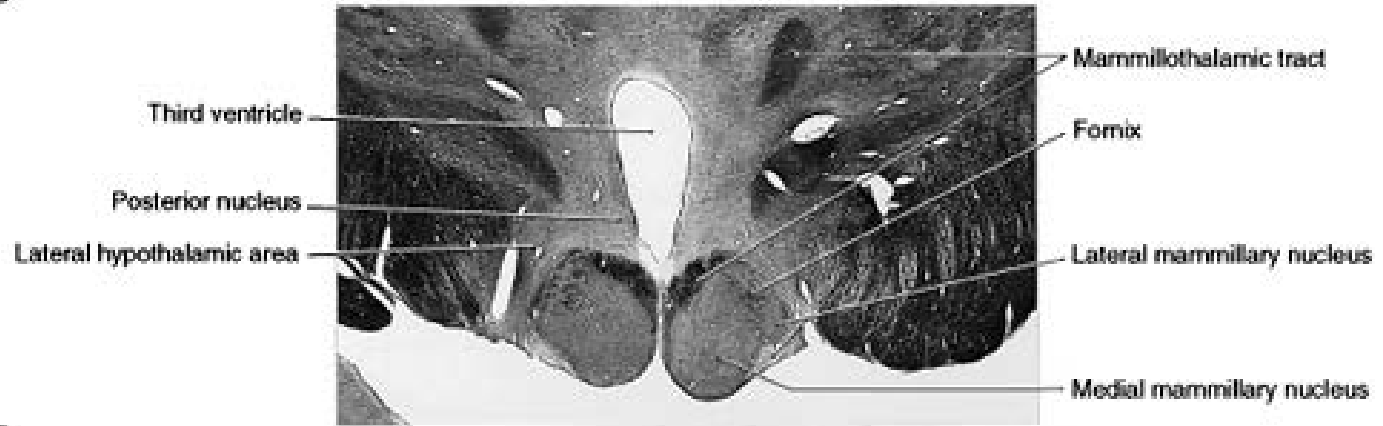
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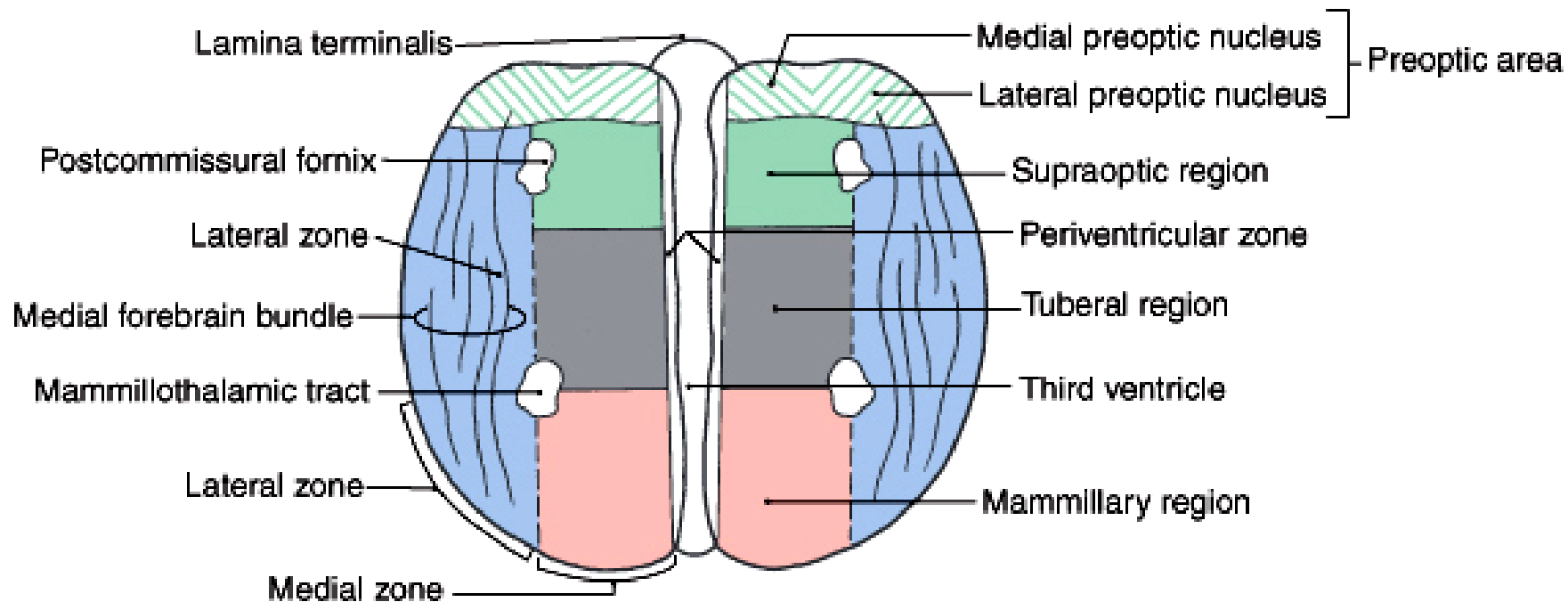
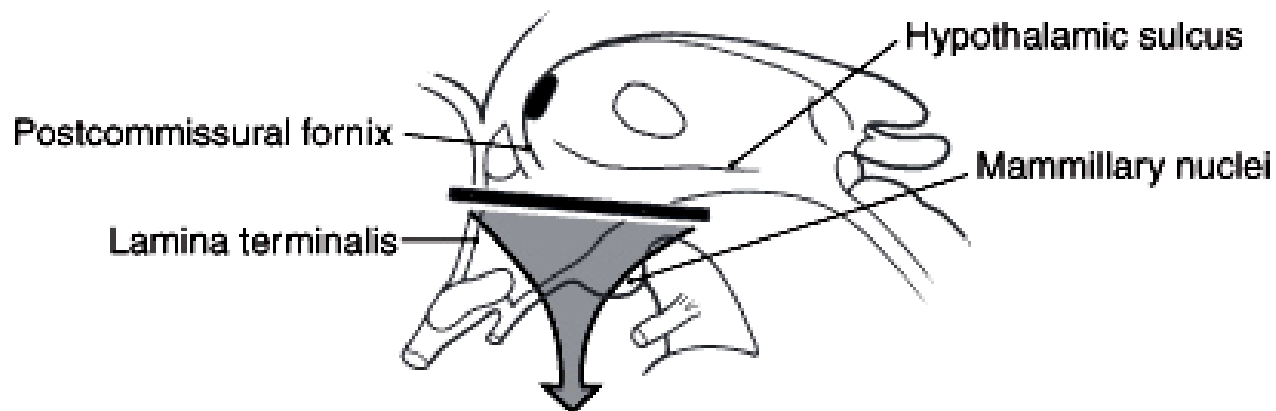
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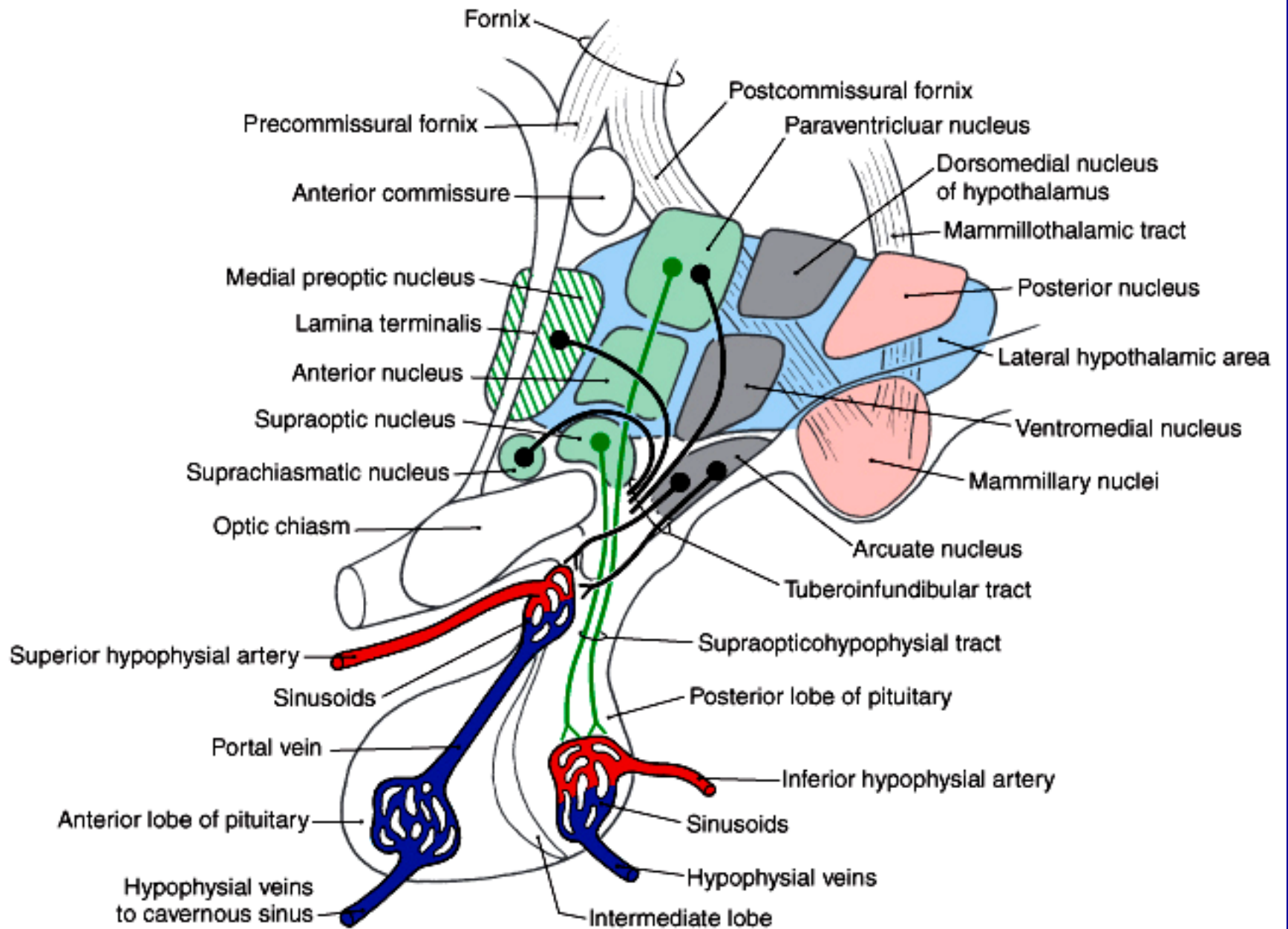


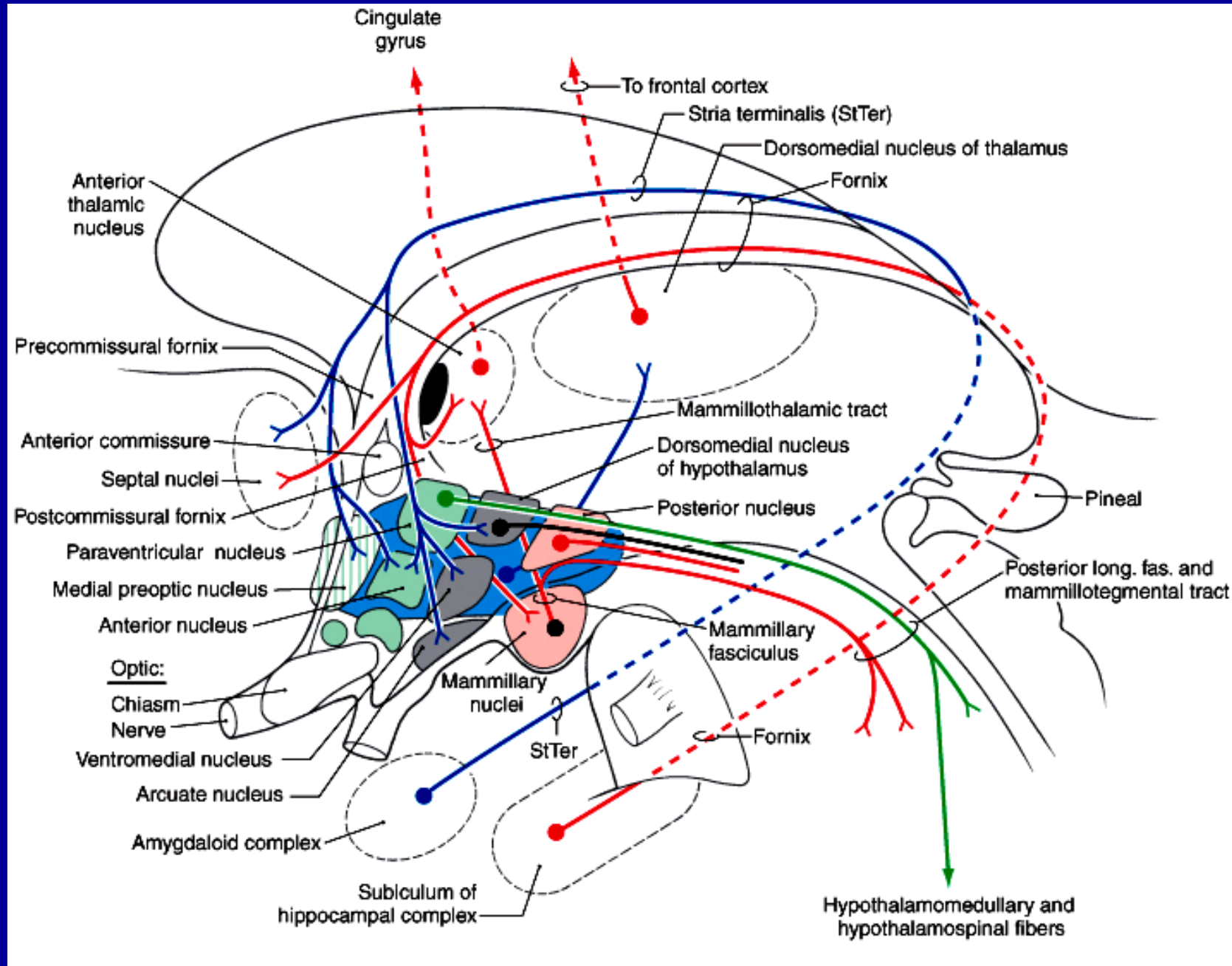
C

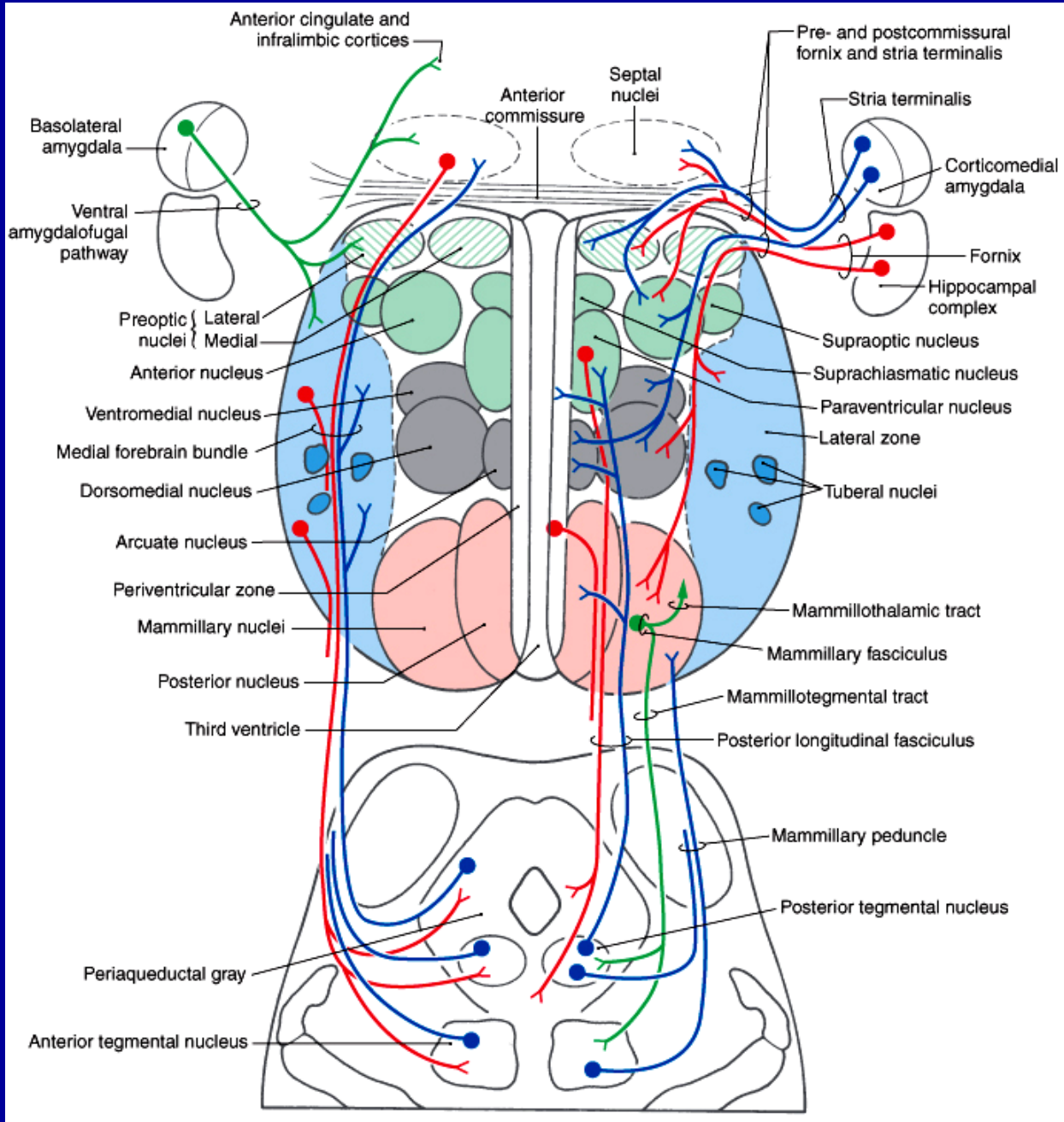


D









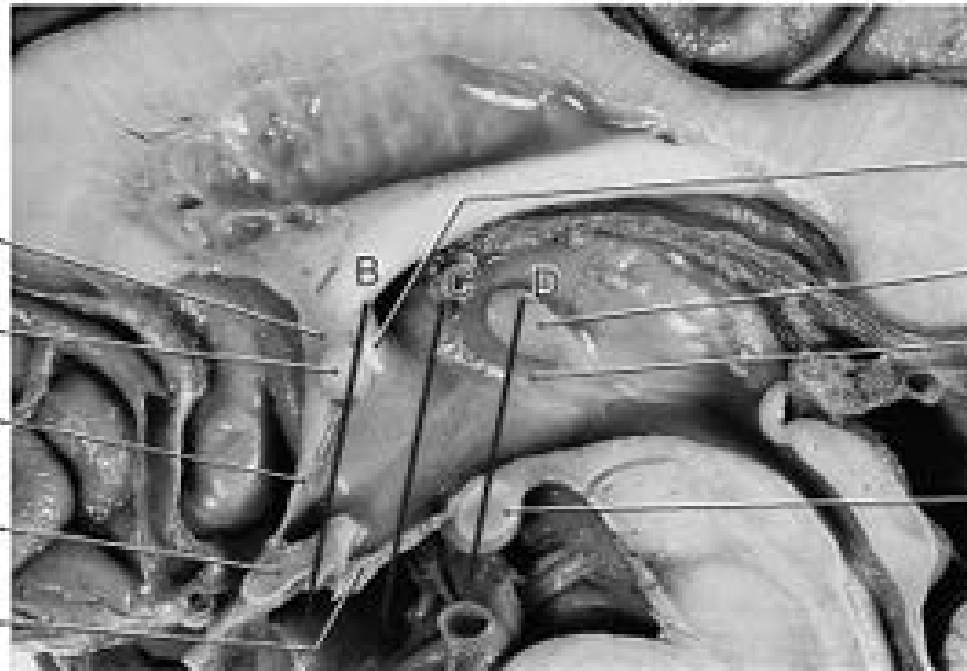
Precommissural fornix

Anterior commissure

Lamina terminalis

Optic chiasm

Infundibulum



Postcommissural fornix

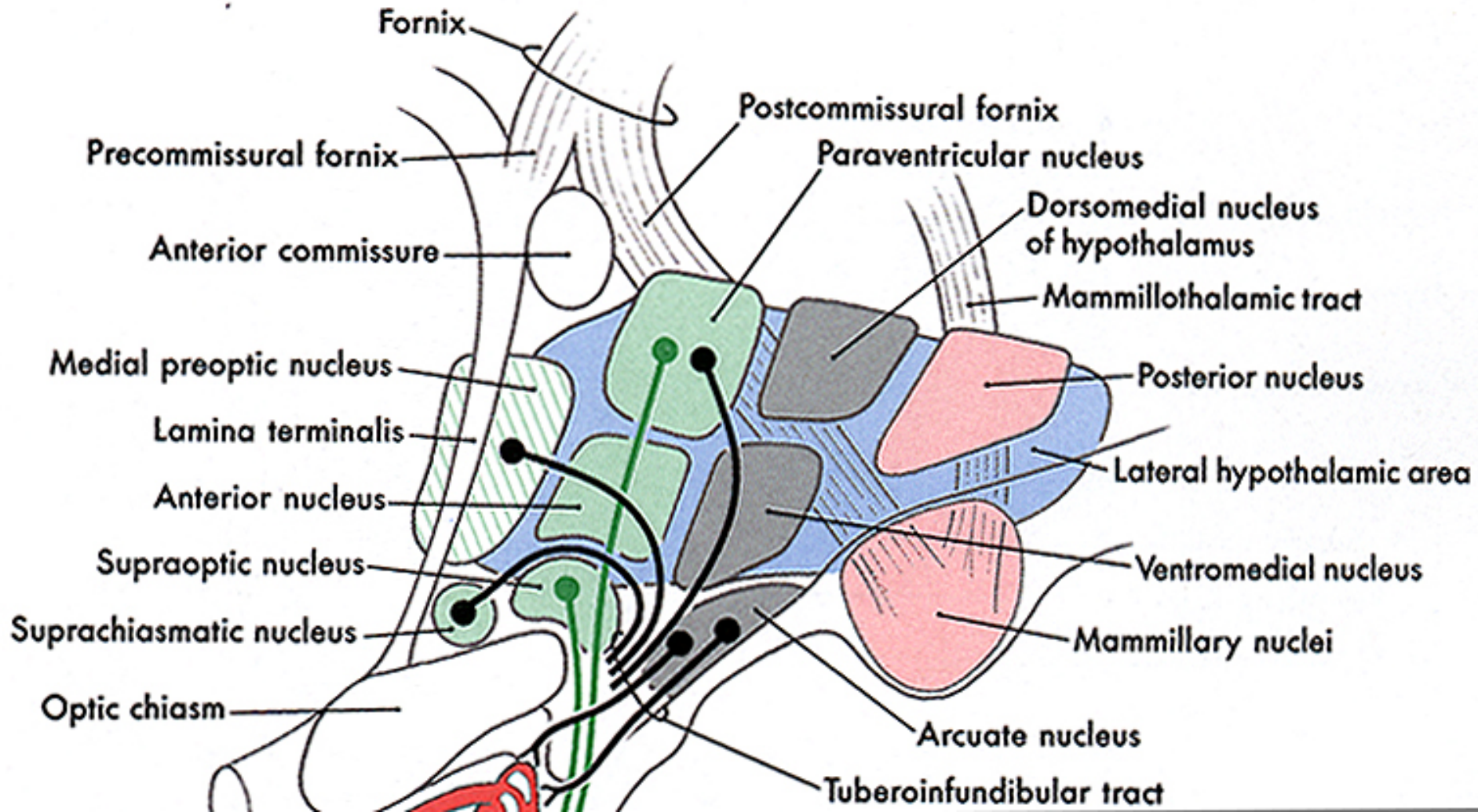
Massa intermedia

Hypothalamic sulcus

Mammillary body

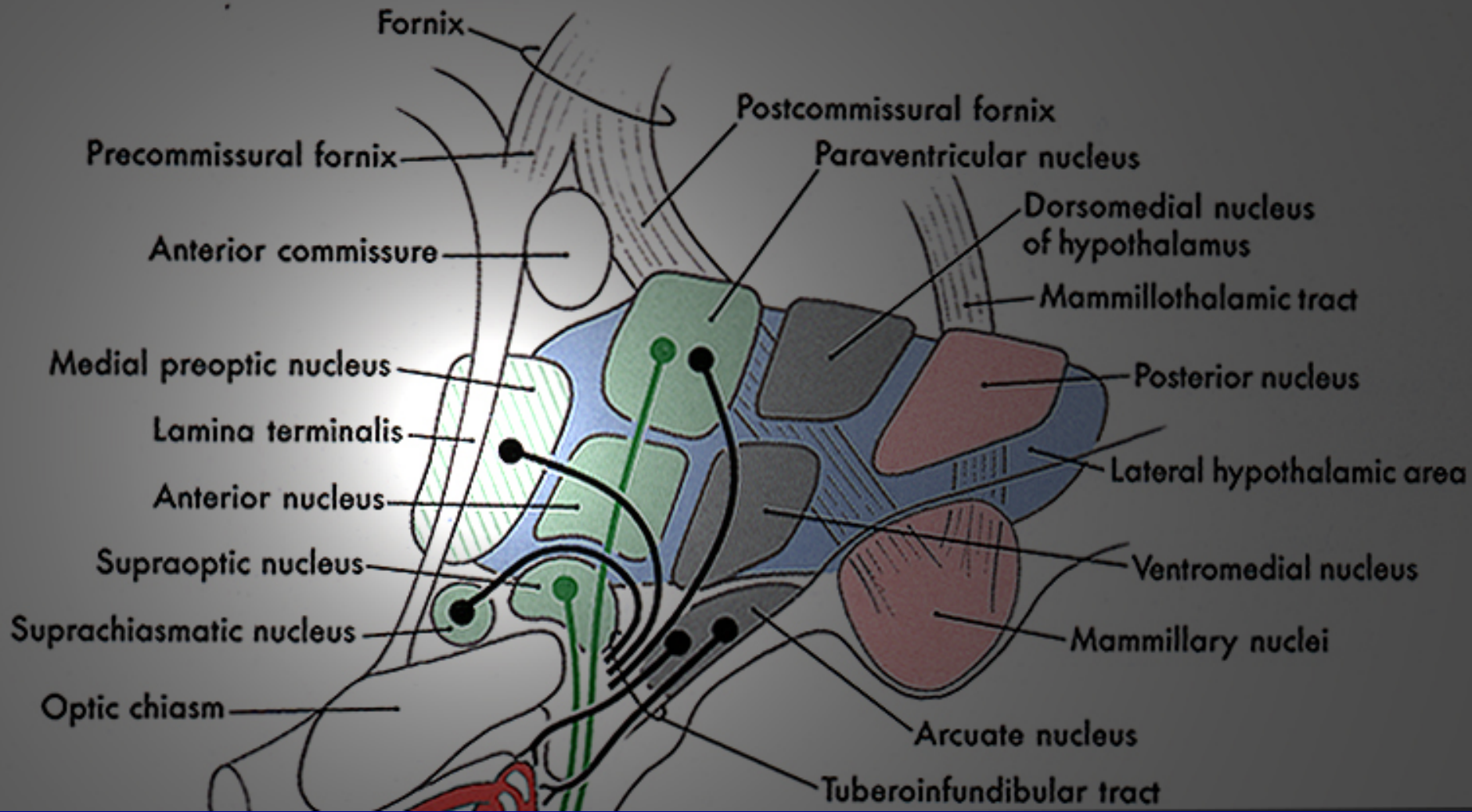
A

Anatomy of Hypothalamus

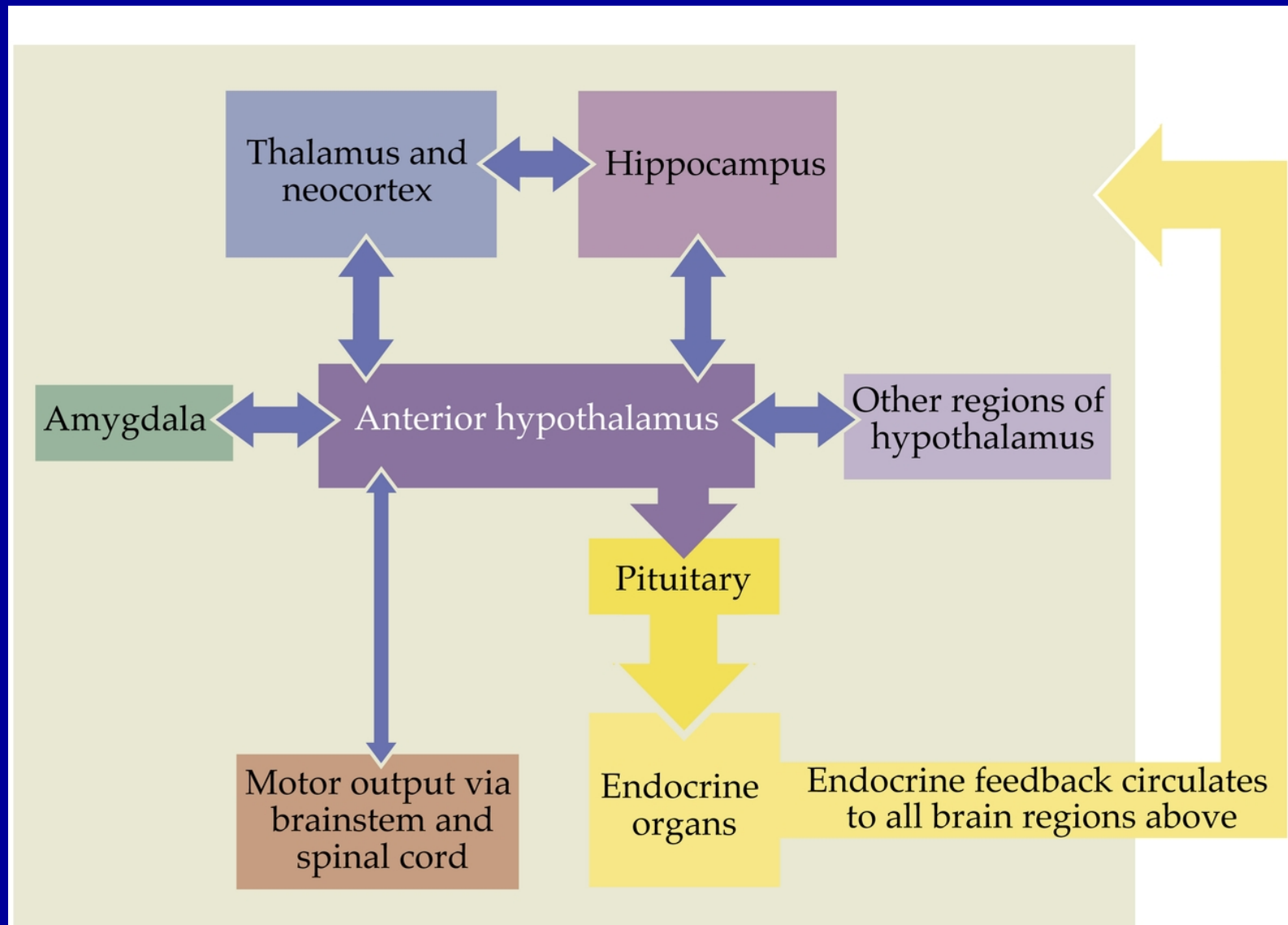


Preoptic area

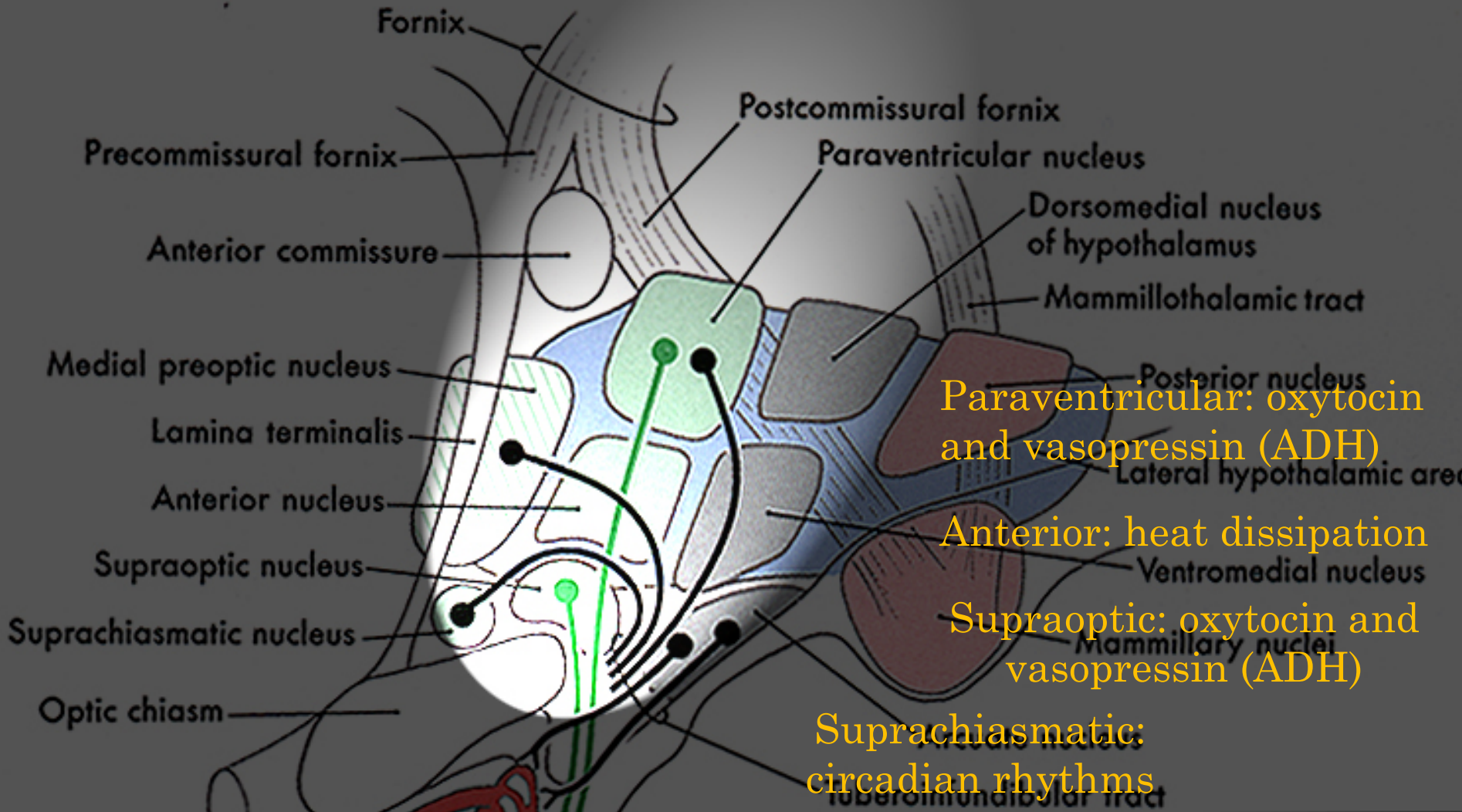
- Medial preoptic: LHRH
- Lateral preoptic: motor control



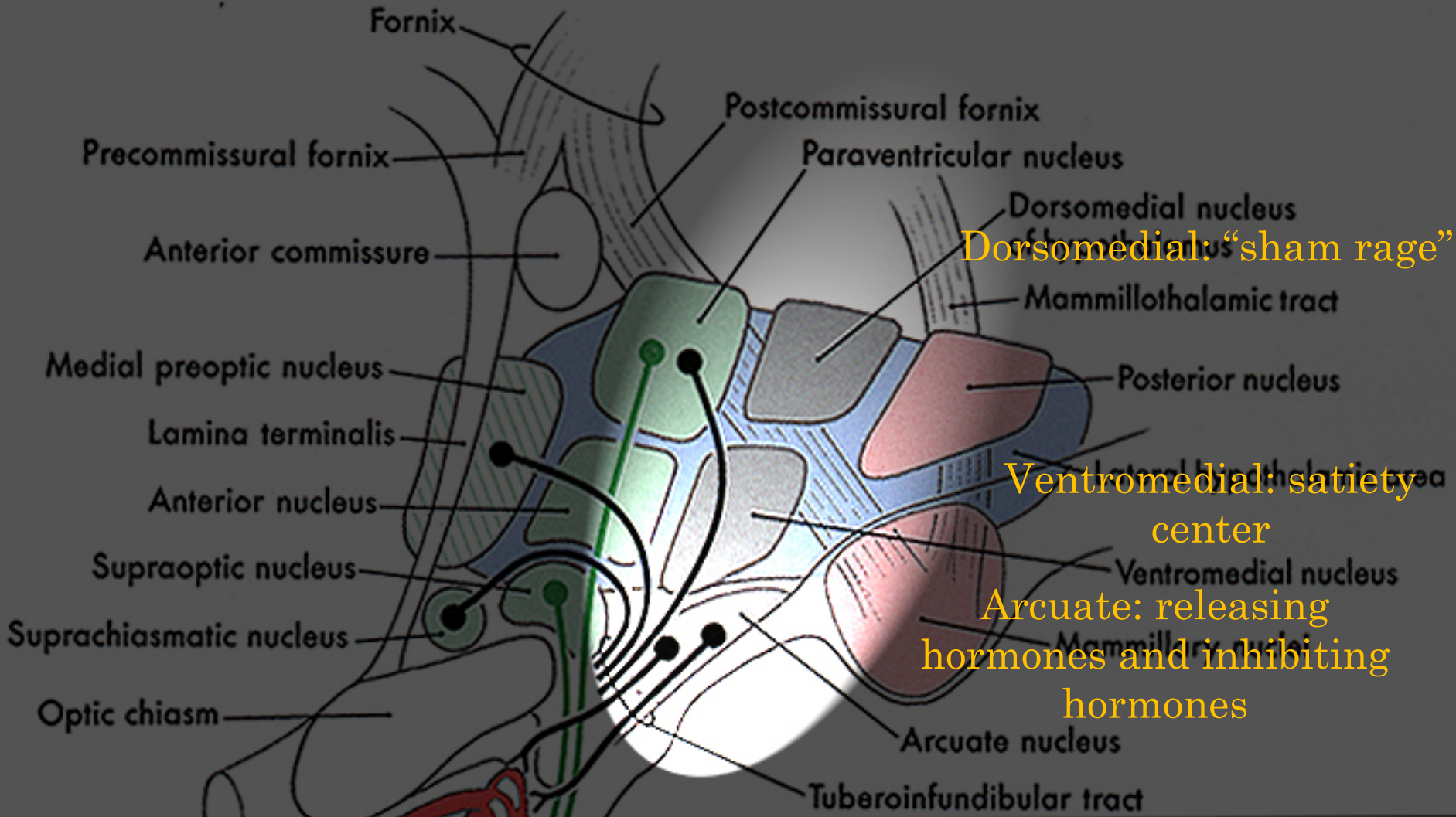
Motor connections of hypothalamus



Supraoptic region



Tuberal region



Mammillary region

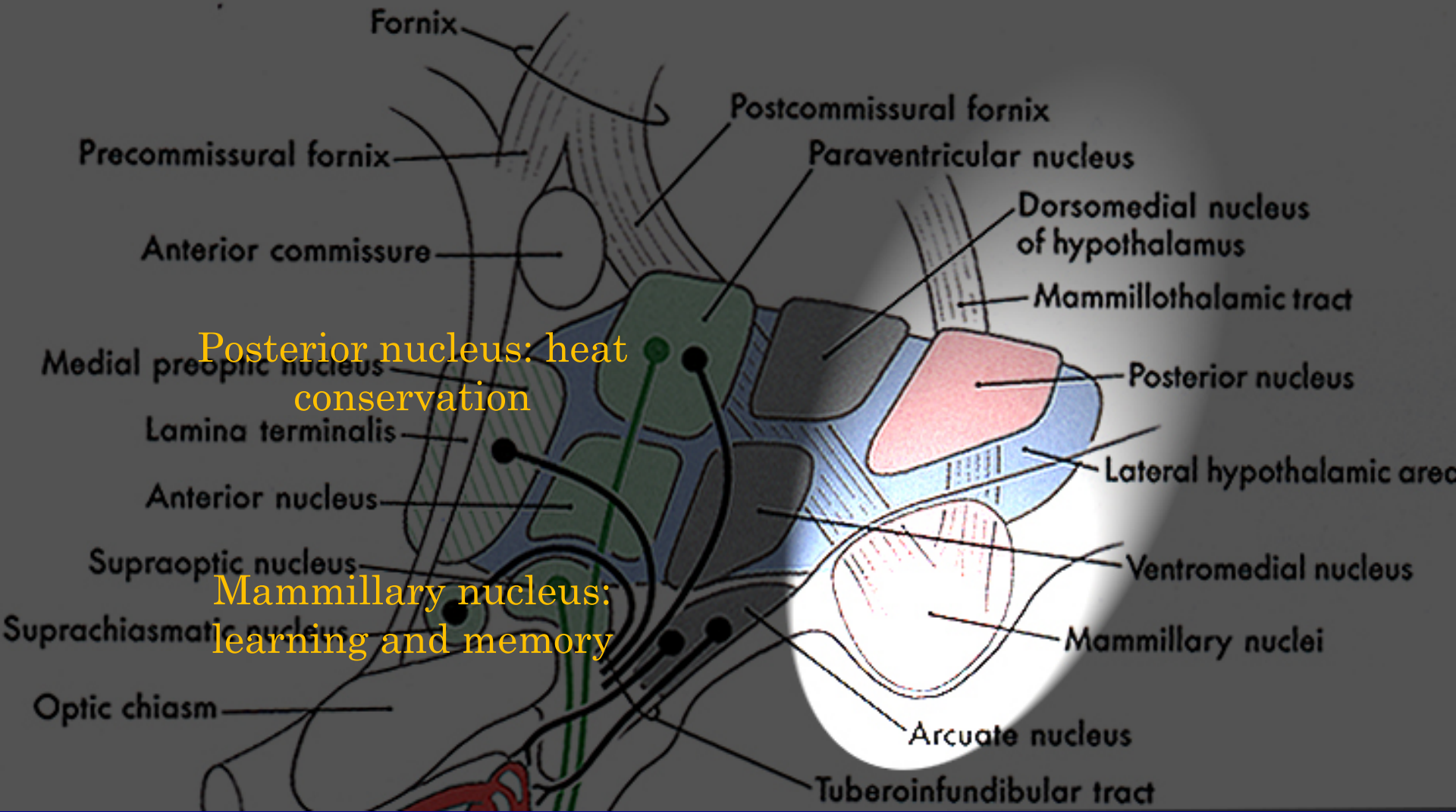


Table 30-1 The Effect of Stimulation or Lesion of the Principal Hypothalamic Nuclei

Nucleus	Stimulation of	Lesion of
Suprachia. n.	Adjusts circadian rhythms	Abolishes circadian rhythms
Supraoptic n. Paraventri. n.	Increased blood pressure	Diabetes insipidus
Lat. Hypotha. n.	Increased feeding	Decreased feeding
Ventromedial n.	Decreased feeding	Increased feeding
Dorsomedial n.	Sham rage	Decreased aggression & feeding
Mammillary body	?	Short-term memory is not processed into long-term memory