

Sleep



Why Do We Need Sleep?

Adaptive Evolutionary Function

- safety
- energy conservation/ efficiency

Restorative Function

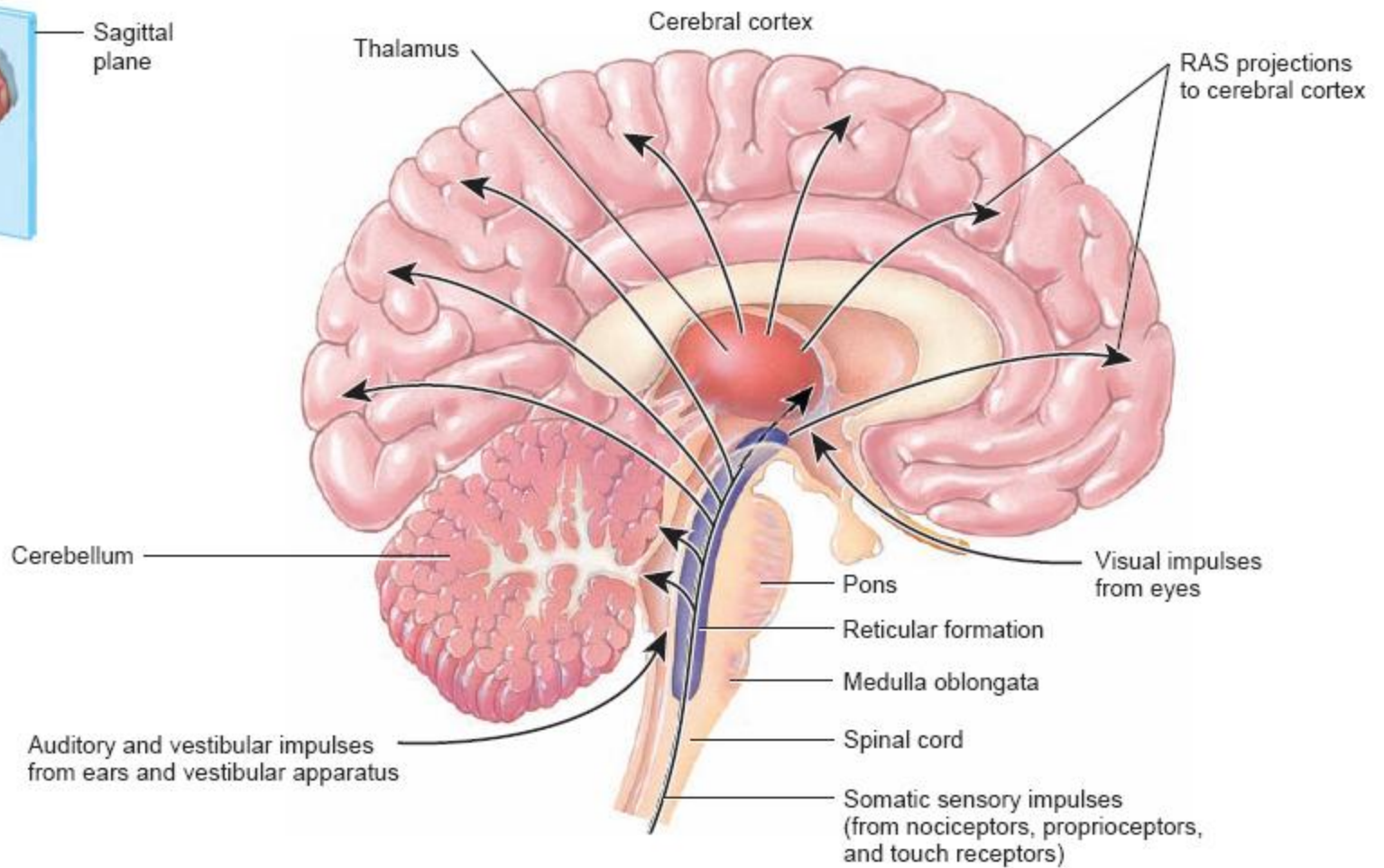
- body rejuvenation & growth

Brain Plasticity

- enhances synaptic connections
- memory consolidation



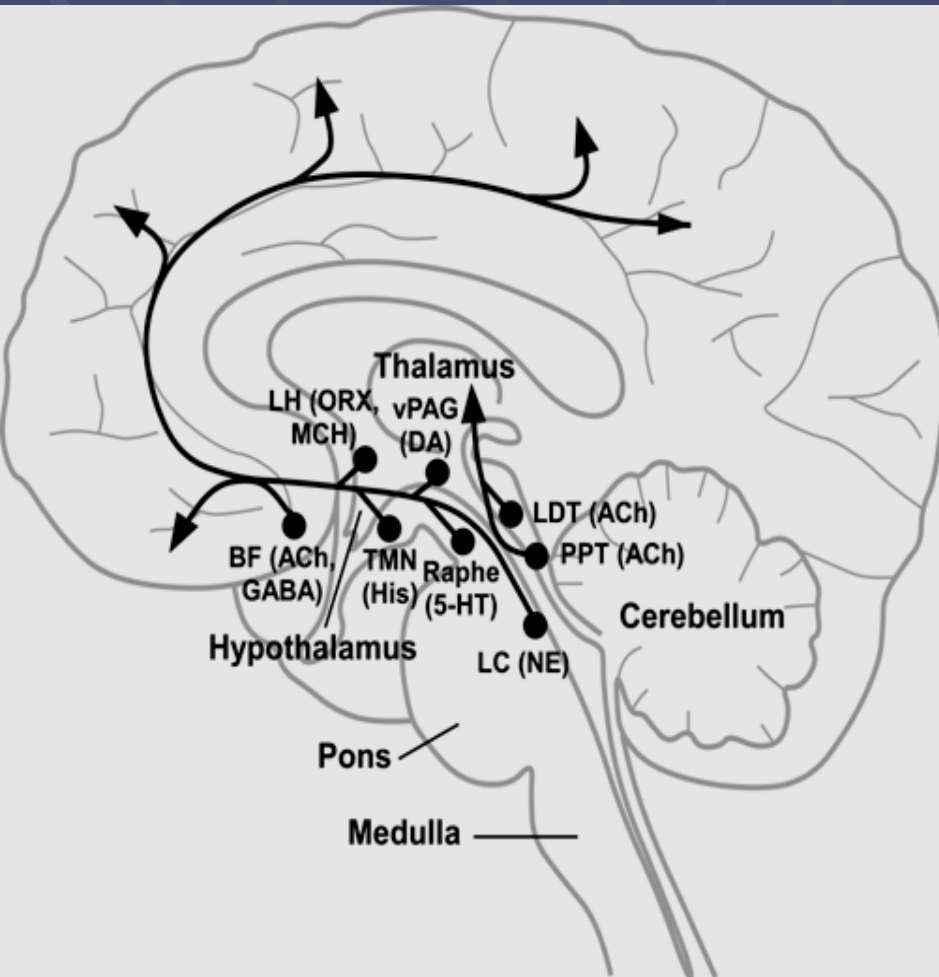
Sagittal
plane



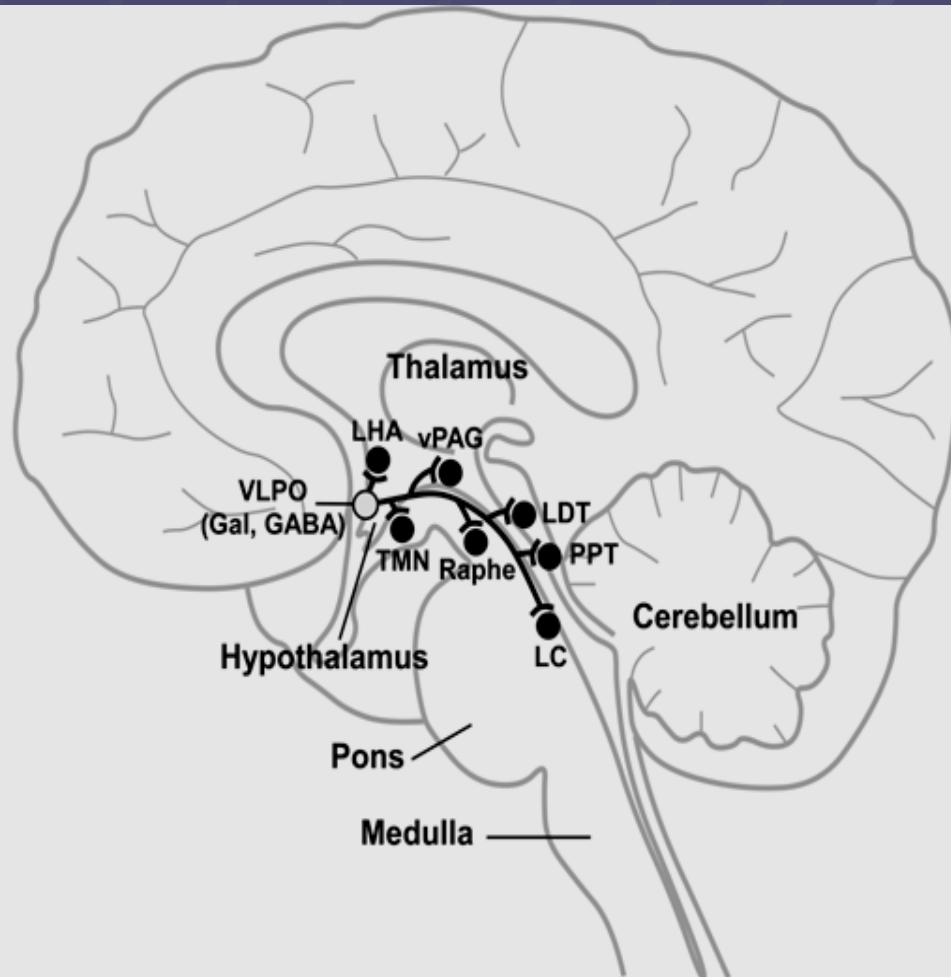
Sagittal section through brain and spinal cord

The ascending arousal system promotes wake

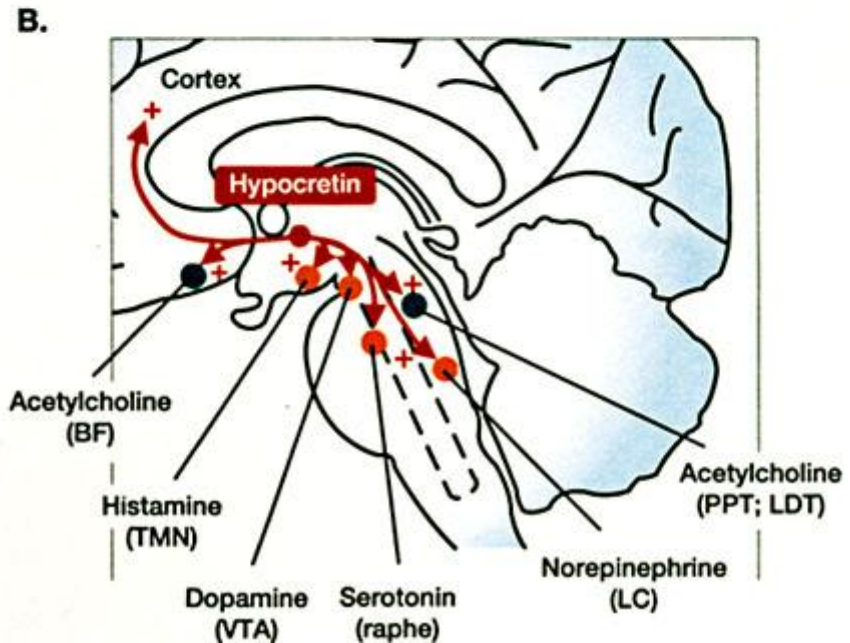
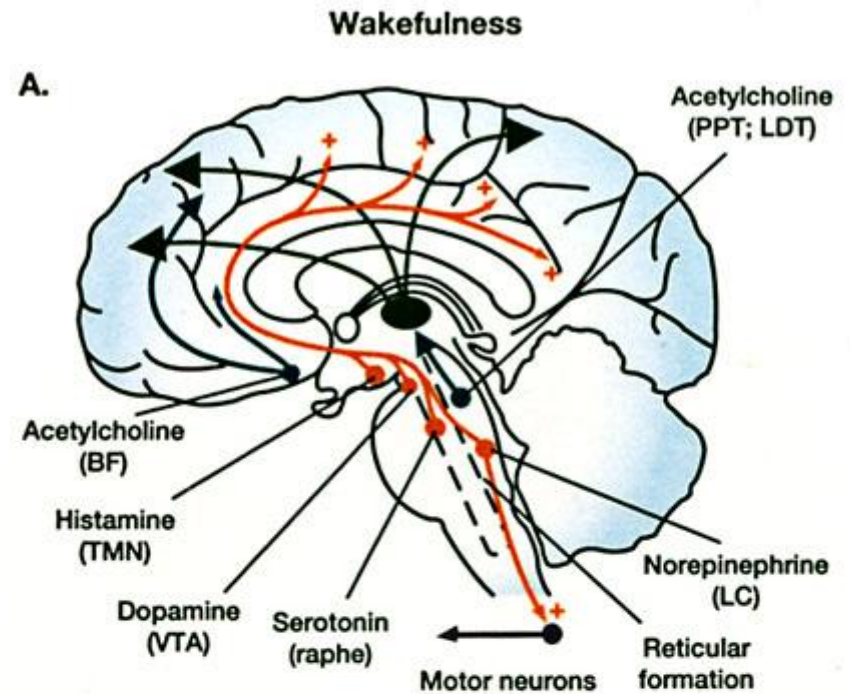
A.

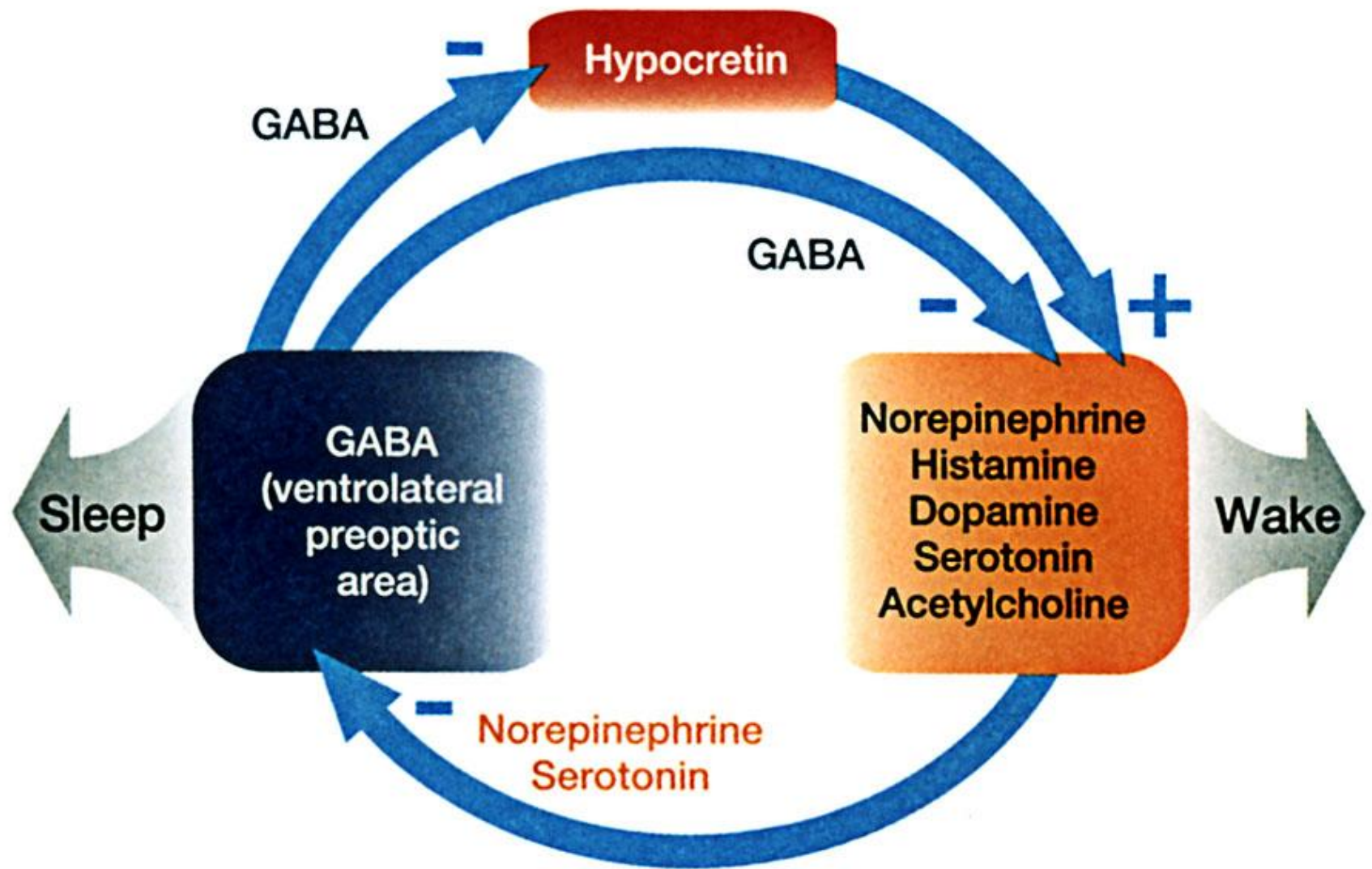


B.



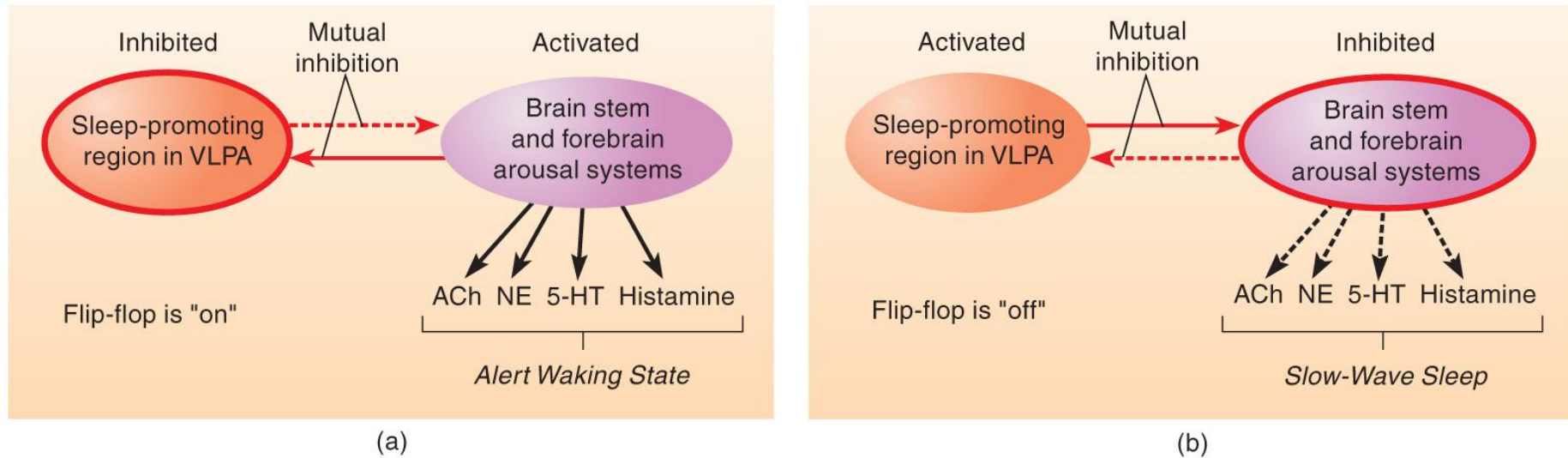
Hypocretin (orexin)





Sleep/Waking “Flip-Flop”

C7B08F11.eps



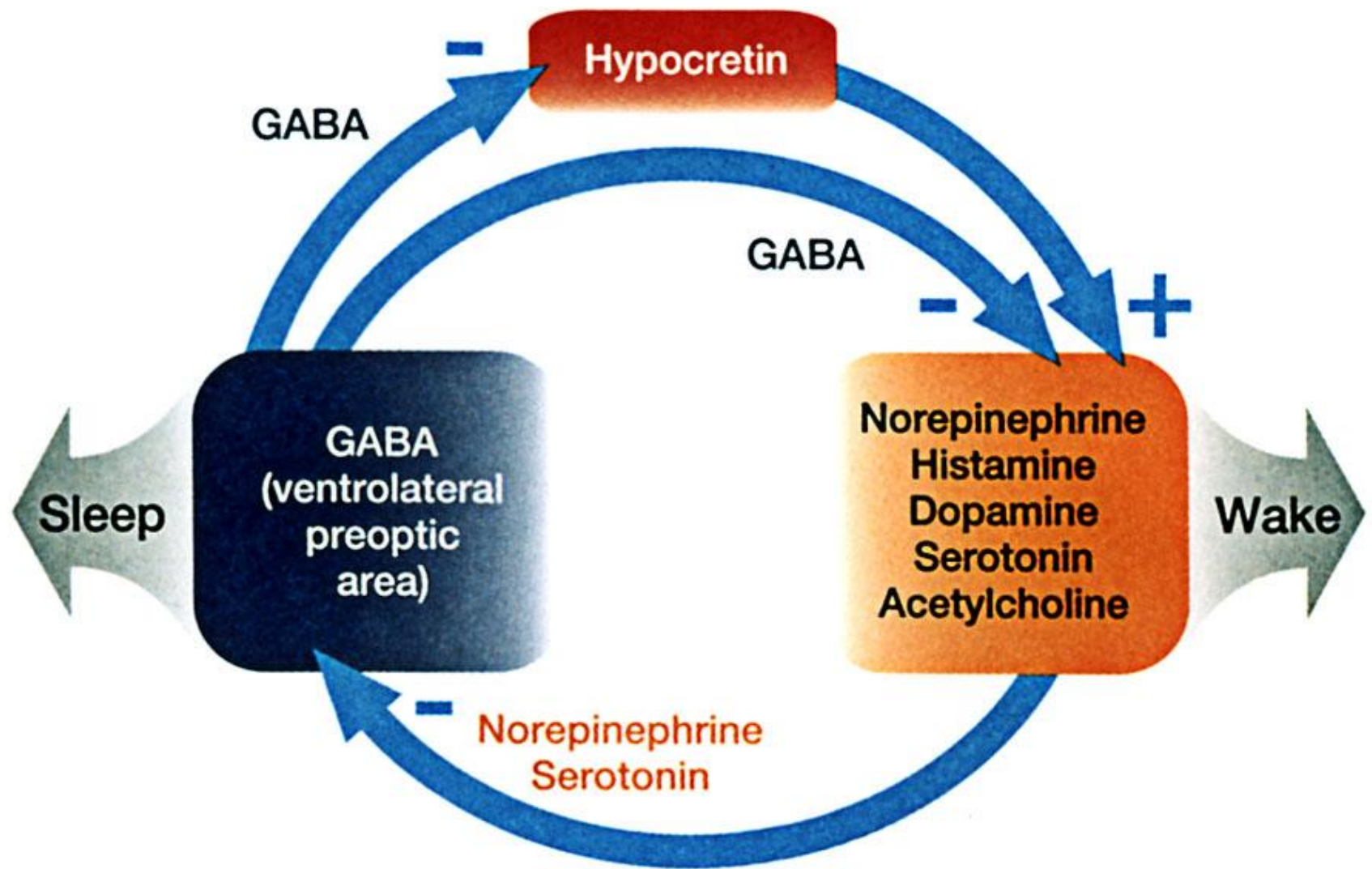
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VLPOA = ventrolateral preoptic area

ACh = acetylcholine

NE = norepinephrine

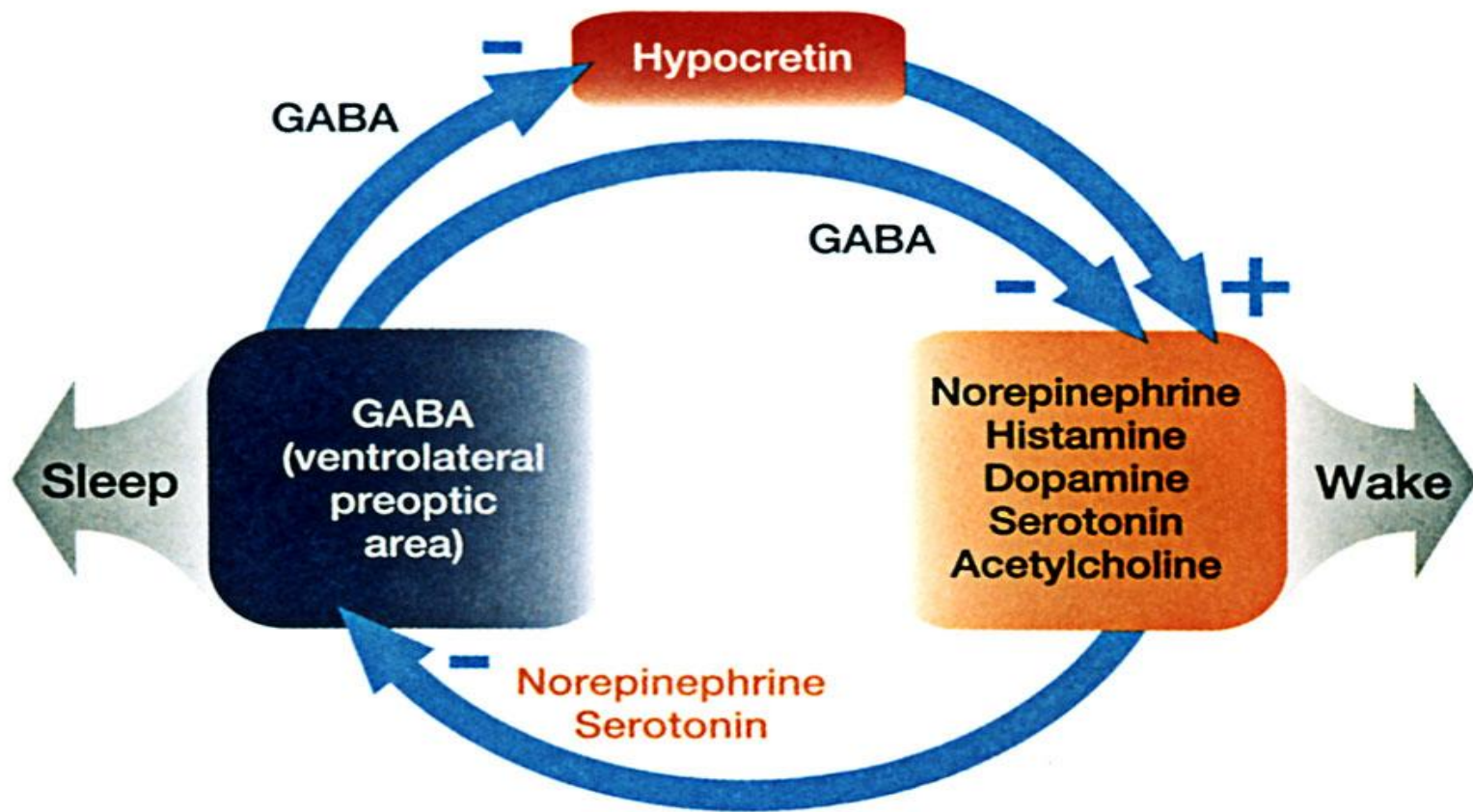
5-HT = serotonin



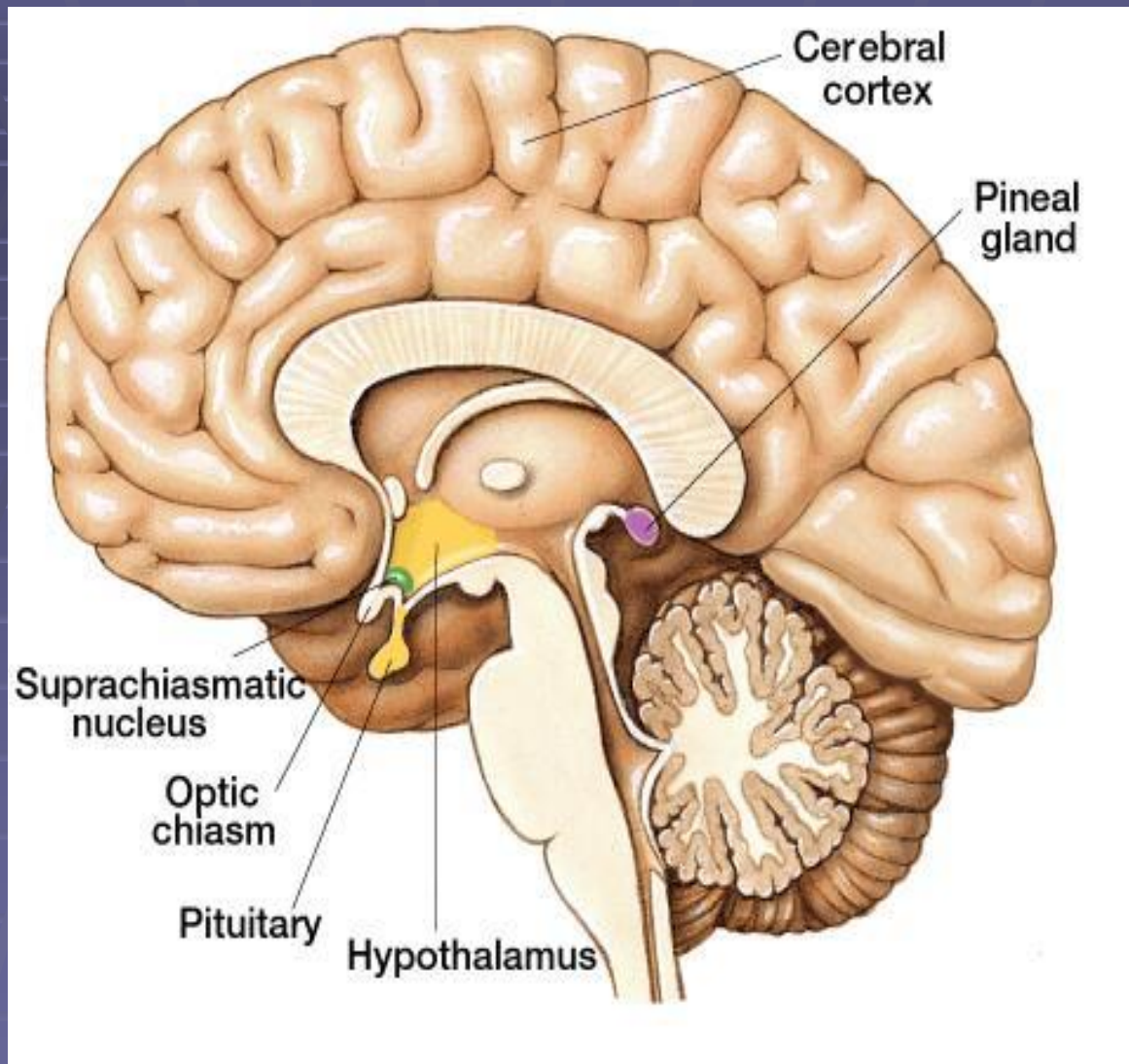
Narcolepsy

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



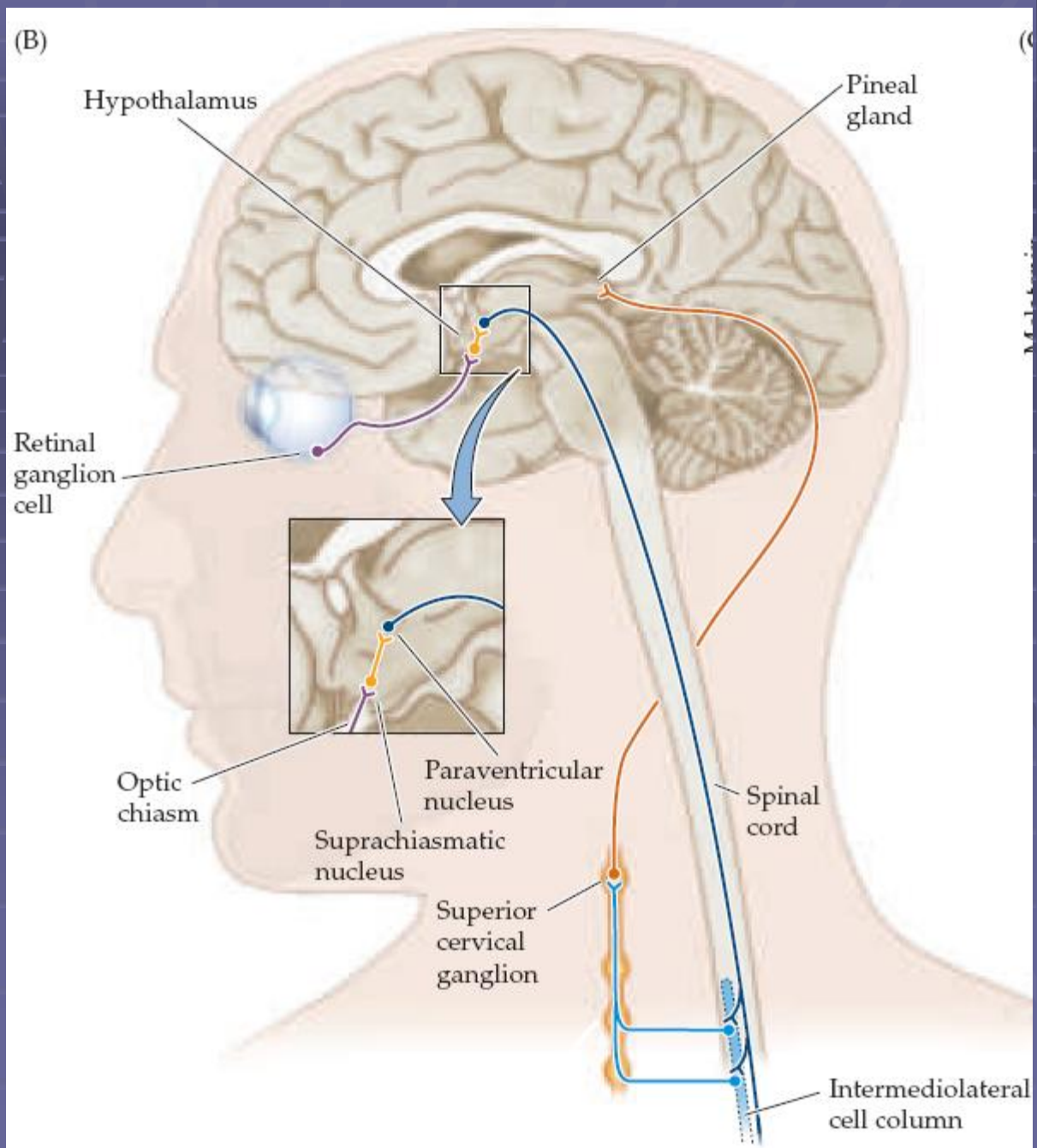
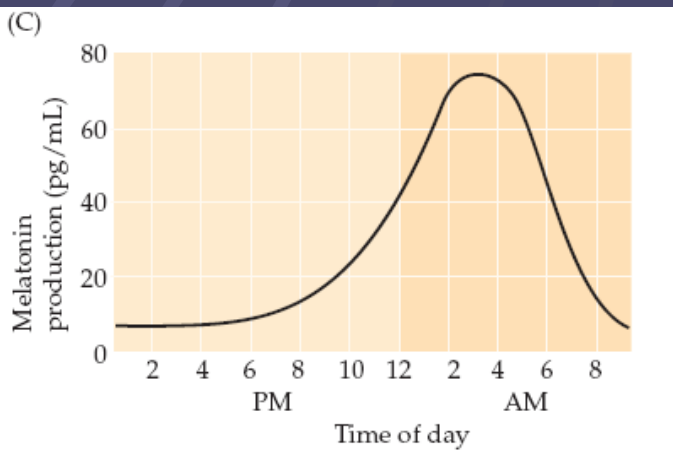
Biological Clocks

- Suprachiasmatic nucleus

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

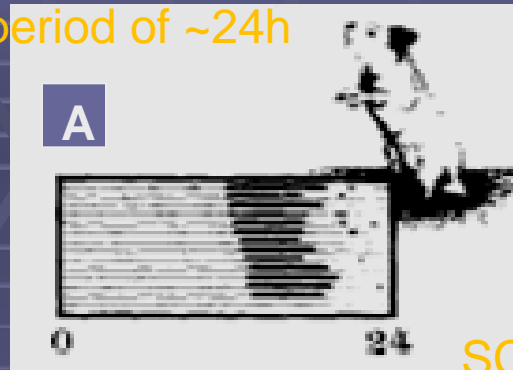
- Pineal gland

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

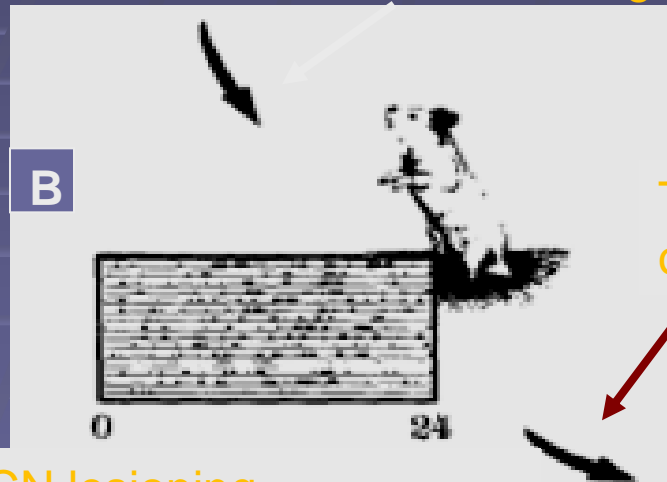


SCN and sleep

Wild type animal
with period of ~24h



SCN lesioning



SCN lesioning
abolishes circadian rhythm

Tau mutant
with period of ~20h



Transplanting SCN
of donor with ~20-h period



Wild type animal acquires
period of donor (~20h)

Coffee



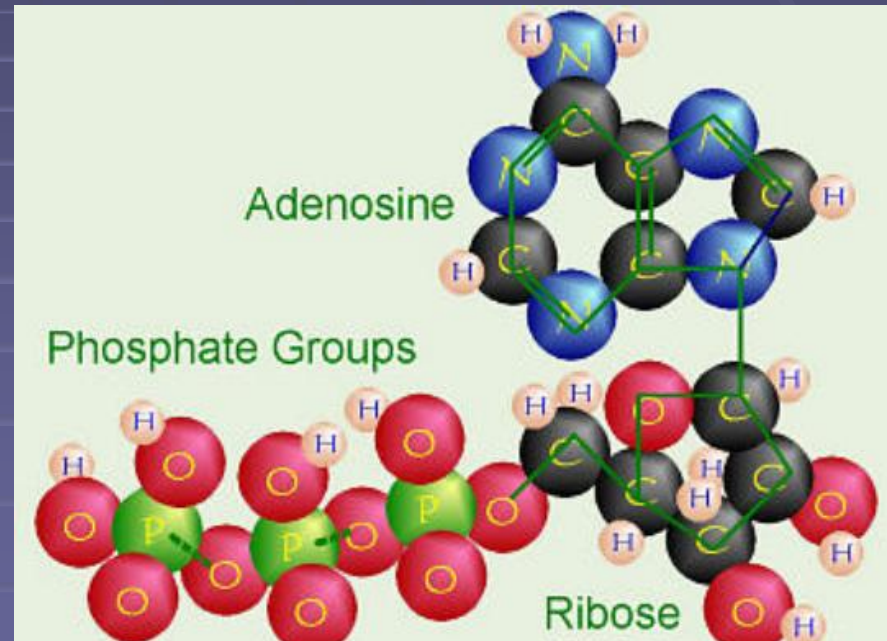
**DRINK
COFFEE**

**Do Stupid
Things
Faster
with More
Energy**



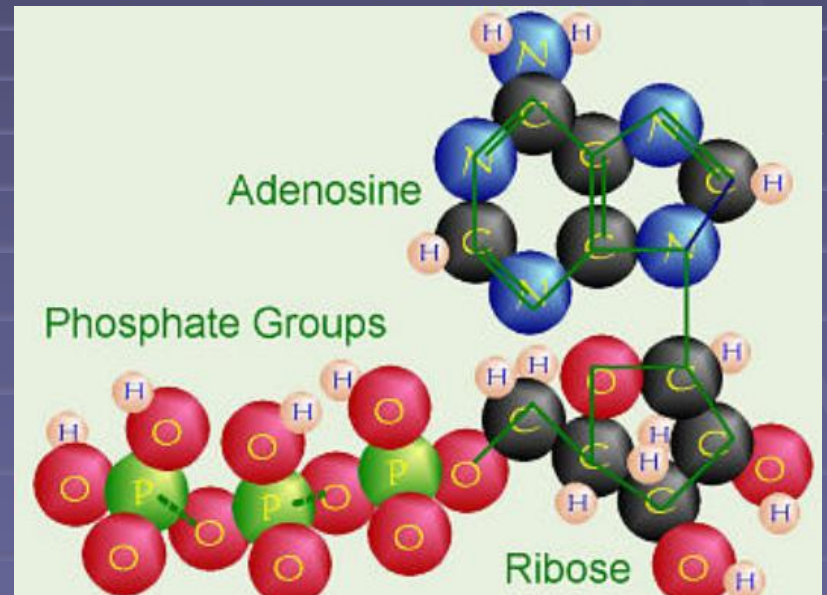
Coffee

- 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

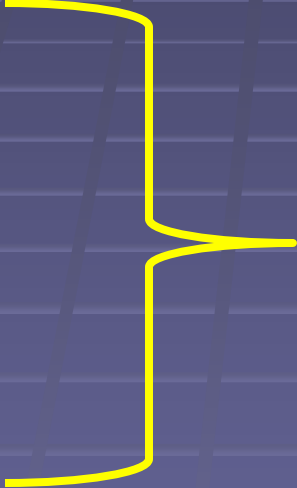
Sleep stages

- **Awake**
- **Stage 1**
- **Stage 2**
- **Stage 3**
- **Stage 4**



Slow wave sleep

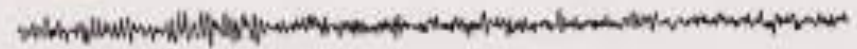
Sleep stages

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

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

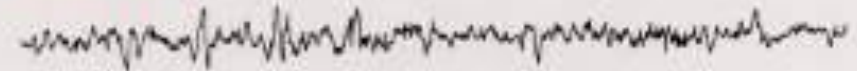
Awake



Alpha activity

Beta activity

Stage 1 sleep



Theta activity

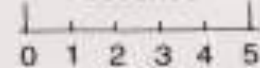
Stage 2 sleep



Spindle

K complex

Seconds



Stage 3 sleep



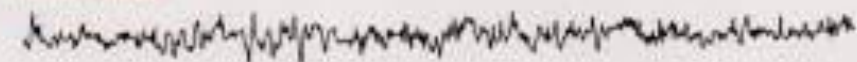
Delta activity

Stage 4 sleep



Delta activity

REM sleep



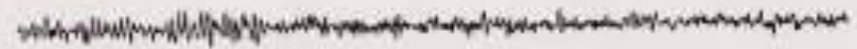
Theta activity

Beta activity

–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

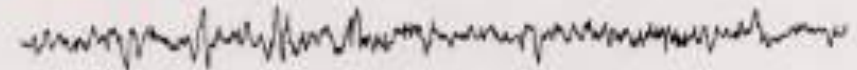
Awake



Alpha activity

Beta activity

Stage 1 sleep



Theta activity

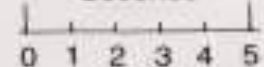
Stage 2 sleep



Spindle

K complex

Seconds



Stage 3 sleep



Delta activity

Stage 4 sleep



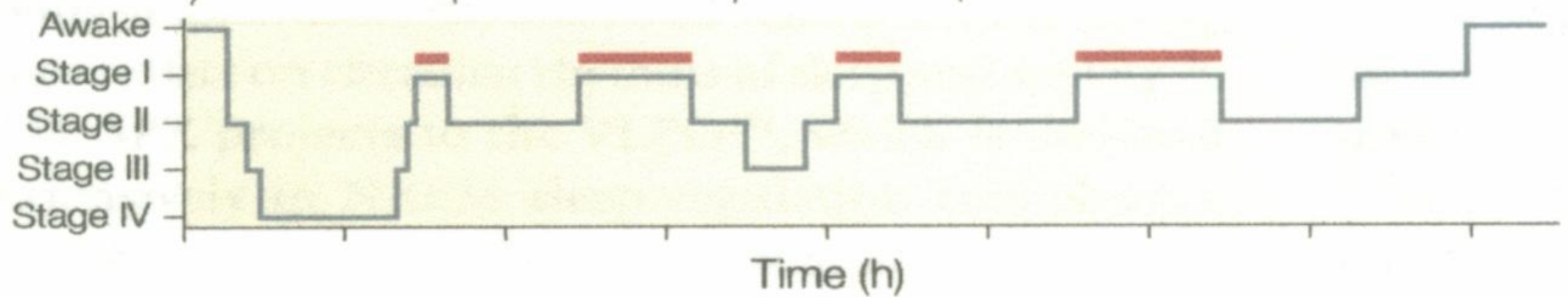
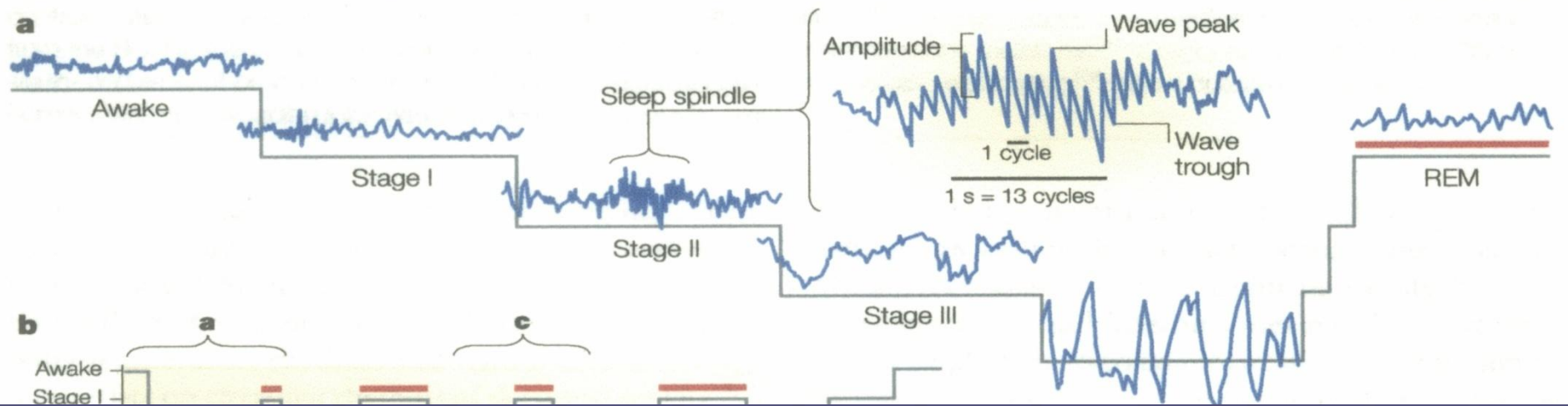
Delta activity

REM sleep



Theta activity

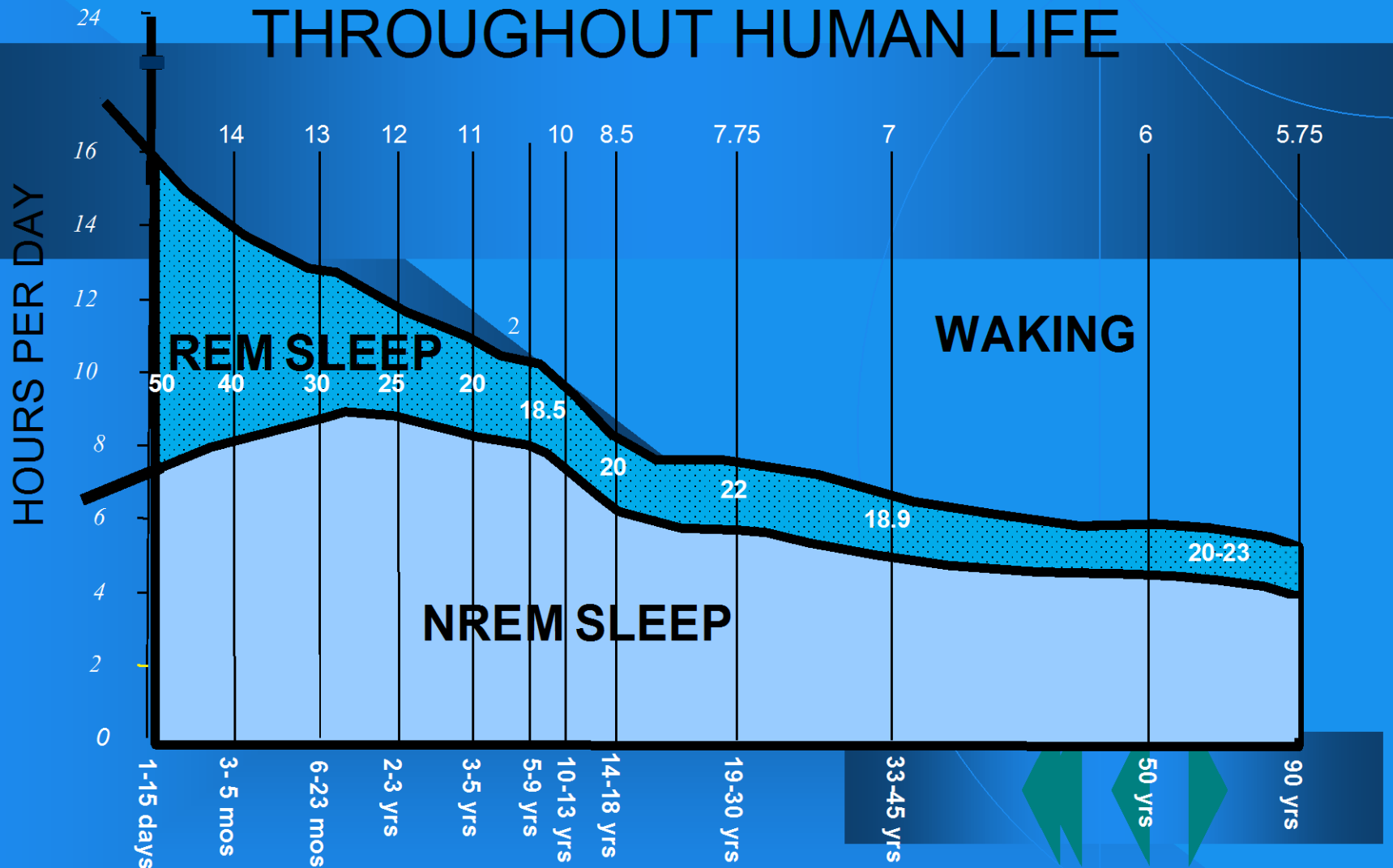
Beta activity



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 & DEMEMENT, *Science* (1966).

REM Dreaming

“vivid and exciting”

~3 per night

- Longer, more detailed
- Fantasy world
- nightmares

NREM Dreaming

● “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

