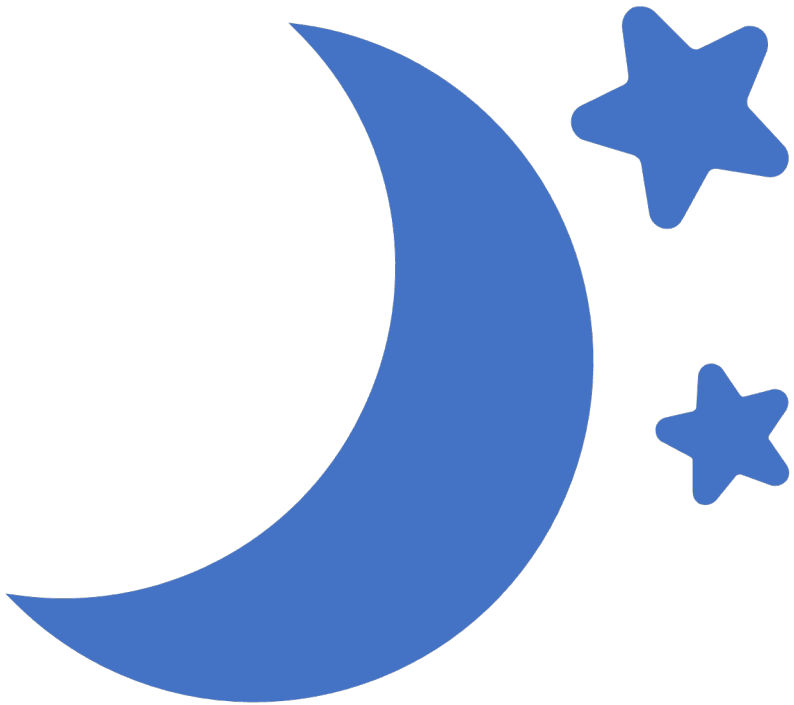
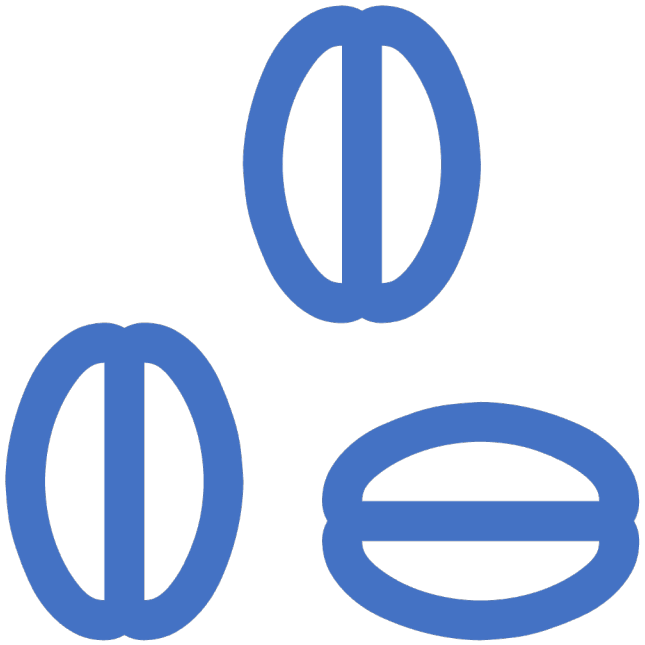


Human Sleep

Robertson: Chapter 1

What is Sleep?

- Sleep is a natural and periodic state of rest during which consciousness of the world is suspended
- Sleep is a need as vital as food and water
- Early theories thought it was a passive state, but it is, in fact, highly complex



Circadian Rhythms

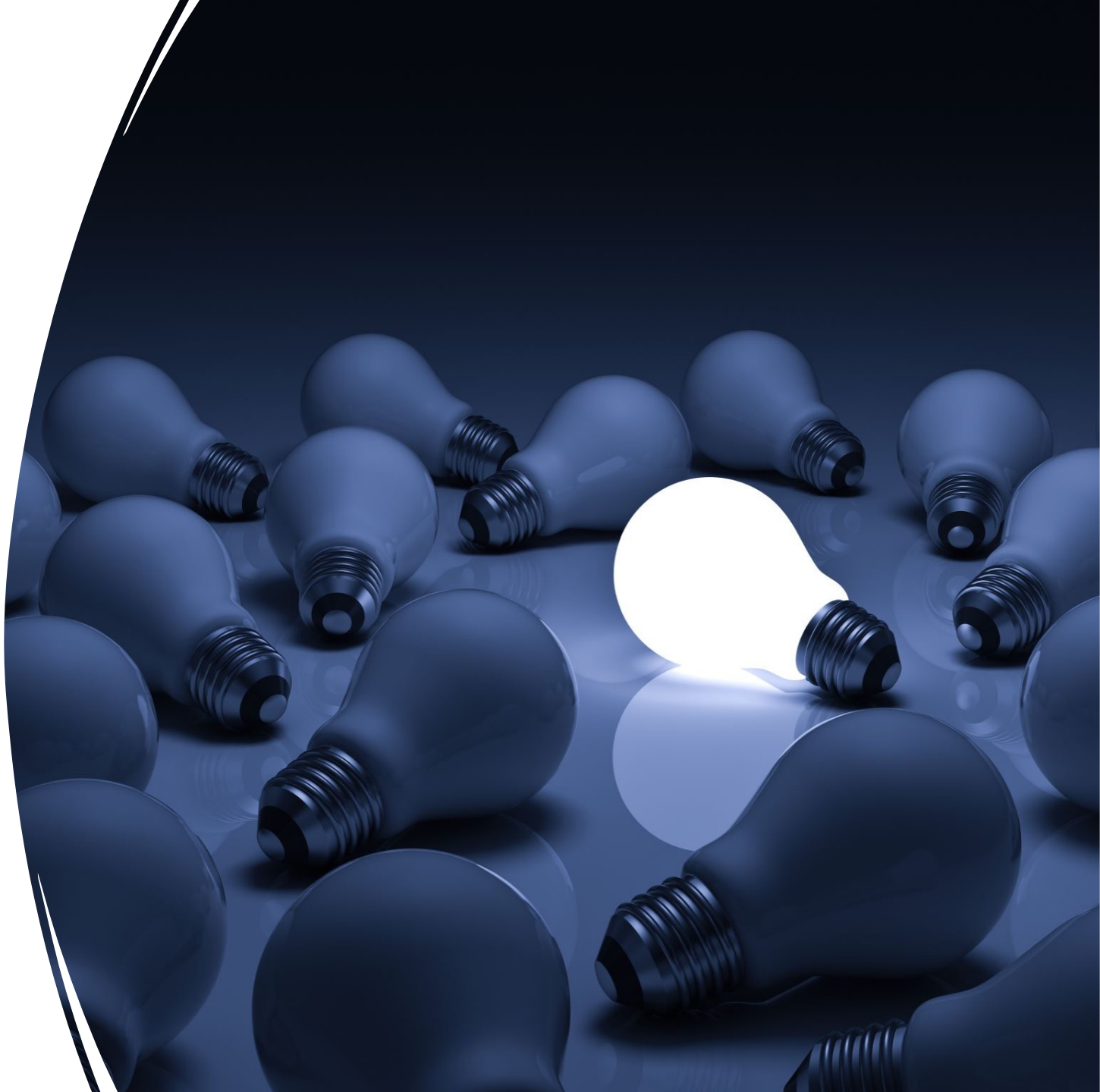
- Circadian rhythm = Daily cycle of biological activity influenced by regular variations in the environment, such as the alternation of night and day
- Circadian rhythms operate on a 25-hour cycle
  - But biological systems run on a 24.2 hour cycle instead
  - Women have shorter circadian rhythms than men by about six minutes
- Circadian rhythm cycles every 90 minutes
  - You will find that energy is higher in the morning and lower after lunch

Circadian Rhythms

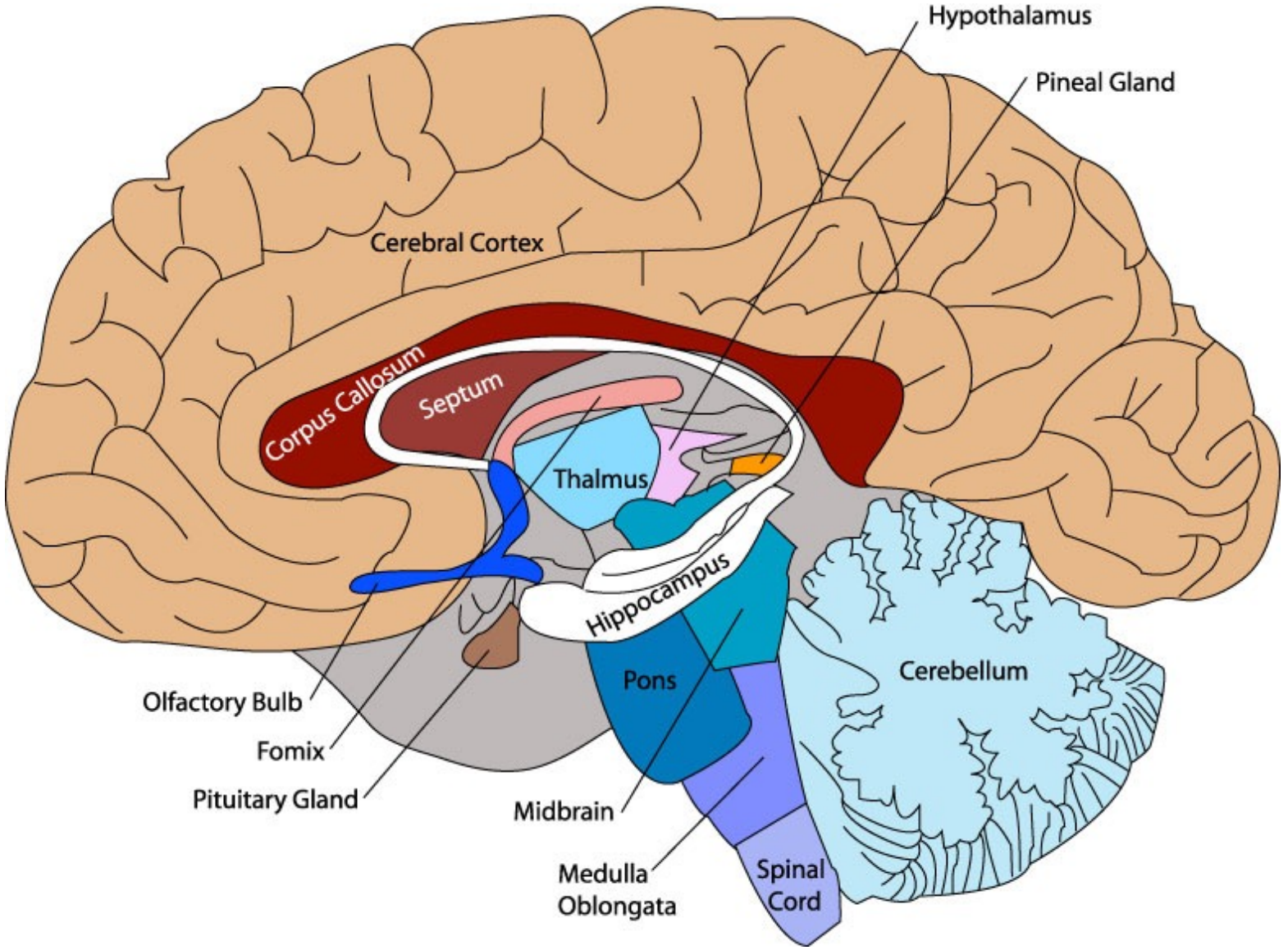
- Factors that affect circadian rhythms:
  - Light – Most dominant factor
  - Temperature
  - Food
  - Drugs
  - Activity

Zeitgebers

- These are any outside factor that affects and resets the biological clock to the external environment
- Most powerful one is light



Brain Structures



Brain's Effect on Sleep-Wake Process

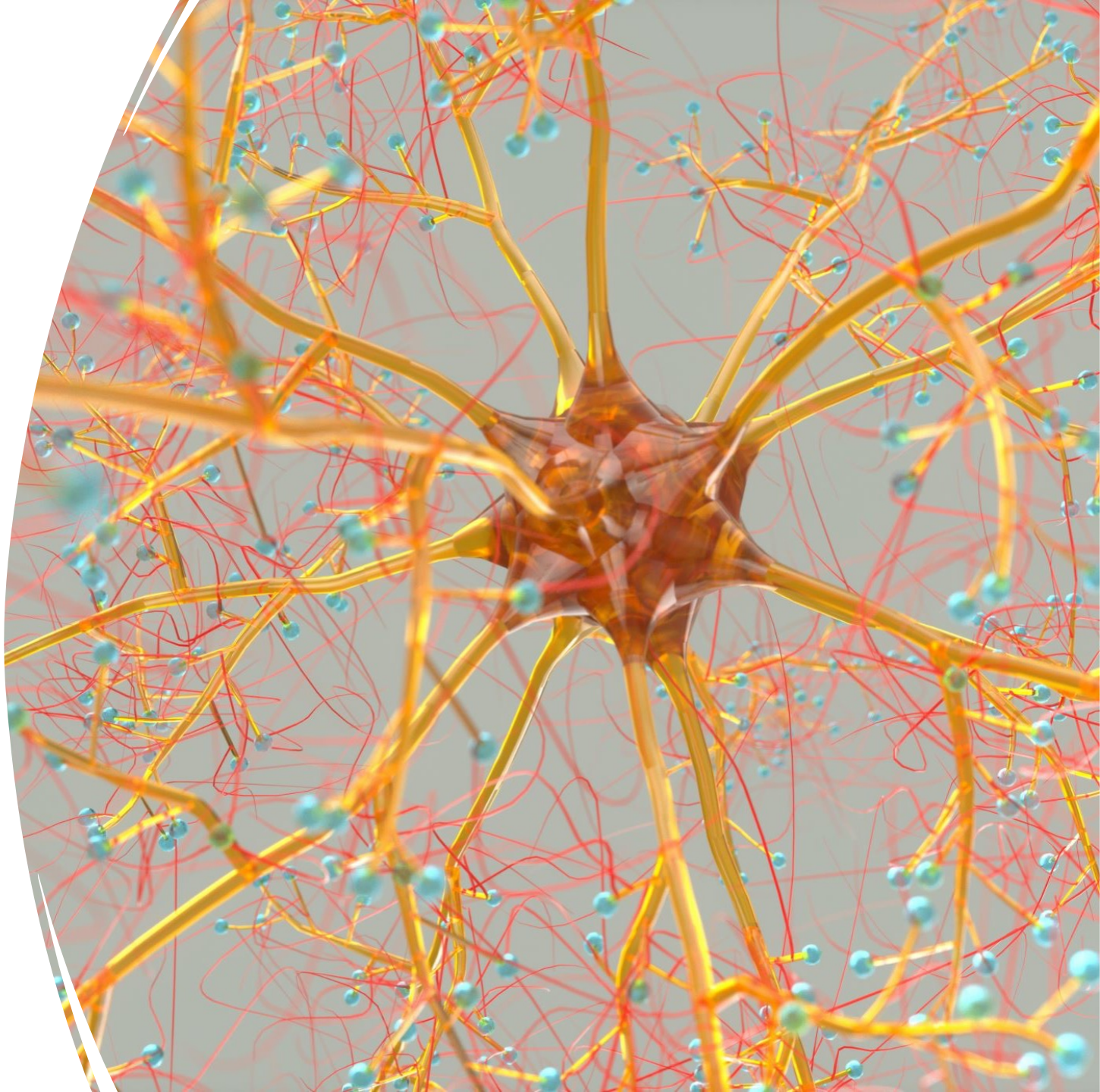
- Different areas of the brain affect the sleep-wake process
- Thalamus is responsible for sending sensory date from the body to different areas of the brain, especially the cerebral cortex
- Suprachiasmatic nucleus (SCN) is located in the hypothalamus and initiates the release of melatonin
  - Melatonin is a hormone released by the pineal gland that promotes sleep
  - SCN is strongly affected by light
  - SCN is responsible for controlling circadian rhythm and is the sleep-wake pacemaker
  - Sits above the optic nerve

Reticular Activating System (RAS)

- This is the center of motivation and arousal
- It connects the brainstem to the cortex of the brain
- If it is deactivated, this causes sensory blockage between the thalamus and cortex, leading to a decrease in external stimuli and loss of consciousness, which results in decreased alertness
  - This deactivation also develops spindles in Stage N2 sleep

Neurotransmitters

- Neurotransmitters are chemicals that transmit neurologic information to another nerve, muscle, organ, or other tissue
- These act almost like an on-off switch for sleep



Acetylcholine (ACh)

- This plays the biggest role in sleep
- Levels of ACh are at their highest during wake and REM
- It plays a role in the scheduling of REM sleep and thermoregulation in sleep
  - ACh-producing cells are called REM-on cells because of firing a minute before REM onset
- The ACh neurons that are most important in the sleep process are found in cell bodies in the pons and basal forebrain

Norepinephrine (NE)

- Also known as noradrenaline
- Vital neurotransmitter in the “fight or flight” response
- Controls the making and release of melatonin
- Located in the locus coeruleus
- Maintains and enhances the activation of the cerebral cortex
- Intertwined with arousal, wakefulness, attentiveness, and sleep
- It is also involved in the formation of memories

Serotonin (5-HT)

- Located in the raphe nuclei
- Plays a role in cortical arousal
- When serotonin is activated, you see a decrease in response to stimuli
- Directly promotes wakefulness and also promotes the formation of sleep-promoting brain factors

Histamine

- Promotes wakefulness and alertness
  - So, if you wondered why you get drowsy when taking an anti-histamine, this is why, because it is blocking histamine
    - Antihistamines block histamine's effects and induce fatigue
- The release of histamine stops all together in REM

Dopamine

This increases during stimulation

Also known as the “feel good” hormone because it plays an important role in pleasure and subjective feelings of happiness

It stops NE’s effects, thus alerting the body to wake up

Glutamate

Also known as Gluatamic Acid

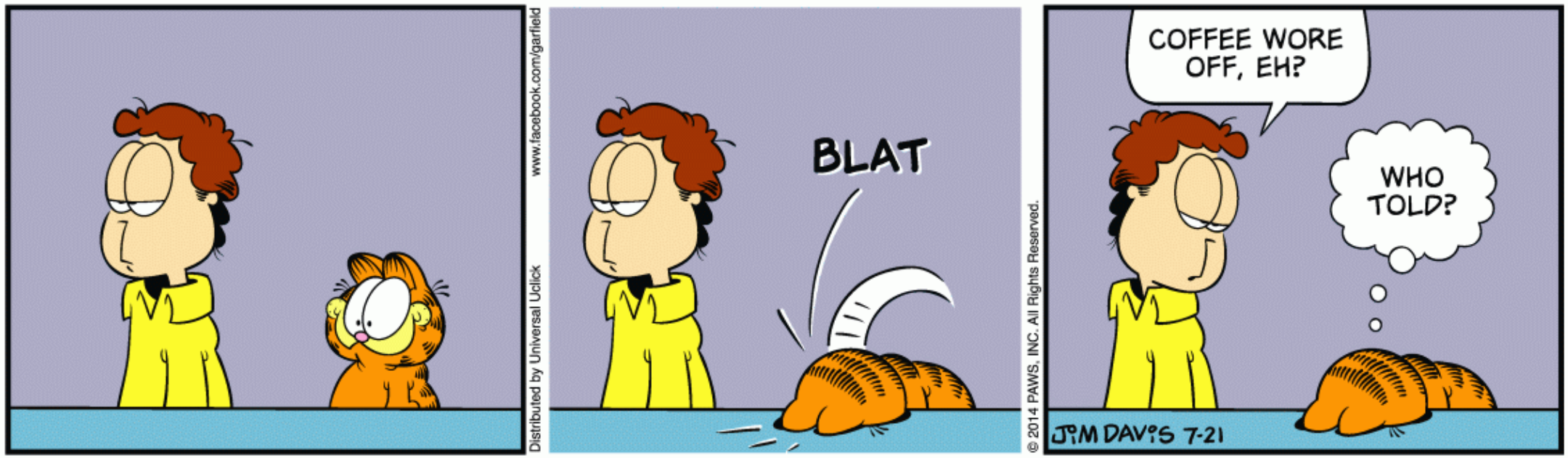
Its most vital function is memory and learning

It is involved in arousal

Lower than normal levels of oxygen in the blood, such as what sleep apnea causes, stimulates the production of glutamate

Adenosine

- This makes you sleepy
- Caffeine will block adenosine temporarily to promote wakefulness



Sleep States

- There are two main sleep states: Non-REM (NREM) and REM
- REM and NREM alternate throughout the night in 90–110-minute cycles

Comparison of REM sleep and NON-REM sleep

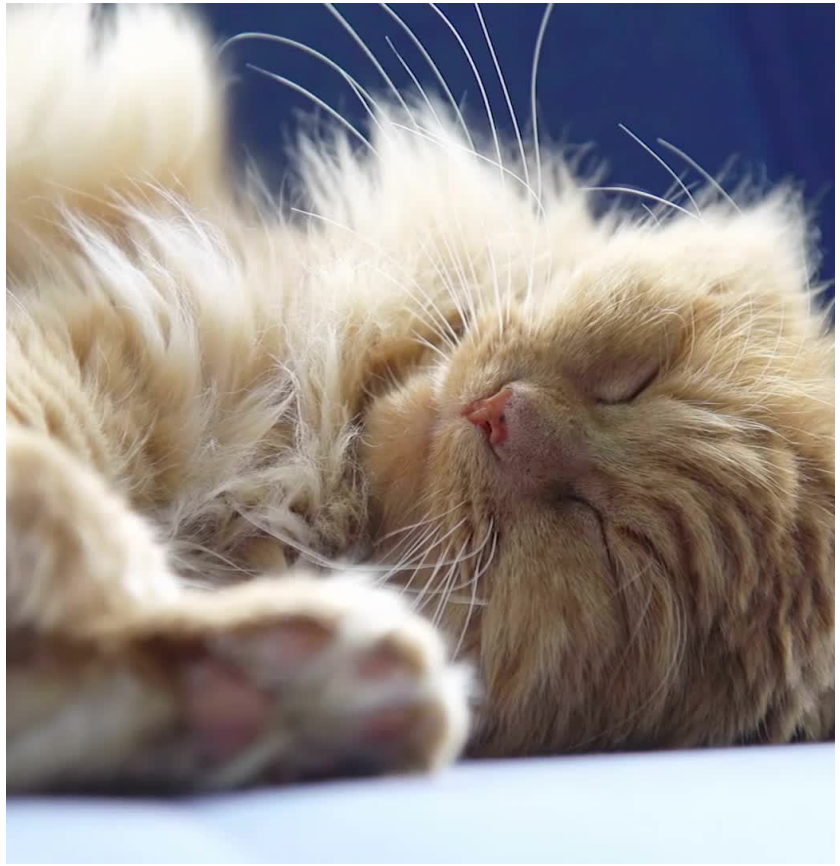
Characteristic	REM sleep	Non-REM sleep
Rapid eye movement	Present	Absent
Dreams	Present	Absent
Muscle twitching	Present	Absent
Heart rate	Fluctuating	Stable
Blood pressure	Fluctuating	Stable
Respiration	Fluctuating	Stable
Body temperature	Fluctuating	Stable
neurotansmitter	Noradrenaline	serotonin

REM Sleep

- Characterized by rapid eye movements during sleep, muscle atonia, low voltage mixed frequency EEG, a decrease in core body temperature, altered respiratory patterns, and penile erections in males
- Two types of REM sleep – Phasic and Tonic
  - Phasic REM = Eyes moving back and forth in rapid motions, and typically sawtooth waves are mostly seen in this type of REM
  - Tonic REM = REM sleep without rapid eye movements
- The length of REM increases during the night and is most prominent in the last third of the night

NREM Sleep

- Comprises about 75% of total sleep
- Divided into 3 distinct stages:
  - N1
    - Transitional stage of sleep
    - May be able to hear external stimuli
  - N2
    - Slightly deeper stage of sleep
    - Defined by sleep spindles and K-complexes
  - N3
    - Deepest stage of sleep—most difficult to awaken a patient from this stage
    - Also known as delta sleep

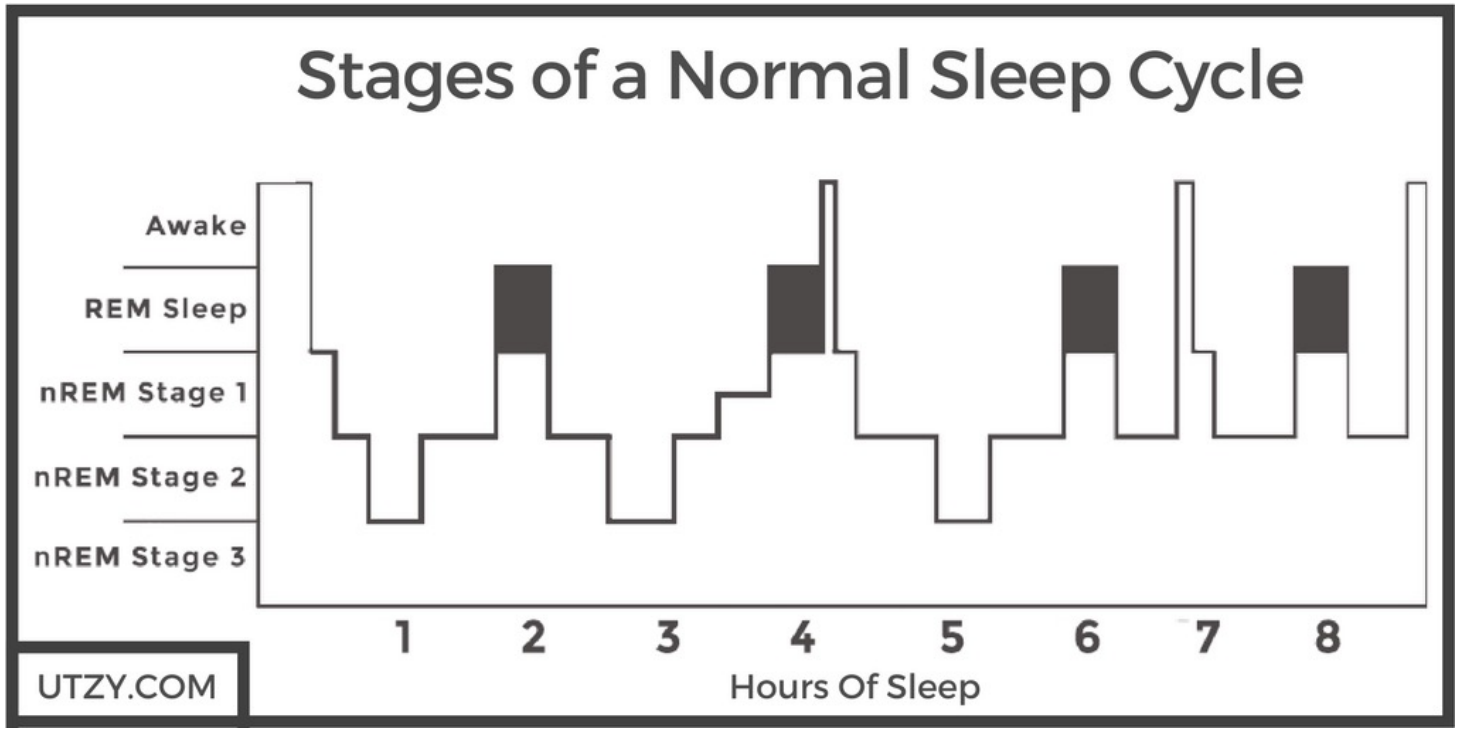


Wake

- Muscle activity and cognitive responsiveness is high
- 2/3 of the 24-hour circadian cycle is spent awake
- EEG is high frequency with mixed voltages
- EMG is high amplitude
- When someone is awake with the eyes closed, alpha waves are commonly seen in the occipital region
- Wake after sleep onset (WASO) = The amount of time awake in minutes after sleep onset was achieved
    - Average person sleeps 90% of the sleep period, so WASO should compose less than 10%

Sleep Architecture

- This is the patterns of sleep stages throughout the night
- Graphical display of this would be known as a histogram or hypnogram



Sleep Architecture Calculations

- Sleep efficiency = Percentage of the night spent asleep
  - Sleep efficiency = Total sleep time ÷ Total time in bed
  - Normal would be considered greater than 90%
  - Decreased sleep efficiency indicates that there is an increased Total Wake Time (TWT)
  - High sleep efficiency may indicate rebound sleep
- Sleep latency = Time it takes, in minutes, to fall asleep
  - Average is 10-20 minutes
  - Decreased sleep latency may indicated excessive daytime sleepiness (EDS)
  - First night effect may increase sleep latency in sleep studies

Sleep Architecture

N1 sleep

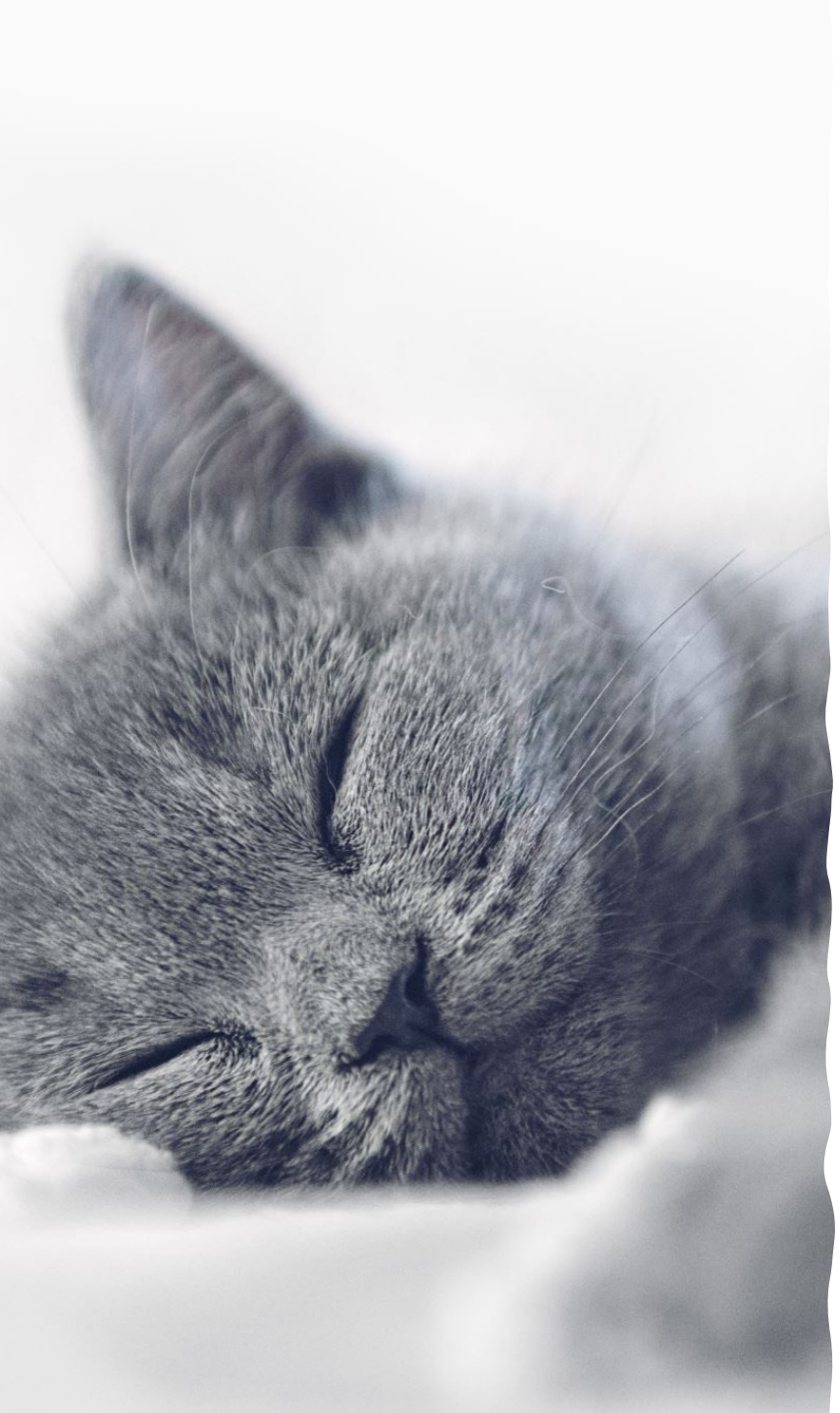
- Comprises 5-10% of total sleep
- EEG is a relatively low voltage pattern with mixed frequency
- It may be difficult to discern between Wake and N1

N2 sleep

- Comprises 40-50% of total sleep
- EEG consists of sleep spindles in the central area of the brain and K-complexes in the front area of the brain
- Senses begin to be blocked in this stage

Sleep Architecture

- N3 sleep
  - Comprises 20-25% of total sleep
  - EEG is low frequency, high amplitude
  - Seen predominantly in the first third of the night
  - Decreases dramatically with age
  - Growth hormone is released in this stage
    - Because of this, N3 sleep is restorative for the body as the growth hormone repairs damaged cells



Sleep Architecture

- REM sleep
  - Comprises 20-25% of total sleep
  - Characterized by rapid eye movements and muscle atonia
  - It is known as paradoxical sleep because the brain activity resembles that of wakefulness, but the muscles are paralyzed
  - REM periods are typically shorter in the beginning of the sleep period, but become longer in later cycles
  - It is considered restorative for the mind as memory processing takes place in this stage
    - Memory is diminished when someone is deprived of REM
  - REM latency (period from first epoch of sleep to first epoch of REM) = 90-120 minutes

Sleep and Aging

- As we age, the following things happen to sleep:
  - The number of EEG arousals per hour (arousal index) increases
  - N3 decreases and N1 and N2 increase
  - Sleep efficiency decreases
  - Sleep problems and disorders increase
  - Decreased need for sleep from infancy to adulthood