



Approved by Dr.Nervana

Physiology
Team
434



Physiology of Sleep ^{z z z}



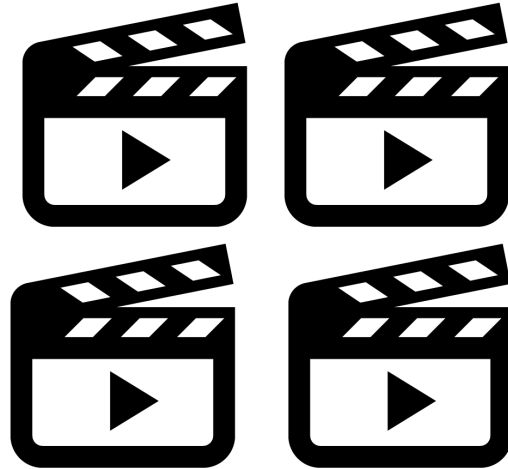
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- Important
- Further Explanation

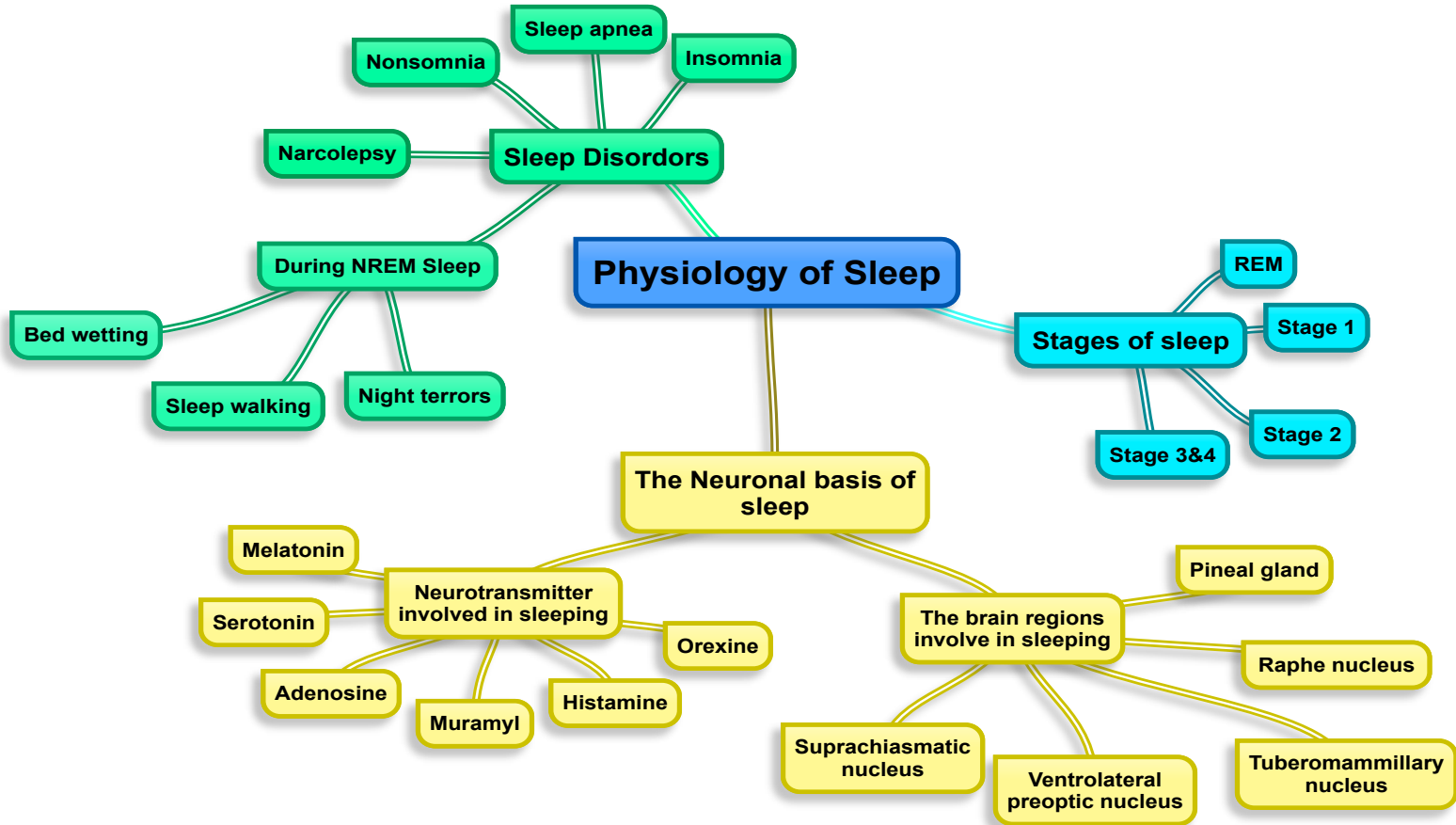
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Related Videos!



Please check out this link before viewing the file to know if there are any additions/changes or corrections. The same link will be used for all of our work [Physiology Edit](#)



Difference Between Sleep & Coma:

❖ Sleep:

Unconsciousness which a person **can be aroused by sensory or other stimuli.**

❖ Coma:

Unconsciousness which a person **can't be aroused.**

Circadian Rhythm¹:

❖ Produced by internal mechanisms that operate on an approximately 24 hours cycle.

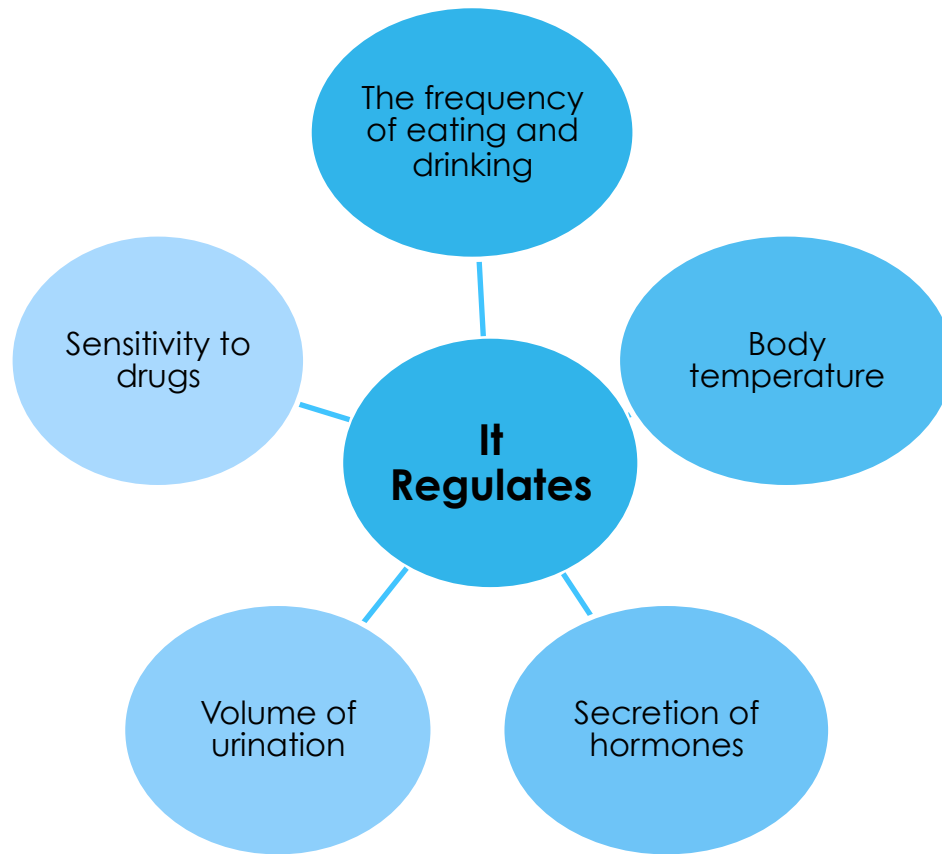
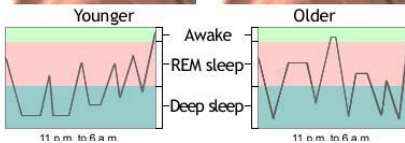
The purpose of the circadian rhythm is to keep our internal workings in phase with the outside world. *IN HUMANS THIS ENDOGENOUS CYCLE HAS A DURATION OF 24.2 HOURS*

Characteristics of The Circadian Rhythm:

Circadian rhythms remain relatively consistent **despite lack of environmental cues indicating the time of day**

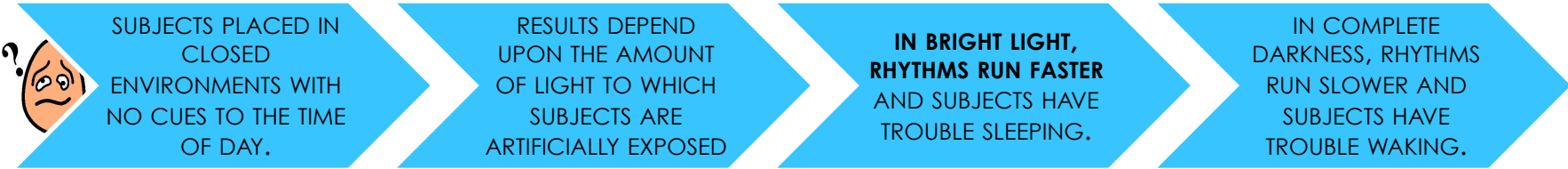
Circadian rhythms can differ between people and lead to different patterns of wakefulness and alertness.

Circadian rhythms change as a function of age with different sleep patterns from childhood to late adulthood



Manipulation¹ of The Circadian Rhythm:

❖ Experiment to determine of circadian rhythm :



ZEITGEBER² : Is a term used to describe any stimulus that resets the circadian rhythms, For example: Exercise, noise, meals, and temperature are other zeitgebers.

❖ **Light is critical for periodically resetting our circadian rhythms.**

JET LAG³ : The disruption of the circadian rhythms due to crossing time zones.

Characterized by sleepiness during the day, sleeplessness at night, and impaired concentration.

1: تلاعب

2: German word, means "timer"

3: Extreme tiredness and other physical effects felt by a person after a long flight across several time zones.

Physiological Importance Of Sleep

- ✧ It exists in all mammals, and after total deprivation there is usually a period of “catch-up” or “rebound” sleep.
- ✧ After selective deprivation of REM¹ or slow-wave sleep, there is also a selective rebound of these specific stages of sleep. *-WILL BE DISCUSSED IN COMING SLIDES-*
- ✧ The essential role of sleep in **homeostasis** is demonstrated where rats deprived of sleep for 2 to 3 weeks often will die.

Why Do We Need Sleep?

- 1-Conservation metabolic energy
- 2-Repair & restoration
- 3-Proteins are rebuilt
- 4-Energy supplies are replenished

Sleep & Brain:

- 1-Aiding learning and memory consolidation.
- 2-Neural maturation.
- 3-Clearance of metabolic waste product generated by neural activity in the wake brain.

Sleep & Memory:

- 1-Sleep plays important role in enhancing learning & strengthening memory.
 - a newly learned task is better if adequate sleep achieved during night
- 2-increased brain activity occurs in the area of the brain activated by newly learned task while one is sleep .



Types of Sleep:

Each night, a person goes through stages of two major types of sleep that alternate with each other these types are called:

Slow-wave sleep or non-rem (NREM sleep) :

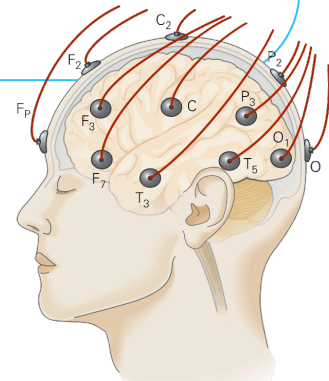
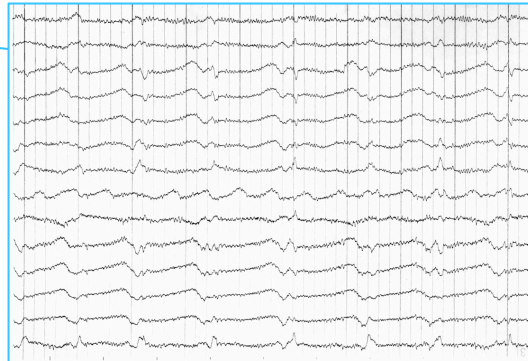
In which the brain waves are strong and of low frequency, as we discuss later.

Rapid eye movement sleep (REM sleep):

In which the eyes undergo rapid movements even though the person is still asleep

EEG (Electroencephalograph):

- Electrodes are placed systematically on the scalp for recording the electroencephalogram
- When the subject is awake with eyes open, the EEG exhibits low-voltage, higher-frequency activities







Stages of Sleep

Impotent notes are
in **bold**

Stage	Experience	Duration	Signs	Waveform
REM¹	Very active stage of sleep. Vivid dreams can occur.	20-25 % of a normal nights sleep.	-	EEG waves are irregular, low-voltage and fast.
Stage 1	That is experienced as falling asleep and transition stage between waking & sleep	<ul style="list-style-type: none"> • 1 to 5 minutes • ~2.5% of a normal nights sleep. 	Eye begin to roll slightly	The EEG is dominated by irregular , Jagged, low voltage wave .
Stage 2	The "baseline" of sleep	<ul style="list-style-type: none"> • 90 minutes • ~45-60 % of a normal nights sleep. 	-	<ul style="list-style-type: none"> • Sleep spindles : 12-14 HZ waves during a burst that lasts at least half a second. • K- complex : a sharp high amplitude Negative wave followed by a smaller slower positive wave.
Stage 3&4	<ul style="list-style-type: none"> • Deep sleep • Delta sleep is the "deepest" stage of sleep and the most restorative² • It is delta sleep that a sleep-deprived subject's brain craves • Generally children Unawakeable or "dead asleep" 	<ul style="list-style-type: none"> • 15-30 minute • Up 40% of all sleep . 	Slowing of heart rate, breathing rate, and brain activity.	<ul style="list-style-type: none"> • EEG recording of slow, large amplitude wave. • Highly synchronized neuronal activity. • Brain activity slows down from the "theta" rhythm of stage 2 to a much slower rhythm called "delta" and the height or amplitude of the waves increases dramatically.

Stages of Sleep cont.

Stages	Waveform	Notes
REM	 REM sleep (beta waves)	Length of the rem stages increases as the night progresses.
Stage 1	 Stage 1 sleep (low voltage and spindles)	-Started when sleep has just begun. -Brain activity begins to decline.
Stage 2	50 μ V [ Stages 2 and 3 sleep (theta waves)	-
Stage 3&4	 Stage 4 slow-wave sleep (delta waves) 1 sec	Stage 3 & 4 sleep predominate early in the night, and the length will increase as night progress.

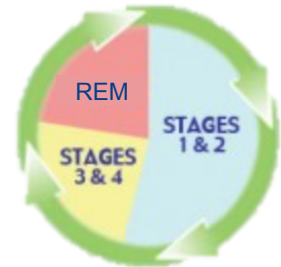
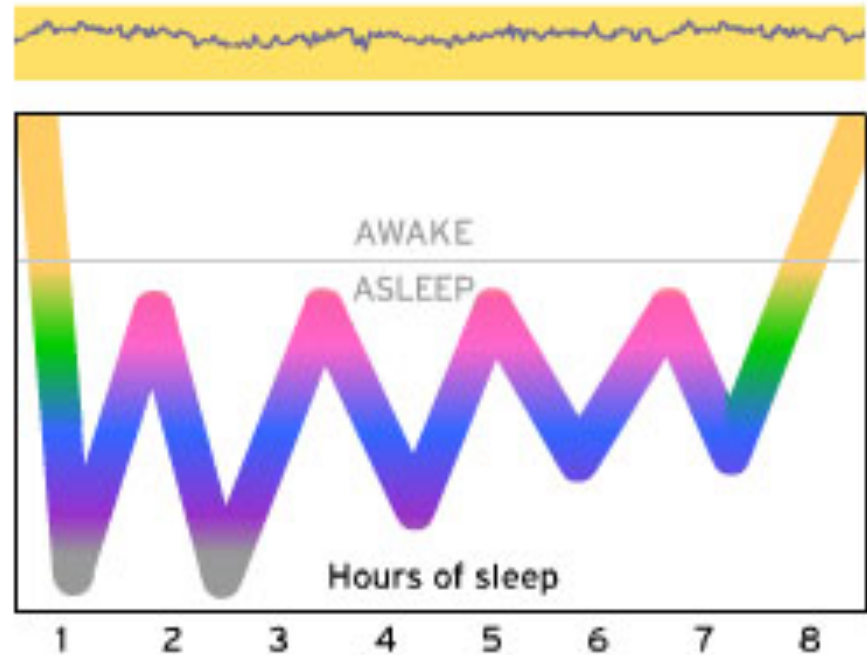
• **Alpha waves** are present when one begins a state of **relaxation**.
This is a relaxed **waking** state.


Quiet wakefulness (alpha waves)

Sleep Cycle

During the course of a night a sleeper passes through the different stages of sleep on a roughly 90-minute cycle.

- AWAKE
- STAGE 1
- STAGE 2
- STAGE 3
- STAGE 4
- REM SLEEP

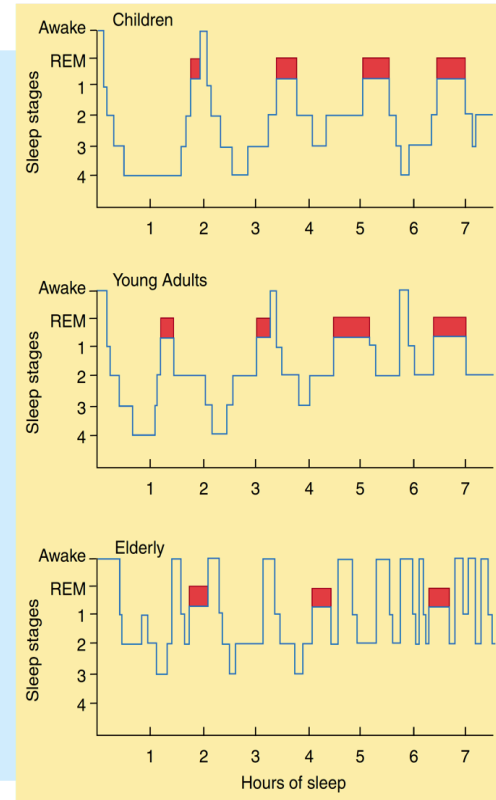


Normal Sleep Cycle at Different Ages

- ✧ Rem sleep is indicated in red.
- ✧ In a typical night of sleep, a **young adult** first Enters NREM sleep → Passes through stages 1 & 2, and spends **70–100 min in stages 3 and 4** → Sleep then lightens, and a rem period follows.

✧ REM sleep occupies:

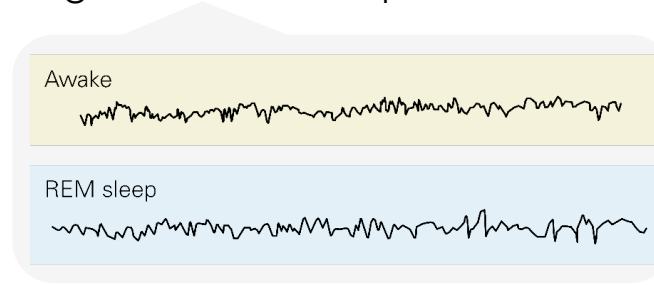
Premature infants	80% of total sleep.
Full-term neonates	50% of total sleep.
Elderly	20% of total sleep.



REM Sleep

REM stands for Rapid Eye Movement sleep, and its also called **Paradoxical¹** sleep, because it is a paradox that a person can still be asleep despite marked activity in the brain.

✧ **On EEG:** REM stage have a similar pattern to wakefulness stage.



✧ Characterized by:

1) Active form of sleep.	5) Irregular muscle movement. E.g. rapid eye movement.
2) It is hard to wake people in REM.	6) The brain is highly active and its metabolism rate is increased by 20%.
3) Muscle tone is depressed. -Because of the strong inhibition of the peripheral muscles	7) It is Not a restful sleep and associated with vivid dreams.
4) The heart rate and the respiratory rate are irregular.	9) On EEG it have a low amplitude and a high frequency pattern.

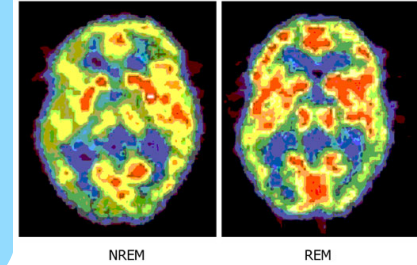
During REM Sleep

Increased activity in limbic system, parietal cortex, temporal cortex and pons.

Cell in pons will send information to the spinal cord to inhibit motor neurons.

Decreased activity in primary visual cortex
we need our eyes shut, The motor cortex we need to be relaxed and the dorsolateral prefrontal cortex.

The Brain will get rid of any useless connections and will consolidate your learned motor skills.



REM Sleep	SWS ¹
Can be remembered	Can NOT be remembered because the consolidation of dream in memory will not occur.
Your muscle activity will be high.	Muscle activity will be less.

*Most sleep during each night is of the slow-wave (NREM), which is the deep, restful sleep.

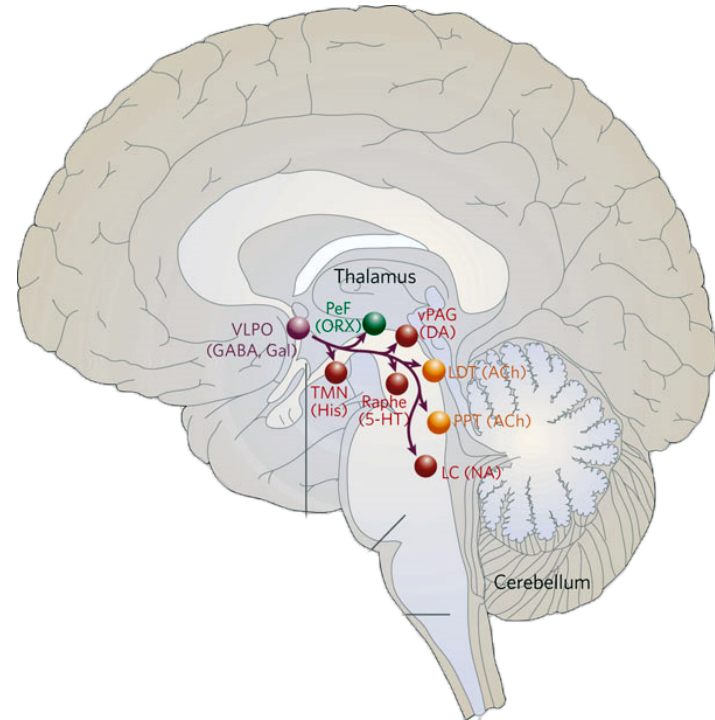
The Neuronal Basis of Sleep

❖ The brain regions involve in sleeping :

- ✓ Suprachiasmatic nucleus
- ✓ Pineal gland
- ✓ Ventrolateral preoptic nucleus
- ✓ Raphe nucleus
- ✓ Tuberosomammillary nucleus.

❖ Neurotransmitter involved in sleeping:

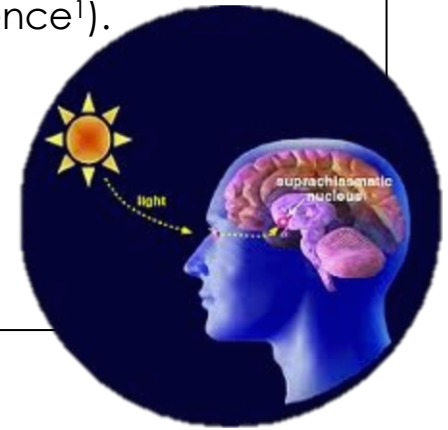
- ✓ Melatonin
- ✓ Serotonin
- ✓ Adenosine
- ✓ Muramyl
- ✓ Orexine
- ✓ Histamine.



The Neuronal Basis of Sleep cont.

Melatonin

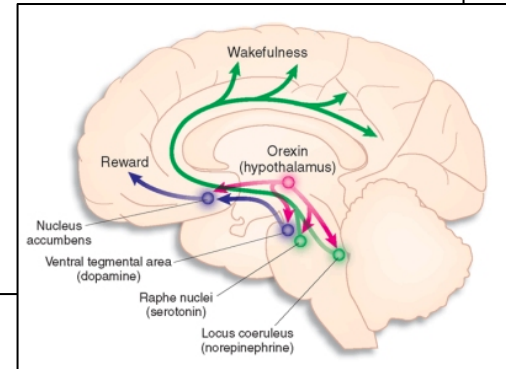
- ✧ There are some ganglion cells (melanopsin) → in the retina that Respond Directly to the light → send it through the optic nerve → to the Suprachiasmatic nucleus (SCN) in the Hypothalamus.
- ✧ The suprachiasmatic nucleus have a biological clock that is responsible of the circadian rhythm → any damage to it will not make the body able to differentiate between the day and night.
- ✧ The SCN regulates the Pineal gland an endocrine gland located posterior to the thalamus which secrete Melatonin, a hormone that increase sleepiness (somnolence¹).
- ✧ Melatonin secretion begins 3-4 hours before bed time.
Exogenous melatonin can phase advance the biological clock and used as a sleep aid.



The Neuronal Basis of Sleep cont.

Serotonin & Adenosine

- ✧ The ventrolateral preoptic nucleus (VLPO), a small group of neurons located in the anterior hypothalamus. → have projections to many brain areas associated with arousal and in these projections are a neurotransmitter (**Glanin and GABA**) associated with **NREM sleep**. → These neurotransmitters are inhibitory and inhibit the monoaminergic cells in the areas associated with arousal in brain (locus coeruleus, the raphe nucleus and the tuberomammillary nucleus). In order to switch off the brain.. and go into NREM
- ✧ **VLPO is activated by:**
 - ✓ Serotonin plays a role in the behavior of the person
 - ✓ Adenosine is inhibited by caffeine.
 - ✓ Prostaglandins D12,
These accumulate in the body during the day.
- ✧ **VLPO is inhibited by:**
 - ✓ Acetylcholine
 - ✓ Noradrenaline

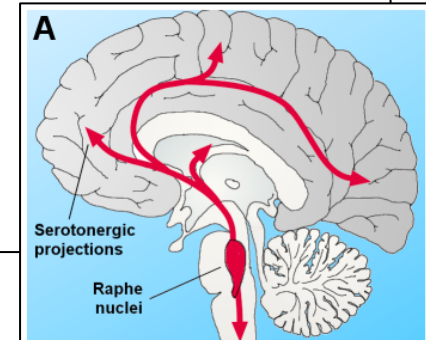


The Neuronal Basis of Sleep cont.

Serotonin & Adenosine cont.

- ✧ **Raphe nuclei:** is a group of neurons located in the reticular formation of the brainstem and contains serotonergic neurons. (With a serotonin inside it)
- ➔ **Any damage to the raphe nucleus will lead to a high state of wakefulness.**
- ✧ These neurons will send messages to the thalamus and hypothalamus and even the limbic system.
- ✧ Projection from the raphe nucleus also terminates in the dorsal horn of spinal

When we give an animal a serotonin-blocking medications, the animal will die ☹



Sleep Disorders

Insomnia

الأرق



- Insomniacs are people who have the desire to sleep but they can't and for sure they will feel tired during the day.
- Depressed old women are more prone to insomnia.

• Insomnia results from:

- ✓ Excessive consumption of caffeine,
- ✓ Stress.
- ✓ Pain.
- ✓ Medications.
- ✓ Emotional changes.
- ✓ Excessive exercise before going to sleep.
- ✓ Epilepsy.
- ✓ Parkinson's disease.

THIS IS SERIOUS INSOMNIA

Fatal Familial: The autonomic and the motor neurons needed in sleep will be damaged.

Narcolepsy

A really dangerous disease where you lose your muscle tone suddenly.

Sleep Apnea

Airway obstruction, if the patient was obese for example.

Sleep walking

Bed wetting

Night terrors

During NREM Sleep.

	NON REM (SWS)	REM
Time	75-80%	20-25%
HR/RR	↓	irregular
Muscle tone		↓ (Except eyes + Respiratory muscle)
Metabolic Rate	↓	↑ (Maybe to 20 %)
Dreams	Not Remembered	Remembered
Wakefulness	easy	hard
EEG	$\theta - \delta$	β

✧ **Sleep:** Unconsciousness which a person can be aroused by sensory or other stimuli.

✧ **Coma:** Unconsciousness which a person can't be aroused.

✧ **Light** is critical for periodically resetting our circadian rhythms.

✧ REM also called **Paradoxical**

• **Melatonin:**

Increase sleepiness (omnolence).

• **Serotonin and Adenosine:**

VLPO is activated by serotonin adenosine and prostaglandins D12.

• **Orexin (Hypocretin):**

Destruction of Orexin receptors will cause Narcolepsy.

• **Histamine:**

Causes a behavioral arousal and cortical activation.

1- Which one of these is responsible of staying awake:

- A. Serotonin
- B. Melatonin.
- C. Adenosine.
- D. Orexin.

2- Which one of these is secreted by the tuberomammillary nucleus:

- A. Orexin.
- B. Muramyl.
- C. Histamine.
- D. Serotonin.

3- Which one of these does NOT happen during NREM:

- A. Narcolepsy.
- B. Bed wetting.
- C. Sleep walking.
- D. Night terrors.

4- During REM sleep:

- A. Brain activity decreased.
- B. Muscle tone increased.
- C. Dreams are not remembered.
- D. Irregular muscle movement.

5- On EEG, K-complex happen in:

- A. REM
- B. Stage 4
- C. Stage 1
- D. Stage 2

6- Which one of these have the Delta wave:

- A. REM
- B. Stage 4
- C. Stage 1
- D. Stage 2

1- Differentiate between sleep and coma.

Sleep is defined as unconsciousness from which a person can be aroused by sensory or other stimuli while coma is unconsciousness from which a person cannot be aroused.

2-what kind of waves happen in each stage of sleep ?

REM> Beta , SWS(NREM)> Delta & Theta

3- Name 3 neurotransmitters that enhance sleep.

Serotonin, Melatonin and Adenosine.

4- In which stage remembered dreams happen ?

During REM sleep

5-Name 2 sleep disorder happen while in NREM sleep.

Sleep walking and bed wetting

6-What is Zeitgeber ?

Zeitgeber is a term used to describe any stimulus that resets the circadian rhythms.

7- Differentiate between insomniac and nonsomniac.

Insomniac people have the desire to sleep but they cant, Nonsomniac. people can sleep for less than the 8 hours and still not feel tired during the day.

8- Why does REM sleep called Paradoxial sleep ?

because it is a paradox that a person can still be asleep despite marked activity in the brain.

THANK YOU FOR CHECKING OUR WORK!

BEST OF LUCK

Done By:

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