

What is sleep



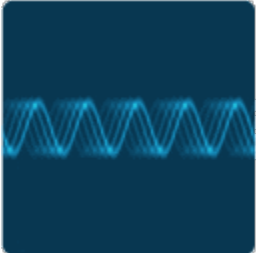
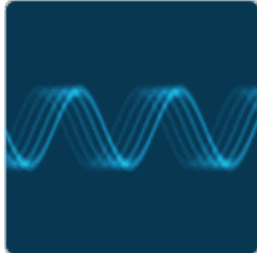
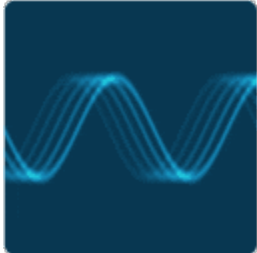
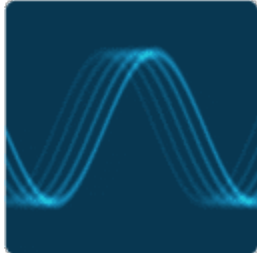
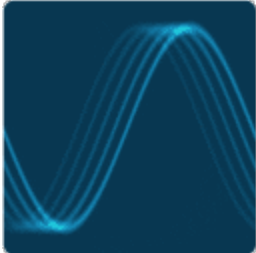
Sleep is a natural, periodically recurring state of inactivity, characterized by the loss or alteration of consciousness and reduced responsiveness to external stimuli.

History of sleep research

- ❖ In 1916 Constantin Von Economo pinpoints the origin of sleep and wake signals in the hypothalamus area of the brain.
- ❖ IN 1920 Hans Berger, German sleep researcher invented electroencephalograph (EEG) and his subsequent realization that brain waves change as wakefulness gave way to sleep, prompted a rapid expansion of sleep study in the 1930s, 1940s and 1950s.
- ❖ In 1953 Nathaniel Kleitman and his colleagues first pointed out the different types of REM and non-REM sleep.
- ❖ William C. Dement showed that a night's sleep consists of several repeating sleep cycles, each composed of different sleep stages. By 1968, the different sleep stages had become standardized.
- ❖ In 1959 **Franz Halberg** (the “father of chronobiology”) researches circadian rhythms and first uses the term “circadian”
- ❖ in 1997 Japanese-American neurobiologist **Joseph Takahashi** identifies and clones the CLOCK circadian gene.

Brain waves frequencies related to sleep

- Brain waves are of four types of

Gamma	Beta	Alpha	Theta	Delta
While you performs large scale brain activity and cognitive problem solving works. wakeup state (38-42 cps)	While you are reading this this is the normal wakeup state (14-30 cps)	You are in Alpha when listening to music, watching or meditating. This is the normal resting state (8-13 cps)	You are in Theta when you are in a pre-sleep semi awake. This is hypnoidal state (4-7 cps)	You are in. delta, when you are in high quality regenerative sleep. This is the deep sleep state. (0.5-3.5cps)
				

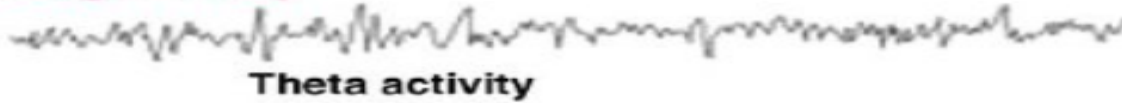
*cps = Cycle per seconds

An EEG recording of the Stages of sleep

Awake



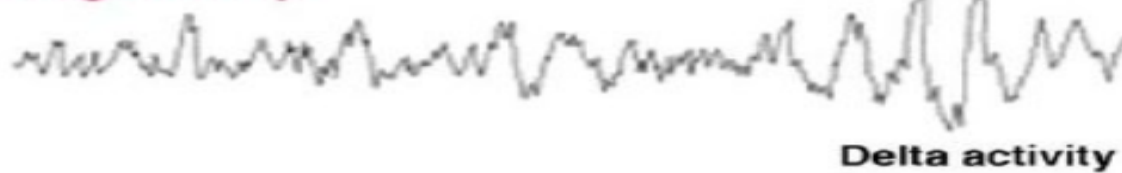
Stage 1 sleep



Stage 2 sleep



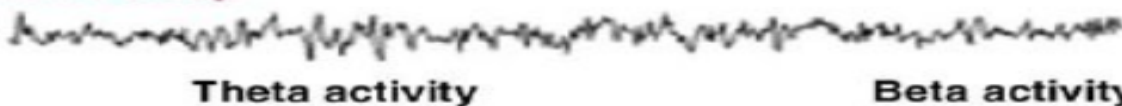
Stage 3 sleep



Stage 4 sleep



REM sleep



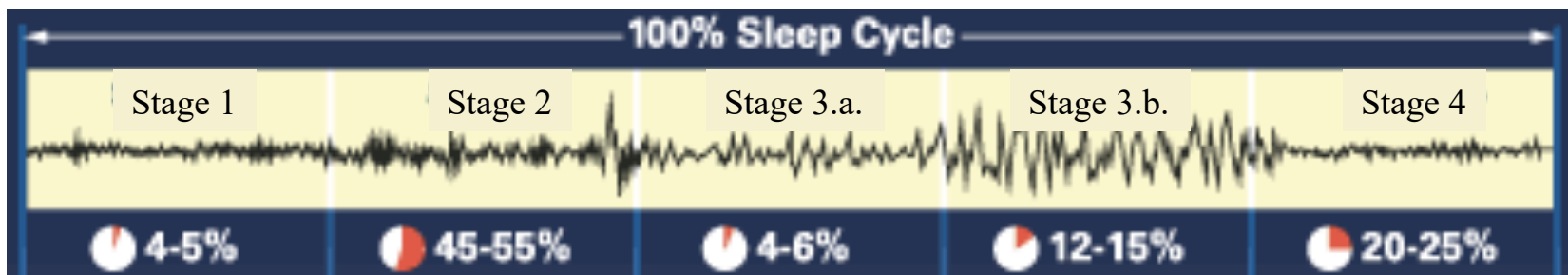
Types of sleep and sleep cycle

There are **two types of sleep** observed

1. Non-REM (**non- Rapid eye movement**) sleep: sleep is also known as quiet sleep
2. REM (**Rapid eye movement**) sleep: sleep is also known as active or paradoxical sleep

Non-REM sleep is further divided into 3 stages

- a. Stage 1: 4-5%, light sleep. Muscle activity slows down. Occasional muscle twitching
- b. Stage 2: 45-55%, Breathing pattern and heart rate slows. Slight decrease in body temperature.
- c. Stage 3: deep sleep (include 2 stages)
 - Stage 3.a.: 4-6%, Deep sleep begins. Brain begins to generate slow delta waves.
 - Stage 3.b.: 12-15%, Deep sleep. Rhythmic breathing. Limited muscle activity. Delta waves
- d. **REM** sleep
 - stage 5: 20-25%, Rapid eye movement. Brain waves speed up and dreaming occurs. Muscle relax and heart rate increases. Breathing is rapid and shallow.



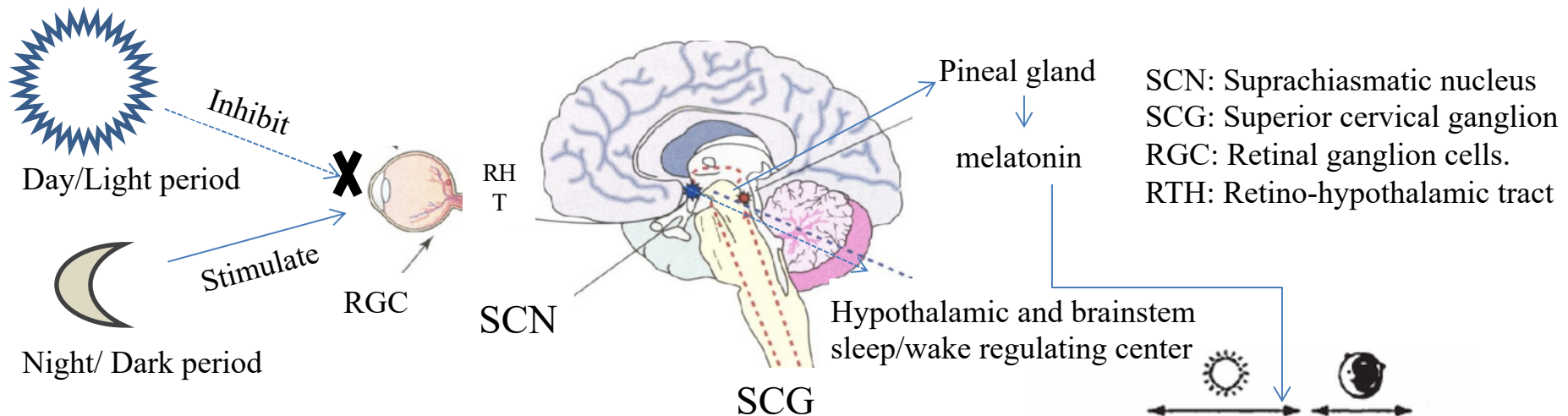
Sleep and Circadian rhythm

Suprachiasmatic nucleus (SCN):

A small group of nerve cells located in the hypothalamus that acts as a master clock, regulated circadian timing system.

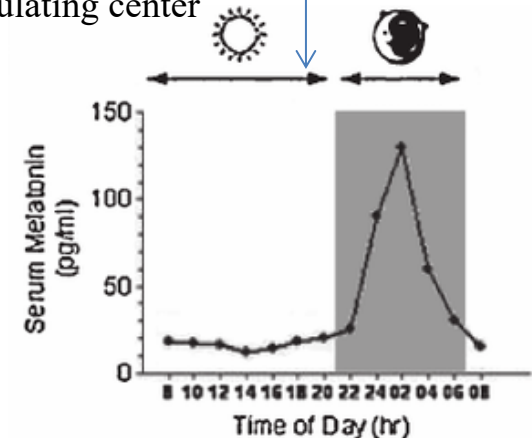
Pineal gland:

It is a small endocrine gland located in the in the epithalamus, near the center of the brain, between the two hemispheres, tucked in a groove where the two halves of the thalamus join of brain of vertebrates. It produces a serotonin-derived hormone known as melatonin or sleep hormone, which modulates sleep patterns.



Melatonin (often called sleep hormone):

Level of melatonin (produced in Pineal gland) normally rises after darkness falls, making people feel sleepy.



Sleep cycle

- **Non-REM**
 - a. Stage 1: last for around 5 - 10 minutes
 - b. Stage 2: last for around 10-20 minutes
 - c. Stage 3: deep sleep last for around 20-24 minutes
- **REM sleep**
 - d. stage 4: In most adult 20-25% of sleep spend is Rapid eye movement out of total sleep. First REM cycle I of night is typically lasts about 10n minutes. But REM stages progressively getting longer as sleeps goes on.

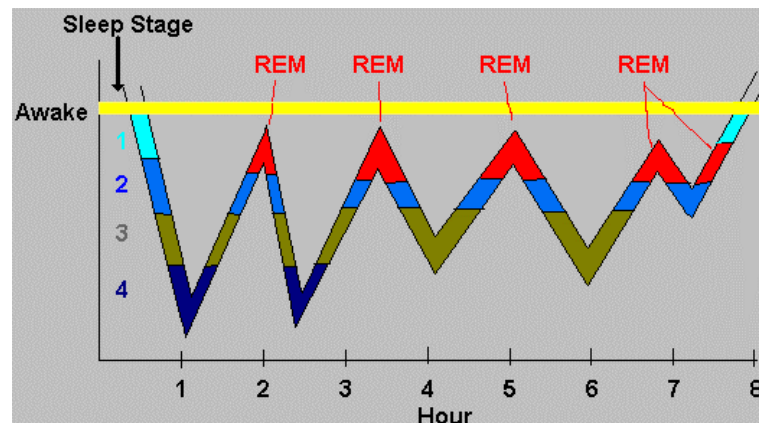


Fig.Ref:<https://faculty.washington.edu/chudler/sleep.html>

Sleep homeostasis



- Sleep is regulated by homeostatic and circadian processes
 - Sleep homeostatic mechanisms influencing functioning of the circadian clock and Both affects physiology and behaviour.
 - Sleep is in synchronized with the body metabolism!
 - Generally adenosine concentration rises during wake and falls during sleep
- Caffeine blocks adenosine receptors

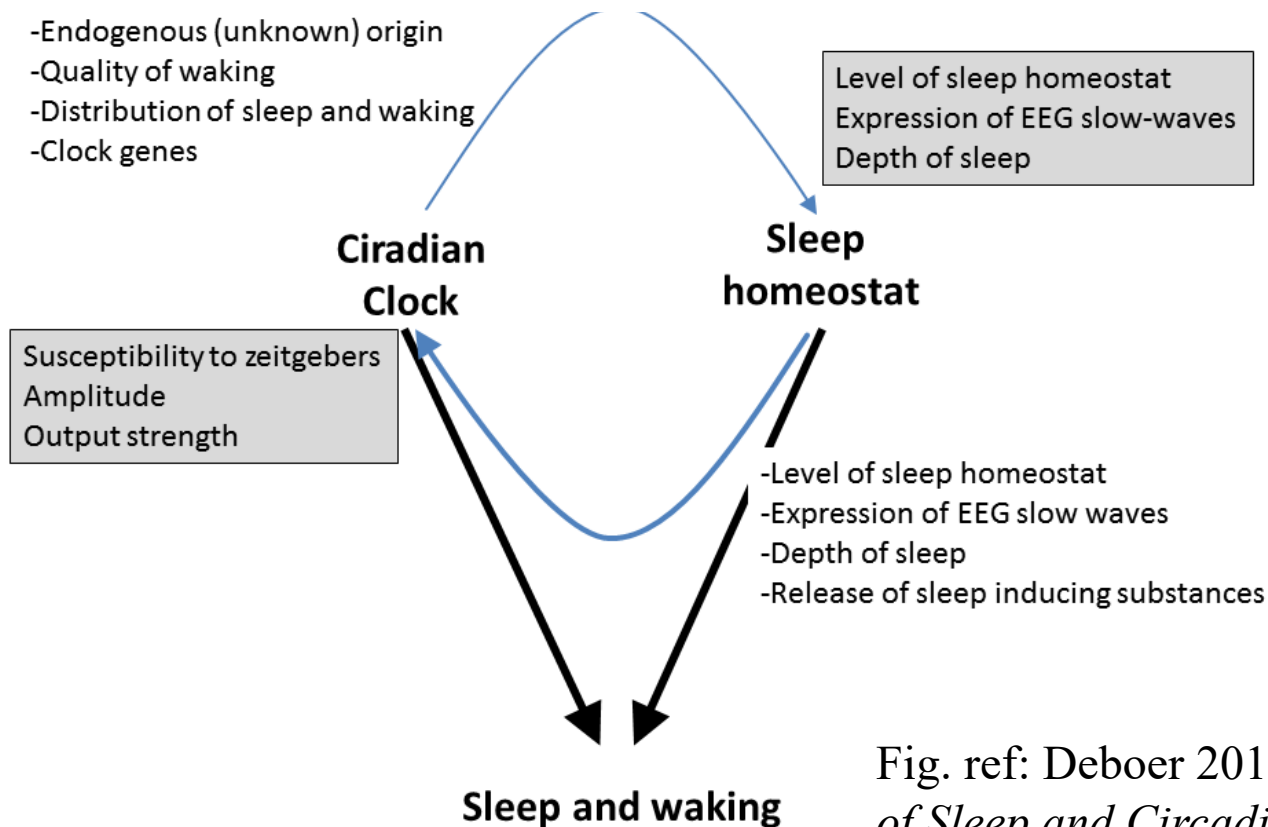


Fig. ref: Deboer 2018, *Neurobiology of Sleep and Circadian Rhythms*

Sleep disorders

Sleep Apnea

- is interruption of passing air through air passage. It caused by cessation of the muscles movement during inhalation, though the initially the lungs volume remains unchanged. person breathing cessation resulting in high level of carbon di-oxide blood levels when the person got awake and stimulate breathing.

There are two main types of sleep apnea:

1. **Obstructive sleep apnea**, is one of the form that commonly occurs when throat muscles relax and air passage get shrunken.
2. **Central sleep apnea**, which occurs when brain areas controlling breathing, doesn't send proper signals to the muscles that control breathing.

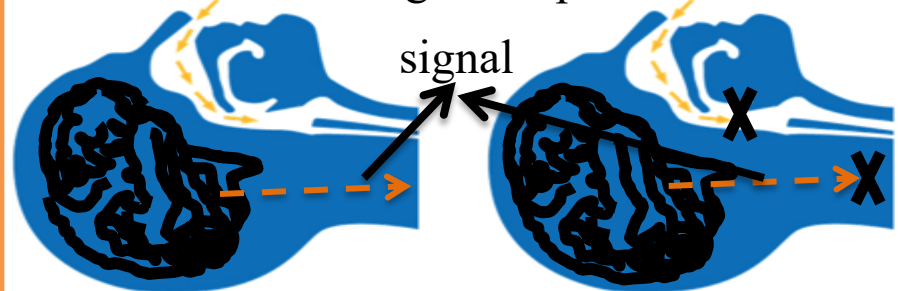
1. Obstructed air passage



Normal air passage

Obstructed air passage

2. Brain signal stops



Normal brain signal

no brain signal

Sleep disorders

Insomnia :

It refers to trouble to getting sleep or remaining asleep as long as he desire, resulting in a poor sleep quality.

Insomnia can be classified as transient, acute, or chronic.

Transient insomnia : It observe for a shorter time such as less than one. It could be caused by the timing of sleep, stress or severe depression,. Its resulted in – sleepiness and impaired psychomotor performance

Acute insomnia : It is the inability sleep well consistently for period of a less than a month. It is also known as short term insomnia or stress related insomnia
Insomnia is present when there is difficulty initiating or maintaining sleep or when the sleep that is obtained is non-refreshing or of poor quality. These problems occur despite adequate opportunity and circumstances for sleep and they must result in problems with daytime function.

Chronic insomnia : It lasts for longer than a month. It might include muscular weariness, hallucinations, and/or mental fatigue. Chronic insomnia can cause by another disorder, or it can be a primary disorder.

Sleep disorders



Narcolepsy:

Sleep appears at odd times

Narcolepsy is characterized by

- **Sleep attacks:** urge to sleep during the day
- **Cataplexy:** Sudden loss in muscle control. typically on both sides of the body, triggered by strong, often pleasant emotions. though person is still conscious.
- **Sleep paralysis:** REM paralysis, i.e. muscle paralysis that normally occurs during REM sleep intruding into waking hours.
- Narcoleptics have reduced CSF levels of the neuropeptide orexin or altered activity of the orexin-B receptor.

Sleep disorders

Restless Leg Syndrome (RLS)

A uncontrollable urge to move your legs.



- It is also known as Willis-Ekbom disease (WED)
- Most people experience "creepy" sensations on their legs like 'itching' or 'pins and needles'.
- These sensations can go on even in your sleep causing constant sleep disturbances.
- People having RLS often shown **sleep walk**
- Most individuals with RLS suffer from periodic limb movement disorder (limbs jerking during sleep), which is an objective physiologic marker of the disorder and is associated with sleep disruption.
- It can be caused by low iron levels and/or imbalance in dopamine levels