

Physiology of Sleep and Common Sleep Disorders

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Etymologically, the term "sleep" comes from a word meaning "to slack"; the term's similarity to the word "slack" is no accident. Sleep is susceptible to various interferences, and many diseases, some harmless and some serious, first exhibit symptoms during sleep. It is therefore important to deal not only with the scientific findings, but also with possible sleep theories because many facts about sleep remain unknown. In the following guide, you will see what sleep is actually about, what stages it occurs in, and what sleep disturbances individuals may experience.



The Need to Sleep

An individual's need for sleep depends upon the following factors:

- One's internal clock
- One's state of exhaustion
- The period of time since one last slept
- One's state of health
- The condition of one's health
- Age
- Time of day

The range of factors which determine one's need for sleep means that **circadian rhythms** can vary markedly from person to person. The cycle of day and night significantly affects circadian rhythms, which in turn affect an individual's metabolism. Furthermore, an individual's need for sleep changes throughout his or her life. However, an one's personal circadian rhythm initially manifests in the first trimester of pregnancy.

Facts on the need to sleep

- Babies spend half of their sleep in R.E.M. cycles, which are critical for infant brain development
- After the age of 5, children no longer sleep during the daytime
- After the age of 50, the depth of sleep diminishes in men
- An individual's capacity to sleep decreases with age
- The need for sleep does not decrease with age
- The need for sleep is greater in winter than in summer

Physiology of Sleep

Sleep is not a passive process. It is a complex and dynamic phenomenon, and it is not consciously perceived. It also follows very strict rules. On average, a person will typically spend one third of his or her lifetime sleeping.

Physiology of sleep in healthy persons

Physiological characteristics of sleep in healthy persons include:

- Closed eyes
- Decreased pulse
- Decreased respiratory rate
- Decreased blood pressure
- Decreased body temperature

Physiology of sleep in ill persons

Physiological characteristics of sleep in ill persons include:

- Rhythmic Movement Disorder (Jactatio capitis nocturna)
- Waking up more than 12 times
- Sweating (Hyperhidrosis)
- Unrecognizable sleep phases

Suprachiasmatic nucleus (the body's clock)

The different light levels of day and night are absolutely relevant to the physiology of sleep. An individual's internal clock helps that individual remain in his or her circadian rhythm. This phenomenon has nothing to do with the schedule of one's personal customs. The site of the body's internal clock is the **hypothalamus**, and it is made up of nerve cells that influence various other brain regions. This physiological headquarters is called the **suprachiasmatic nucleus (SCN)**.

It is in the SCN that stimuli are triggered which act on other organs to influence the rest and activity phases of the human body. The SCN is activated by daylight, which is necessary because a human's day-and-night cycle needs to maintain a certain flexibility.

Essentially, the 24-hour circadian rhythm is also maintained in the absence of daylight.

Duration of Sleep

The typical duration of sleep is not the same for every person, ranging anywhere from 6 to 9.5 hours. Scientists recommend that an individual's sweet spot for sleep duration should be between 7-8 hours per night. But an individual's subjective feeling should be the decisive factor in determining how long he or she should sleep. In addition, sleep quality should be considered in relationship with sleep duration. Interference by external factors and sleep disorders can significantly affect one's quality of sleep. Because most recovery occurs during the first few hours of sleep, a short sleep duration of four hours, for example, does not necessarily cause fatigue. However, such short sessions of sleep should be avoided.

The Purpose of Sleep

Sleep performs several important functions for the human body. A lack of sleep can be life-threatening after a certain point. Not being able to sleep may indicate that an individual is ill or under the influence of particular drugs.

The functions of sleep are:

- Physical recuperation (muscles)
- Mental recuperation → During sleep, different parts of the brain are used
- Stress relief

Sleep Phases — The Four Stages of Sleep

- **Stage one:** Falling-asleep and waking-up phase
- **Stage two:** Superficial sleep
- **Stage three:** Medium-depth sleep
- **Stage four:** Deep sleep with R.E.M. cycles

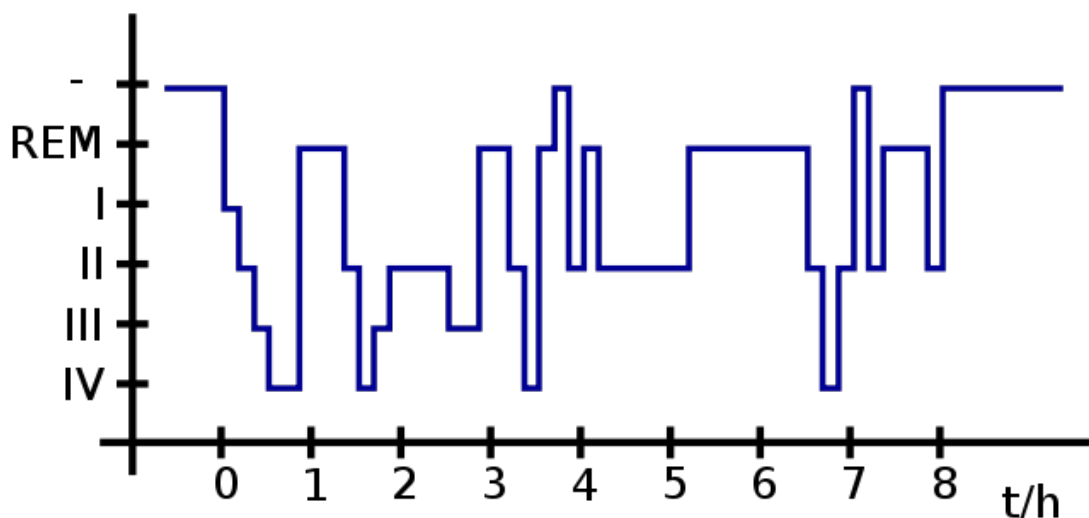


Image: "Graph showing sleep phases." by Markus Mueller. License: [Public Domain](#)

Sleep occurs in cycles. For a healthy person with a normal daily routine, each sleep cycle typically lasts about 70 to 110 minutes.

The cyclical nature of sleep means that stages 2 through 4 are repeated several times every night. The frequency of such repetitions depends on the total duration of one's sleep. Normally, an individual experiences 4–7 of these repetitions per night. The sleep cycle always ends with a phase of R.E.M. sleep. As the number of sleep cycles an individual experiences during the night increases, deep-sleep phases become shorter while R.E.M. cycles become longer.

Indicators of the four stages of sleep

The waking period just before falling asleep involves:

- Relaxation
- Alpha waves in the brain

Stage one: Falling asleep is characterized by:

- Theta waves increasing in the brain (slower than alpha waves)
- Muscle spasms diminishing

Stage two: Superficial sleep is characterized by:

- Muscles beginning to relax further
- Limbs becoming tangibly heavier
- Pulse becoming consistent
- Breathing becoming regular
- Beta spindles, vertex waves, and K-complexes becoming detectable in EEG

Stages three and four: Indicators of medium-deep sleep and deep sleep can be summarized as the following:

- Eyes begin to steady
- Muscles spasms decrease further
- Heartbeat slows
- Breathing steadies
- Blood pressure decreases
- Delta waves become detectable in EEG

End phase: R.E.M. sleep

R.E.M. stands for **Rapid Eye Movement**. This phrase signifies that this particular sleep phase is characterized by rapid movement of a sleeper's eyes. Another commonly-used term for R.E.M. sleep is "**dream sleep**." It is considered certain that a sleeper is dreaming during this period. However, an individual can also experience dreams in other sleep phases. In a sleep cycle, R.E.M. sleep is situated between the waking state and light sleep. It is therefore repeated several times per night, up until the moment that the sleeper passes from R.E.M. sleep back into light sleep, which begins a new sleep cycle.

Characteristics of R.E.M. sleep:

- Paralysis of voluntary muscles (involuntary muscle processes remain unparalyzed)
- Rapid eye movement
- Increased blood pressure
- Irregular heart rate
- Irregular breathing
- Increased blood flow to sexual organs

Scientists assume that R.E.M. sleep serves the **psyche** and the **nervous system** by providing them a pause to rest. At this stage of sleep, the muscles also experience their highest level of relaxation. People who are awakened from this stage commonly report having vivid dreams. But it is in the R.E.M. phase of sleep that many organ systems are as active as they would be during a waking state.

After a R.E.M. phase ends, the sleep cycle begins anew, through light sleep to deep sleep. The deep-sleep phases become shorter towards morning.

Awakening can be characterized by:

- Wake-up threshold changing (40—50 decibels)
- Wake-up stimulus as a result of full bladder
- Rotational movements on a harder mattress
- Temperatures above 22° C (71.6° F)

Hormone Production During Sleep

Note: During the first hours of sleep, the production of the hormone renin increases.

Renin is produced in the kidneys and serves to raise blood pressure.

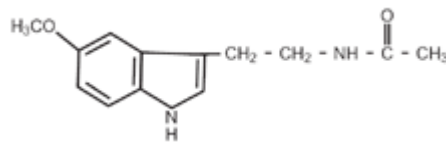


Image: "melatonina structural formula" by Davide.Radice i-b. License: [CC BY-SA 3.0](https://creativecommons.org/licenses/by-sa/3.0/)

The hormone **melatonin** is produced in the pineal gland of the human brain. Its production is triggered by darkness and fatigue. Melatonin is detectable in the blood and is also commonly referred to as "the sleep hormone." Supplements that contain melatonin are therefore used for treating sleep disorders and especially for treating people who do not have a regulated day-night rhythm, such as shift workers.

Note: The hormone **cortisol** decreases during the first phase of sleep and rises again in the early hours of the morning.

Sleep Disorders

Sleep disorders are considered in patients who report experiencing sleep-related problems at least three times per week over a period of four weeks and who perceive their sleep problems as impairing. In diagnosing **insomnia**, a physician must distinguish between the difficulty of falling asleep and the difficulty of staying asleep. There are as yet no scientific definitions to differentiate the two.

The largely unanimous opinion of sleep experts is as follows:

A sleeping disorder is considered likely when the process of falling asleep takes longer than 30 minutes. Statistically, a person should fall asleep within 15 minutes.

Complications of Insomnia

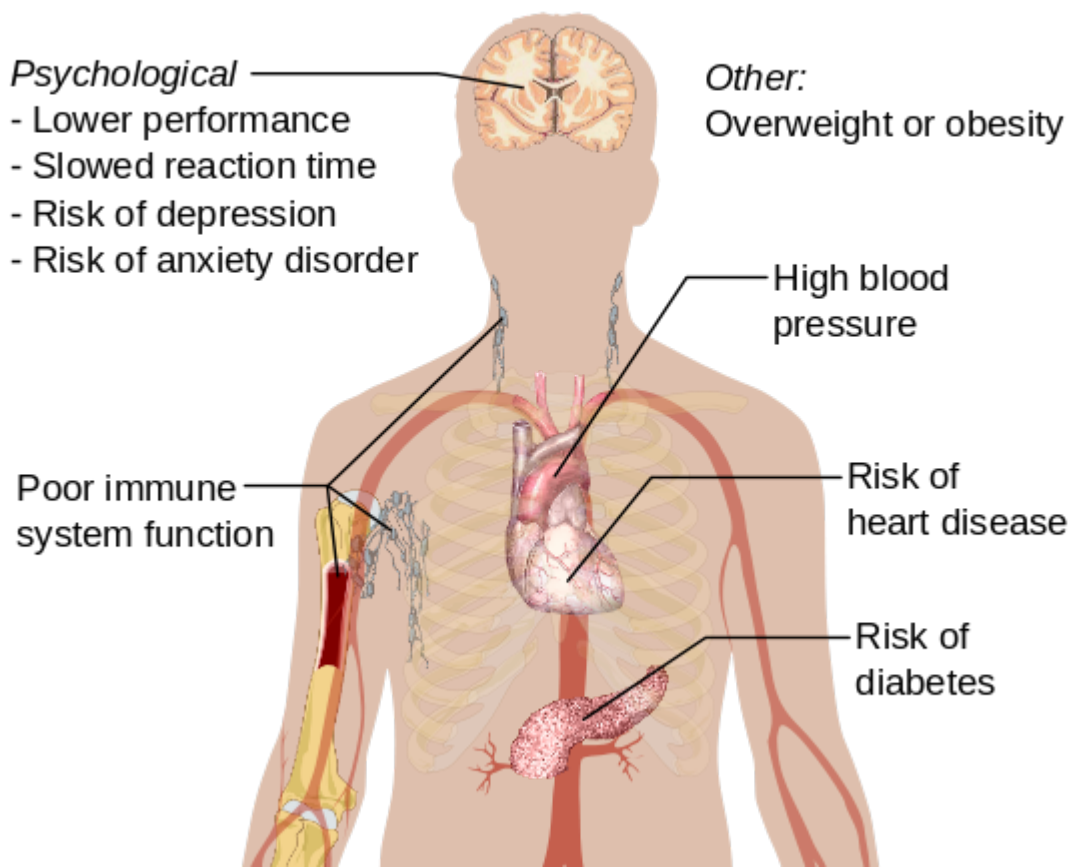


Image: "Main complications of insomnia" by Mikael Häggström. License: [Public Domain](#)

Sleeping and waking throughout the night

Sleep is not a continuous process but may be interrupted by repeated awakenings throughout any given night, triggered by various stimuli. But there is no hermetic seal to sleep, so the transition between waking and sleep can be fluid. Only when an individual wakes up 12 or more times during the night will a waking disorder be considered.

Basic rule: The higher the **vegetative tension** a person has before going to sleep, the greater the likelihood they will experience frequent waking.

Among sleep disorders, **waking-up disorders (i.e., Arousal Disorders)** include **drowsiness, sleepwalking**, and (i.e., pavor nocturnus).

A **sleep-maintenance disorder** is also considered likely when the duration of sleep is less than 6 hours as a result of sleep interruptions.

What is problematic about assessing actual sleep problems is that not every waking during the night is a sleep interruption. The fact that someone feels tired and is not fully rested in the morning, despite supposedly having a long period of sleep, is not a reliable indication of insomnia. As part of diagnosing sleep disorders, a range of possible diseases must be taken into consideration. The causes may very well be psychological.

Nightmares

Nightmares are categorized as a sleep disorder. By definition, these types of dreams are considered to cause anxiety within the dreamer.

Nightmares are characterized by the following processes:

- Waking up
- Strong memory of the relevant dream
- Occurring at all ages (children are more commonly affected)
- Being linked to the R.E.M. phases of sleep

Nightmares can occur as a phase and thus not necessarily be considered as a chronic problem. However, one can still need treatment for nightmares. Consideration must especially be given if such dreams were caused by a medication.

Those who are particularly prone to nightmares:

- Children aged 5 and younger
- Women
- People with very creative inclinations

If one falls outside of the aforementioned parameters but still has consistent nightmares, he or she can experience serious consequences. For example, sufferers of nightmares can develop a fear of sleep. At this point, mental disorders and chronic fatigue can result.

Night terrors (pavor nocturnus)

Night terrors are also considered to be a sleeping disorder. Night terrors should not be confused with nightmares.

Sufferers of night terrors wake up with:

- Whimpers
- Wheezes
- Anguished cries

Children affected by night terrors exhibit:

- Pronounced fear
- Internal unrest
- Dilated pupils
- Rapid breathing
- Confusion
- Stereotypical movements

These signs can be exhibited for a period of up to 10 minutes. The next day, however, the memory of a night terror no longer exists. General anxiety can still be noticeable on the following day and fragments of dreams may persist in the memory. The disorder usually heals itself with no need for further treatment. Night terrors appear to run in families and can have harmless or serious causes, such as brain injuries.

Harmless triggers include:

- Stress
- Powerful experiences
- Overworking

- Acute respiratory disease

Mostly children, especially young boys, are affected by night terrors. In adults, the phenomenon is rather rare. An individual could be diagnosed with **chronic night terror disorder**, which could thereafter drag into adulthood.

Somnambulism (sleepwalking)

“**Somnambulism**” is a term derived from a combination of the Latin words “ambulare,” or walking, and “somnus,” or sleep. Somnambulism is a sleep disorder that occurs more prevalently during childhood and then typically subsides afterwards. In adults, it is rare but requires medical treatment. It can be described as abnormal events that occur when an individual enters a state between sleeping and waking.

Signs of somnambulism in stages:

1. Waking and sitting up, possibly sorting through nearby objects
2. Rising up, opening doors/windows, leaving the room
3. Leaving home (rare)

Sleepwalkers commonly walk towards light sources and therefore they are sometimes referred to as “moonstruck.” Sleepwalkers can complete complex movements while not being aware of them, which means that they do not recognize hazards. They also cannot adequately detect obstacles that are in their way. Sleepwalkers must be returned quietly and without excitement to bed. When sleepwalking happens frequently, physicians must determine whether or not a neurological disease is the cause.

Somnambulism is one kind of parasomnia. **Parasomnias** are undesirable behaviors occurring during sleep. Over time, without serious treatment, parasomnias can lead to nervousness, lack of concentration, fatigue, depression, and muscle and other types of pains.

Treatment of sleep disorders

For the purposes of adequate therapy, properly diagnosing a sleep disorder is crucial. The following instruments and methods are available to help physicians make an accurate diagnosis:

- Electroencephalography (**EEG for brain stem waves**)
- Electrocardiogram (**ECG for cardiac function**)
- Hospitalization at a sleep disorder clinic
- Blood tests
- Electrooculogram (**EOG for eye movements**)
- Electromyogram (**EMG for muscle activities**)

As a physician, it is important to educate patients about all the possible causes of a sleep disorder. Sleep disorders can be treated by using relaxation techniques, behavioral therapies, and psychotherapies. It may also be necessary to treat any underlying diseases and to provide medical monitoring.

Review Questions

Solutions can be found below the references.

1. Which answers are correct?

1. R.E.M. sleep is part of the deep-sleep phase.
2. Cortisol levels rise at night and decrease in the morning.
3. During R.E.M. sleep, muscle tension increases.
4. Theta waves can be detected with EEG during deep sleep.
5. Delta waves can be detected with EEG during a state of relaxation.

2. When are sleep disorders considered to be apparent?

1. When a patient subjectively feels that they have a sleep disorder.
2. When the process of falling asleep lasts longer than 30 minutes.
3. When a patient wakes up more than 3 times per night.
4. When a patient is asleep for more than 8 hours.
5. When a patient is asleep for less than 6 hours.

3. What should be considered when discussing somnambulism?

1. The patient must be immediately presented to a neurologist.
2. The patient must not be disturbed, remove all obstacles in his or her way.
3. The sleepwalker's certitude protects him against accidents.
4. The patient should be awakened immediately.
5. The patient should be gently returned to bed.

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Correct answers: 1A, 2B, 3E

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