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# UNDERSTANDING SLEEP



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Disclaimer: This is not intended to treat or diagnose any medical condition, and is not a replacement for medical advice from a medical professional, but is intended as an introduction to sleep science and a guide to understanding what happens in your body as you sleep. All opinions expressed are my own.

# UNDERSTANDING SLEEP

## Introduction

This guide intends to introduce you to the complex and extraordinary process of sleep. It will provide helpful and scientifically accurate information on what is happening in your body when you sleep and some initial insights into how we can address common sleep issues. No matter how long you've had sleep issues, there is hope for improvement, which can start with understanding your sleep.

## What is sleep?

On the surface, sleep is the time where we are not conscious between times of wakefulness. If we go a little deeper, sleep is a regulating force that recenters almost every process in our body. There are deep connections whether we look at sleep and its effects on memory, mood, physical activity, recovery, weight, or immune system functioning. It's no wonder that sleep has been referred to as the foundation of our health, a superpower, and yet it often goes unattended.

## Why do we sleep? What regulates sleep?

Sleep is the foundation of our health. It is a powerful regulating force that helps restore and reboot cognitive, emotional, immune, metabolic functions. We can function and survive without optimal sleep, but it is harder to thrive and optimize. To clarify at the beginning of this document, there is a difference between time asleep and time in bed. A sleep window is the time when you get into bed until the time you get out of bed. Sleep time is the amount of time we are actually asleep and no one sleeps 100% of the time they are in bed. In general, 85% sleep time, or higher, is considered good quality sleep. When we sleep, there are many hormonal and physiological functions at work. Two of those factors are your circadian rhythm & sleep drive.

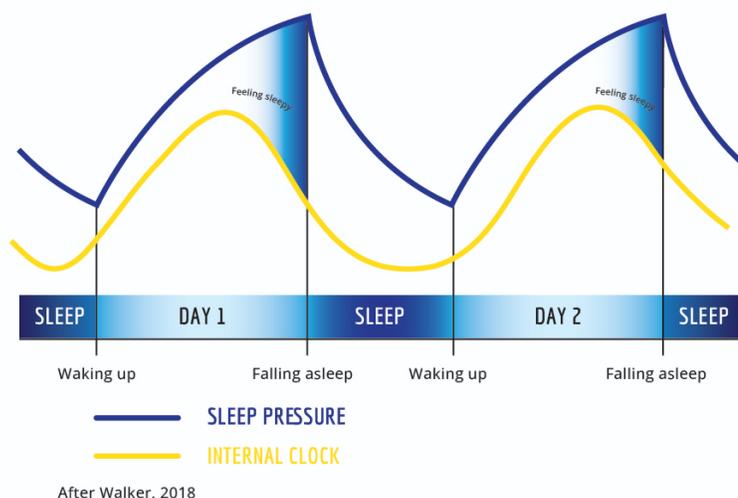
## Circadian rhythm

The circadian clock is "housed" in the suprachiasmatic nucleus (SCN), located in the hypothalamus, right above where the optic fibers of your eyes cross. The SCN consists of 2 small parts that have about 10,000 neurons each. Those small and mighty neuronal bundles send signals to help regulate digestion, cardiovascular functioning, sleep, and other body functions across a period of time, which averages 24 hours in humans. The circadian rhythm is like a little orchestra conductor in the brain coordinating your body's systems around the clock, but behaviors can influence it.

Because of the placement of the SCN in the brain, next to your optic nerves and behind your eyes, it is sensitive to light. Light is one of the influences that sets and drives your circadian rhythm. If you get up at a consistent time each day and get some light exposure, your body can start to "memorize" that pattern and that can help get you going in the morning. Light can be natural or artificial, but should be about 10,000 lux (a measurement of light). People believe that forcing a particular bedtime drives good sleep, but it's really more crucial to have a consistent wake up time.

## Sleep drive

Sleep drive refers to the process of waking up refreshed and, as you go throughout the day, you get more sleepy. Some have called it "sleep pressure" as well, with the pressure building as bedtime approaches. Your sleep drive is influenced by a hormone called adenosine. Adenosine is at its lowest point when you wake up and then builds throughout the day and is at its peak before bedtime. When adenosine peaks, it triggers the body's need for sleep and may be one reason why our body sinks into deep sleep first (more on that later). The sleep drive system works in concert with your circadian rhythm and should flow together, as seen in this chart.



However, both the circadian rhythm and sleep drive can be influenced by our behaviors. Caffeine, unhelpful naps, inactivity, and getting in and out of bed at inconsistent times can jerk these systems around and result in less than optimal sleep.

## Arousal Systems

We've covered what major systems are at play as the body's systems prepare for sleep, but there is another system that comes into the picture and can greatly interfere with the sleep process. The arousal system is also referred to as the stress response system, the fight, flight, and freeze response. This system likely has an evolutionary purpose. Once a stressor is registered, the brain initiates a cascade of physiological processes that get you ready to face the impending event. The number of systems involved is impressive! Your brain releases cortisol and adrenaline, which in turn mobilize your heart rate & increase blood sugar for energy and resources. Your blood flow changes to protect vital organs, your visual field changes, your brain is more likely to make black and white decisions and over-categorize things as threats. As your body uses these resources to activate, it decreases energy to "non-essential" functions (in times of survival!) such as digestion and sexual function.

If we are getting chased by a bear, all of these bodily changes would be really useful! These physiological changes may have been helpful to our cave-dwelling ancestors, but what if your stressor is financial, work, relationships, or chronically poor sleep? This is where chronic stress and the physiological processes that go along with it become a vicious cycle and we can struggle to get out. But there is a solution! There is also a parasympathetic nervous system that can calm and deescalate the stress response system. The key is learning awareness and behavior modification. For people who are diagnosed with insomnia, this can be addressed with CBT-I, but 1 in 3 people do not get enough rest and most people could benefit from improving their sleep health using other methods.

## Sleep duration recommendations

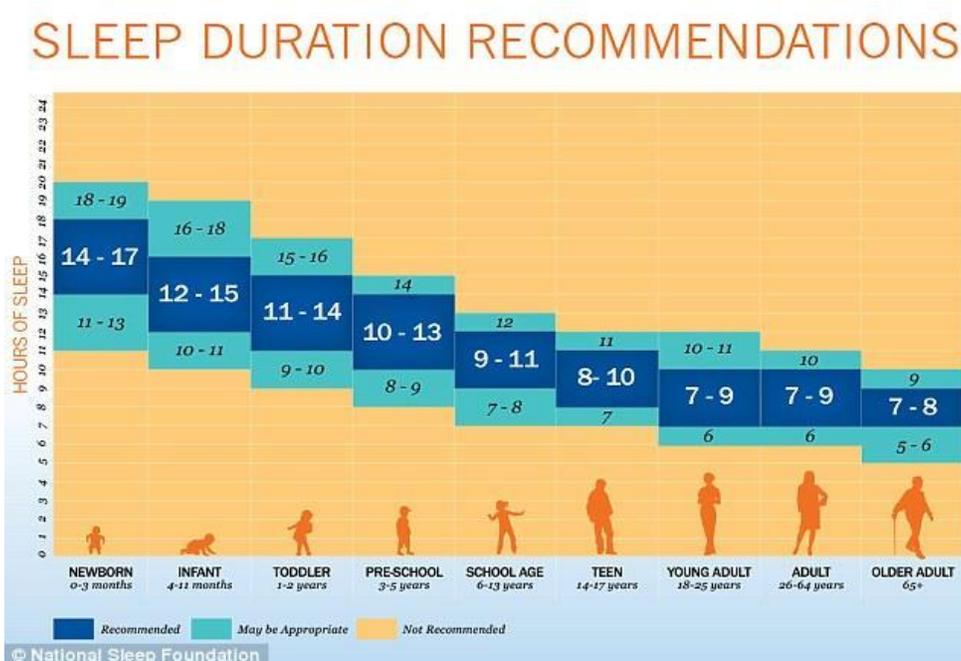
First of all, as explained previously, it is important to distinguish sleep from time in bed. Keeping this in mind, we often hear about how there is something magic about getting 8

hours of sleep. That is simply not true. There are healthy ranges of sleep that are broad. This should provide comfort, and relieve some pressure to get the so-called magic 8 hour total.

When we become fixated on a particular number it can add to stress about our sleep and activate that arousal system noted previously. For an adult, ages 18-64, the range of sleep can be 6-10 hours, with a general average of 7-9 hours. The most important thing is to find a sleep window that does not have long awakenings (some awakenings are normal) and you wake feeling well-rested and ready to take on the day. That amount of sleep will be *your* magic number.

### Sleep across lifespan

As we get older we do not sleep as much, which is illustrated in the graphic below. This is not because we need less sleep, but because our brain cannot generate sleep to the same extent over time, and so our bodies adjust. After age 65, the range of sleep decreases to 5-9 hours, with an overall average 7-8 hours. It may also be common to have more awakenings. These should be brief and not too disruptive. It is not general knowledge that it's normal for sleep to shift as you age, and some people spend the same amount of time in bed even though their sleep needs go down. This can cause sleep to break up and become lower quality.



## Sleep stages

As we sleep, our brain cycles through multiple different stages and depths of sleep, each producing different brain waves and each having their own unique benefits. A chart illustrating the stages of sleep can be found at the end of this section.

### Non-REM stages 1-3 and REM sleep

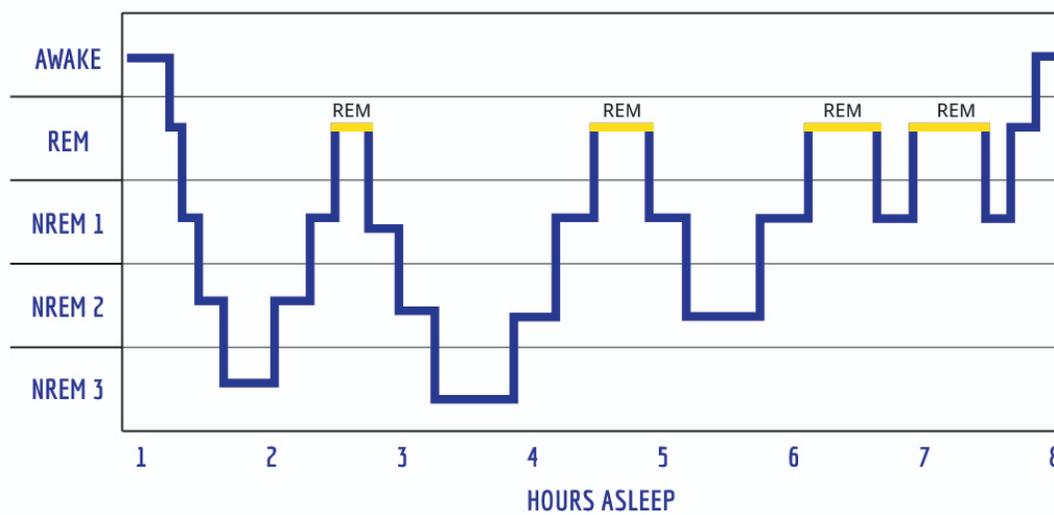
- **Non-REM stage 1**
  - This is the stage of sleep you enter after you first doze off. If you wake up during this stage, you may not even know if you are awake or asleep. Your brain waves start to slow down along with your respiration rate, and decreased muscle tone. This stage lasts 5-10 minutes and repeats every sleep cycle. Think of Non-REM (NREM) stage 1 sleep like a downward escalator; it's necessary to take you to your final destination of deeper sleep but no repairs or restoration are occurring yet.
- **Non-REM stage 2**
  - As we continue down the escalator to deeper sleep and descend into NREM 2, our eyes stop moving, our muscles continue to relax and brain waves slow down more. NREM 2 lasts about 25 minutes in the first sleep cycle and lasts longer in subsequent cycles. This stage is about 50% of your total sleep. Sleep spindles, bursts of brain activity during sleep, appear in NREM 2 sleep and are connected to learning and brain plasticity. They occur in other stages or sleep too, but are most common here. When new material or new physical tasks are learned, more sleep spindles show up in our sleep. Sleep spindles naturally decrease as we age, just as so many aspects of sleep change as we grow older.
- **Non-REM stage 3**
  - We've arrived at our deepest sleep. During this stage, brain waves are large and slow, and called delta waves. We are unaware of our surroundings and difficult to wake. NREM 3 sleep helps with memory of facts and material we learn, so you may want to rethink an all-nighter. During this stage of sleep

many hormones and molecules are also released that help restore your body. Some include:

- Human growth hormone: this helps with tissue repair and healing and produces collagen
  - Cytokines: these can help protect against inflammation
  - Immune memory cells: these help our bodies fight infection
- This stage lasts 20-40 minutes. All of your deep sleep occurs during the first half of the night, then you continue to pass through consecutive stages of NREM 1 and 2 and REM sleep. If you go to bed much later on the weekends or have an irregular sleep schedule you can miss out on some of your highly beneficial NREM sleep, or have an unbalanced amount of other sleep stages

- **REM sleep**

- After the deep, restorative sleep of NREM 3, you enter a different stage- REM sleep, also known as the 4th stage of sleep. The first cycle of REM sleep lasts about 10 minutes and happens 90 minutes after we fall asleep, after you've been down in NREM stages 1-3. After that, the REM cycles get longer and account for 20-25% of our total sleep. During REM our brain waves are very busy, almost the same as when we're awake. It is also the stage where we are most likely to remember our dreams. Dreams likely occur at other stages too, but we just don't remember them as well. REM has been shown to be important for our thinking abilities, memory, and regulating our emotions.



After Rechtschaffen & Kales, 1968, Weiten 2004, Kalat, 2005

## Differentiating between sleepy and tired

People often think being tired is the same thing as being sleepy, but these are two very different sensations that are important to differentiate. Being sleepy can be defined by no longer being able to stay awake because your body is physiologically rolling into sleep. Sleepiness is marked by eyelids feeling heavy, dropping head, rubbernecking, and having difficulty sustaining wakefulness.

On the other hand, being tired does not involve as strong of physiological sensations and can be for various reasons. Being tired feels like having a lack of energy or feeling run down, not genuinely sleepy. Our bodies can feel tired when dehydrated, do not have enough vitamin D, have thyroid conditions, have pain, or are underactive during the day. Chronic conditions such as diabetes, depression, anxiety, or asthma can also deplete our energy resources and make us feel tired. It is important to differentiate between sleep and tiredness because if we always attribute our low energy to our sleep, we could be missing out on other vital pieces of the puzzle and not finding a solution to match the real problem. We all lead busy lives (perhaps overbusy sometimes!) and can often feel tired. It's important to get regular physicals to check our blood levels, and we should see our physician if persistent fatigue won't let up. If we always blame our sleep for how we feel, it might accidentally create more sleep anxiety or pressure to sleep, interfering with our ability to relax and get a good night's sleep.

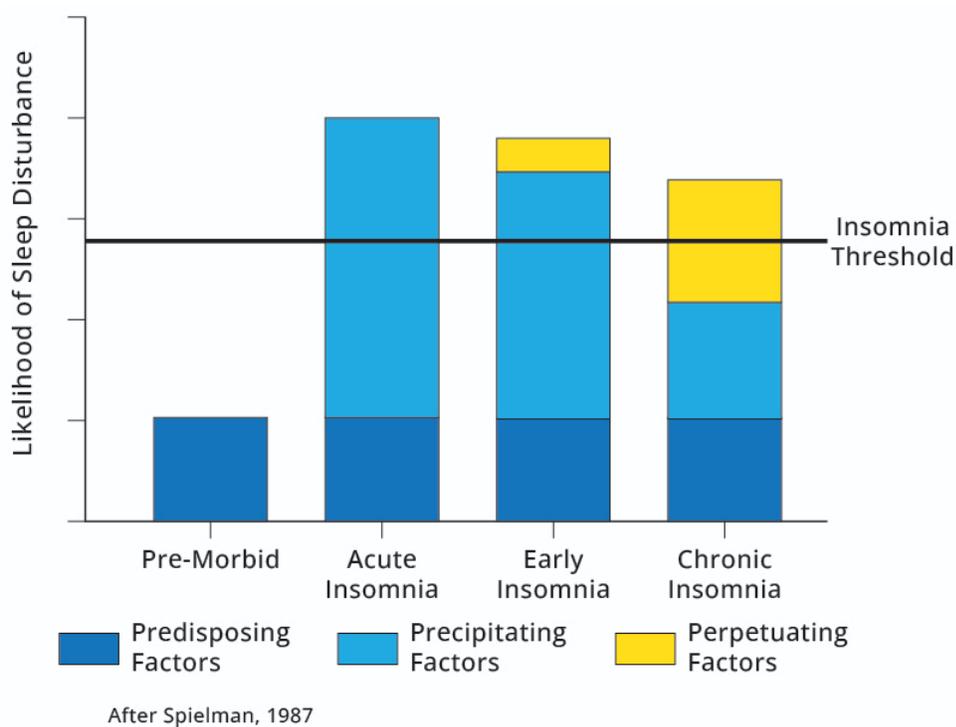
If fragmented sleep is part of your health story, CBT-I can help fix it. It is also important to work on those thoughts that may over-blame sleep for other issues and start to take action on them, improving your sleep and health every step of the way.

## Effects of insomnia

People often ask how and why insomnia can persist for several months or even years or, why doesn't it come and go like a cold? Our best understanding of how chronic insomnia develops is the "Three P model". The model, described by Spielman in 1987, has stood the test of time. It suggests that insomnia develops because of three primary factors, namely: 1) predisposing, 2) precipitating, and 3) perpetuating.

- **Predisposing** factors refer to the genetic factors that drive sleep problems. Did you know scientists have identified genes that may carry a risk for insomnia? It may be that these same genes are also associated with depression and diabetes, which is a link researchers continue to explore. Genes can carry a risk of developing insomnia, but we don't necessarily have sleep problems right after birth. Events and stressors can turn these genes "on" and are called "gene by environment" interactions.
- **Precipitating** factors refer to those events that put our genes into action or trigger sleep issues. For some people, this is one event. It could be traumatic or just very stressful, but not life-threatening. For others, it's a series of life junk that accumulates and culminates in sleep problems. This could be relationship related, school, medical, parenting, financial, or any type of event that causes ongoing stress. One function of stress is turning on our stress response system (also known as fight or flight, or fight, flight, freeze, or sympathetic nervous system). When our stress response system kicks into gear, our bodies and minds go into safety mode, and we can struggle to go with the flow of the natural sleep process.
- **Perpetuating** factors are when insomnia can really solidify. When poor sleep first enters our lives, it's uncomfortable and disruptive. We get tired and start to compensate in various ways. We might take naps or start to rely on a few extra coffees or sodas throughout the day. Then at night, we wake tossing, turning, and worrying in bed, or start worrying about sleep during the day, which can lead to sleep anxiety and becoming less physically active. I describe these behaviors as the "cement" between the insomnia building blocks. These are only a few perpetuating factors, but they result in a vicious cycle that replays like a bad movie every night when they add up. CBT-I can help "un-cement" these unhelpful patterns. It's also why experts believe medications do not resolve chronic insomnia. Medications can sedate you, but they cannot dismantle your thoughts and behaviors that accidentally spin the insomnia cycle. Insomnia is mainly an issue of thoughts and behaviors, which is why CBT-I can be so effective.

Of course, left unchecked, poor sleep can take its toll on us physically and mentally. Because so many physical and mental processes are restored during sleep, prolonged sleep issues can contribute to depression, anxiety, diabetes, memory decline, cancer, pain, and so on. These associations can scare people. That is not my intention. There is a monumental difference between things being correlated versus causal. Sleep has a special relationship with your body, and can have many adverse outcomes, but it's not the sole factor that can cause all of these issues. There are ways to improve your sleep and many paths to support your overall health, even when sleep is poor.



## Effects of healthy sleep

Because sleep is so fundamental to our health, it is crucial to seek help from appropriate healthcare providers if you're struggling with sleeping well. When we take the steps to improve our sleep, we can feel unstoppable, and there is some truth to that. Our energy, concentration, memory, mood, and physical performance can be enhanced by the appropriate quality and quantity of sleep. It is possible to function and survive without optimal sleep, but it is harder to thrive and optimize. Having a healthy relationship with sleep is essential to being the best version of you.

## Extra sleep resources

If you're interested in learning more about sleep, and expanding your sleep toolkit, I recommend spending some time exploring the following:

- National Sleep Foundation: <https://www.thensf.org/>
- American Academy of Sleep Medicine patient info: <https://aasm.org/clinical-resources/patient-info/>
- American Academy of Sleep Sciences sleep education for different age groups: <https://sleepeducation.org/healthy-sleep/>
- American Sleep Association: <https://www.sleepassociation.org/>
- Sleep centric blog posts:
  - The connection between sleep and health, explained by a sleep expert: <https://www.levelshealth.com/blog/the-connection-between-sleep-and-health-explained-by-a-sleep-expert>
  - Sleep, the Immune System and COVID-19 vaccines: <https://crescent.co/blog/sleep-immune-health-and-covid-vaccine>
  - Words to Sleep By: <https://crescent.co/blog/sleep-words-thoughts>
- App resource to track your sleep:
  - CBT-I Coach: <https://mobile.va.gov/app/cbt-i-coach>
- App resources for mindfulness and relaxation:
  - Mindfulness Coach: <https://mobile.va.gov/app/mindfulness-coach>
  - Relaxation and stress management: Breathe2Relax <https://apps.apple.com/us/app/breathe2relax/id425720246>