PRYMD

MODULE 7
SLEEP

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WHAT IS SLEEP?

Sleep is the one universally demonstrated behavior in all studied animal species, insects and mammals. In humans, sleep occupies about one-third of our lives, and is one of the most significant of all human behaviors. To put that into context, the average 25-year-old will have slept for 9 years and dreamt for 2.5 years. Although much research has been done on the functions of sleep, it is not yet entirely understood. What we do know is that it is essential for survival. In fact, prolonged sleep deprivation will cause severe cognitive and physical impairment, and finally death. We tend to think that sleep is a time for rest and recovery from day to day stress. Research has shown that sleep is in fact, a dynamic activity in which processes essential to well-being and health take place. Evidence now reveals that sleep is not only essential for assisting in the maintenance of cognitive performance, memory and mood but it also plays a key role in the function of a normal endocrine and immune system. The essential nature of sleep becomes even more relevant as disturbed sleep is linked to virtually every psychiatric illness, often forming part of the criteria for diagnosis in specific disorders.

In 1913, Henri Pieron defined three features of sleep:

- It is periodically necessary
- It has a rhythm, relatively independent of external conditions
- It is characterized by complete interruption of the sensory and motor functions that link the brain with the environment.

Until the late 1950s, sleep was viewed as a lapse in the waking state when there is insufficient stimulation to keep the brain awake. This concept changed when sleep began to be regarded as an active process characterized by a cyclic succession of different psychophysiological phenomena.

"Sleep is a reversible behavioral state of perceptual disengagement from, and unresponsiveness to, the environment."

STAGES OF SLEEP

There are four stages of Non-REM (Non-rapid eye movement) sleep. As the person falls asleep the electroencephalogram (EEG) progresses through all the 4 stages of slow wave sleep.

Basically, a specialized machine called an electroencephalogram is attached to a person's head, and measures electrical brain activity while a person sleeps. As the person falls asleep
the EEG progresses through all 4 stages of slow wave sleep.
The sleep stages are categorized into non-REM and REM sleep according to these patterns. Non-REM sleep is further divided into 3 or 4 stages, depending on who's educating you.

Non-REM = Stages 1–3
Stage1: Slow eye movement begins and we often feel like we haven't even been asleep if we wake up during this stage. This is the stage where people often experience muscle twitching. It is thought that in infants, this muscle twitching is the brain establishing neural connections and learning how to use different parts of the body.

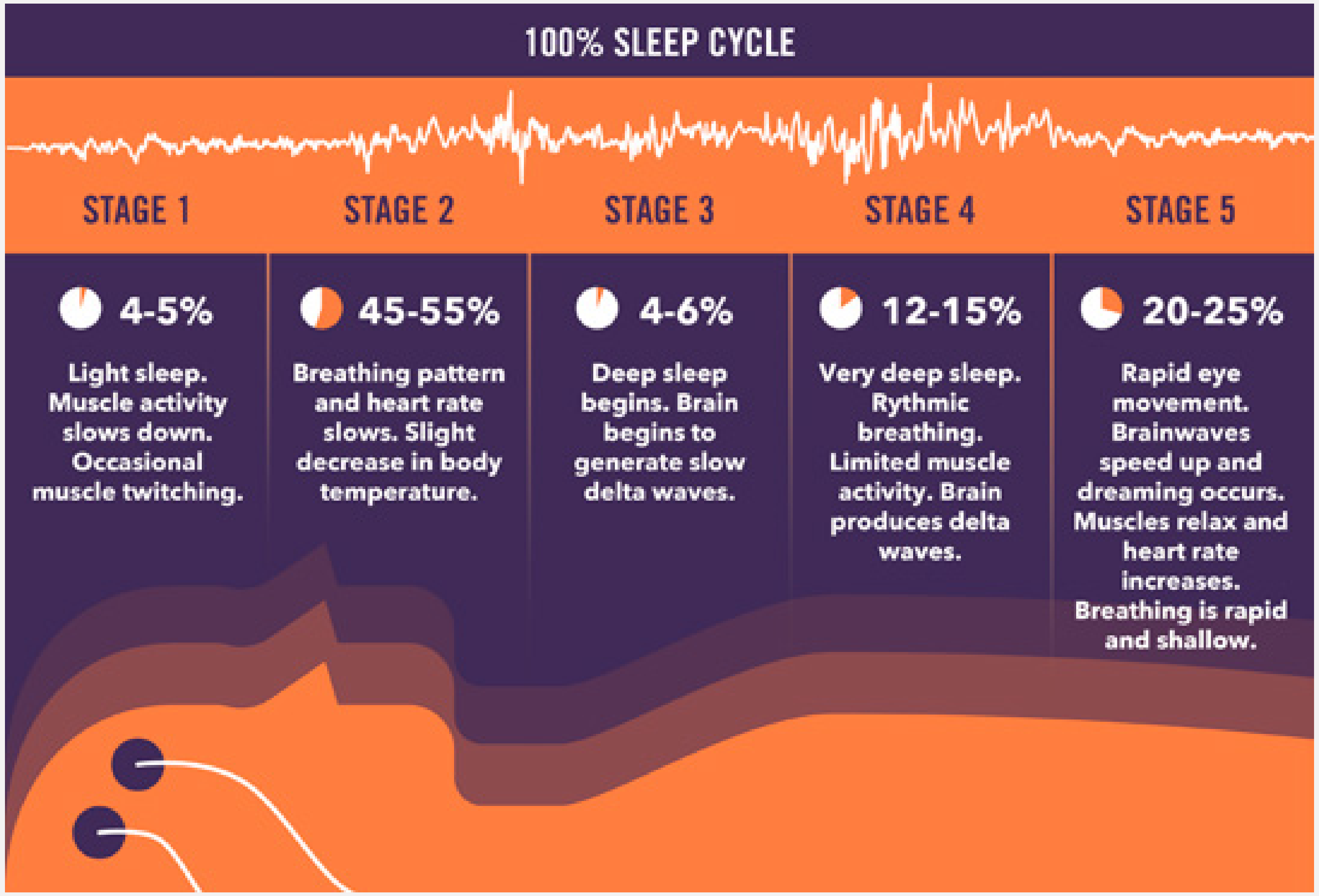
STAGES OF SLEEP

Stage 2: Now the brain begins to block the processing of external stimuli that it registers as non-dangerous. Memory consolidation begins here.

Stage 3: This stage is also known as delta sleep because the delta brain waves predominate here. These are very slow waves demonstrating deep sleep. It is very difficult to wake someone in this stage.

REM

This stage occurs after stage 3 but interestingly, people become easier to awaken. Eyes start to move rapidly, blood pressure increases, breathing becomes more rapid, heart rate increases, limbs become temporarily paralyzed, and brain waves are similar to those of a person in the waking state. This is when most dreams occur and if awakened you can remember them. Most people have 3–5 REM sleeps in a night. Infants spend 50% of their sleep time in REM, while for adults this is around 20%. The amount of REM sleep decreases as we age.



WHY DO WE SLEEP?

While we can now investigate sleep and related phenomena, not all researchers agree on exactly why we sleep. Some of the theories are:

Why we sleep: Non-REM (NREM) Sleep

Energy conservation: Brain neurons depend on glycogen for energy. NREM sleep uses much less energy than wakefulness. Some have suggested NREM sleep may provide time to restore our brain's glycogen stores which are depleted by the demands of wakefulness. Sleep targets areas of prior neuronal activities.

Brain plasticity: Synaptic efficiency and efficacy of the brain depends on keeping the synaptic connections refined, integrating new neuronal firing patterns. Sleep periodically occurs to allow the brain to do this, thus maintaining brain plasticity.

Immune function: Recent studies suggest that sleep may strengthen our immune defenses and insufficient sleep impairs them.

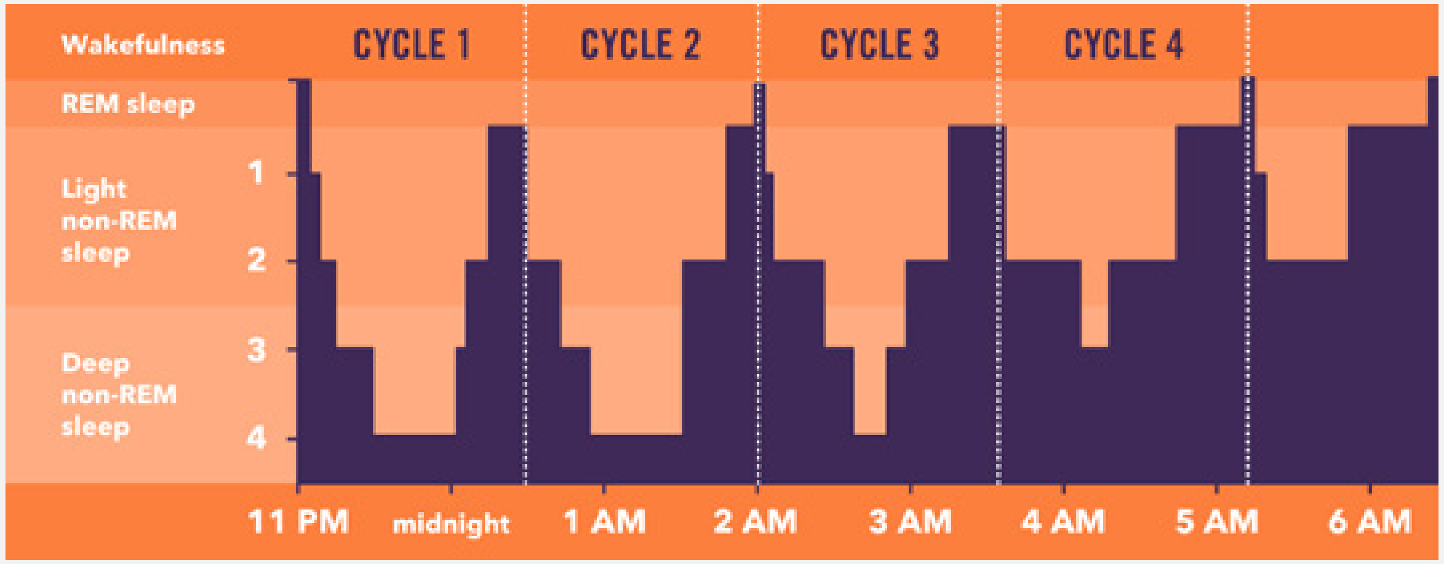
Why we sleep: REM Sleep

Memory consolidation and learning:
- Visual learning is enhanced by sleep and impaired by loss of sleep. In order to learn a new skill, we must first be trained, then that information encoded and consolidated in our memory, if we are to retain it.
- Sufficient sleep the night before initial training has been shown as crucial for encoding memory.
- REM sleep enhances learning but recent research emphasizes that we also need NREM sleep stage 2 and 3 as well.

Brain growth: REM sleep dominates sleep time during critical periods of brain maturation in infants. REM sleep during infancy may help establish the right balance of synaptic activation and receptor sensitivity.

SLEEP ARCHITECTURE - THE RIGHT MIX OF SLEEP

Sleep research shows that infants, teenagers and adults require approximately 16, 9.5 and 7-9 hours of sleep each night, respectively. It is as important to get the right quantity of sleep, as well as getting the REM and NREM sleep combination right, with shallow and deep sleep. REM and NREM sleep alternates in normal sleep patterns through the night in accordance with a predictable pattern called 'sleep architecture.'



Alternate cycles of NREM and REM in 90 to 110 minutes, repeated 4 to 6 times a night make up a complete sleep cycle. On average, adults spend over half their total daily sleep time in stage two, approximately 20% in REM sleep, and the rest of the time in other stages of sleep. The amount of time in any stage during the night is not constant. Each night, the first cycle of sleep has a fairly short phase of REM sleep and a longer phase of slow wave sleep. As the night progresses, the REM period increases in length and the periods of slow wave sleep shorten.

Alongside these nightly changes, sleep architecture will vary during the course of our lifetime. Newborn babies are in REM sleep approximately half the time, and young children are in deep NREM sleep for substantial amounts of time. Adults normally spend about 20-25% of their sleep in REM and this is constant during adulthood. As people get older, lighter sleep predominates and there is a decrease in the amount of stage 3 and 4 REM sleep. Even though sleep can be more fragile as we get older, our need for sleep does not decrease with age.

THE SLEEP-WAKE CYCLE

Each night we go to sleep and wake up in the morning. What makes this happen? To know why sleep is so important for us, we need to understand the basics of the mechanism for the sleep-wake cycles. These cycles roughly consist of 8 hours nocturnal sleep and 16 hours daytime wakefulness. These are controlled by the internal influence of sleep homeostasis and circadian rhythms.

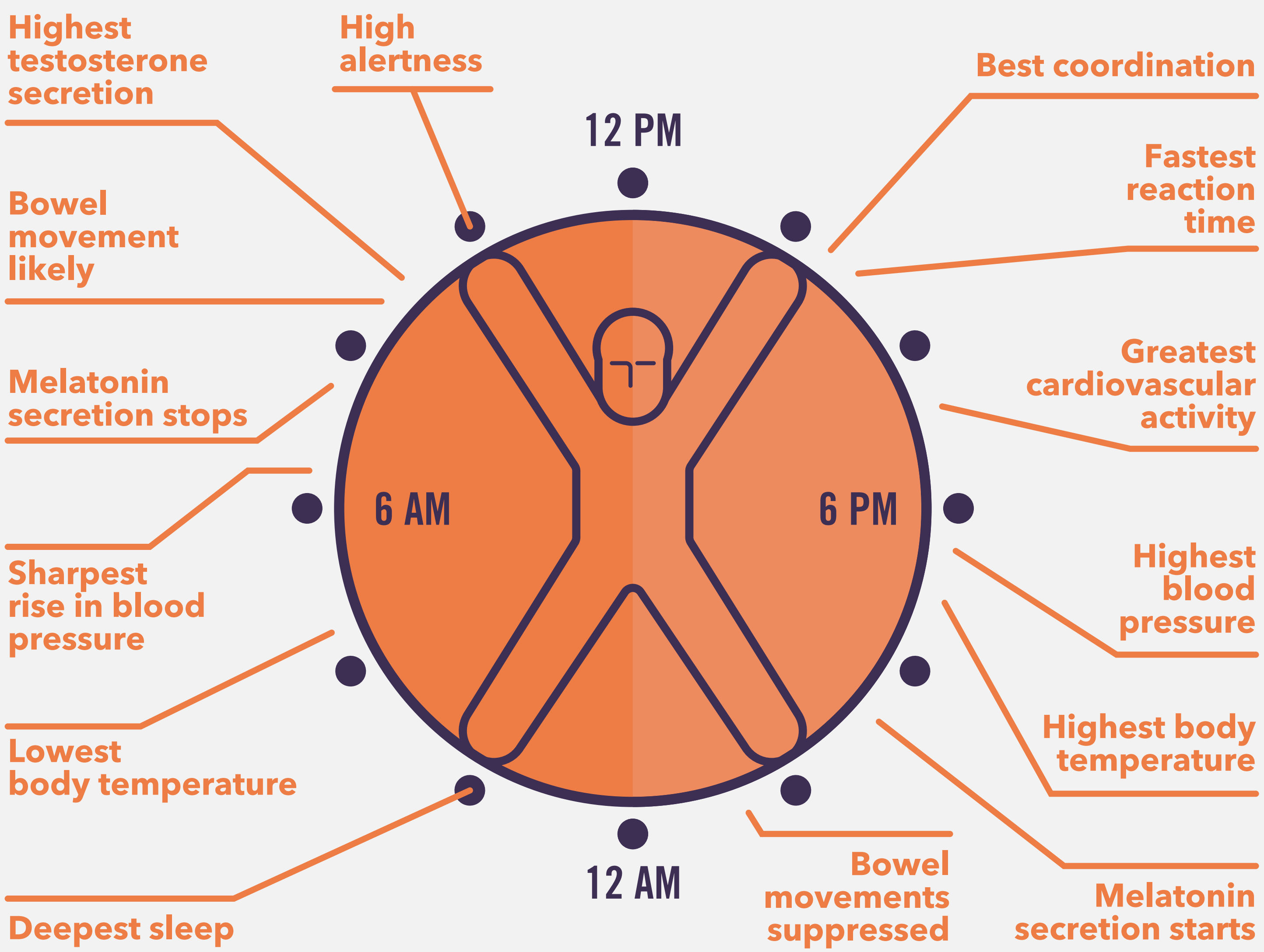
Homeostasis is a process whereby the body maintains and is in an internal 'steady state' such as body temperature, acid-base balance and blood pressure. Homeostasis controls the amount of sleep we have each night. From the moment we wake up, we accumulate a homeostatic drive for sleep which reaches its maximum by late evening which is when most individuals go to sleep. Evidence indicates that even though neurotransmitters of the sleep homeostatic process are not fully understood, adenosine (the sleep-inducing chemical) rises continuously in the bloodstream when we are awake which results in the growing need to sleep. Conversely, adenosine levels decrease during sleep thereby lowering our need to sleep. Some drugs like caffeine block these adenosine receptors thereby disrupting this process.

SLEEP DEBT

Loss of sleep results in an accumulation of a sleep debt that at some point must be repaid. If we decide to be up all night, it is inevitable that our bodies demand that we make up every hour of lost sleep. We may do this by having naps or having longer sleeps in later cycles. Even one hour of lost sleep that accumulates over several days may result in a negative and powerful effect on daytime mood, thoughts and performance.

Circadian rhythms are the cyclical changes driven by our brain's biological clock over a 24-hour period like hormone levels, sleep and fluctuations of body temperature. In humans, our biological clock is made up of a group of neurons located in the hypothalamus part of the brain known as the suprachiasmatic nucleus (SCN). Our internal 24-hour circadian rhythm is synchronized in physiology and behavior to our external social, work schedules and physical environment. Light is our strongest synchronizing agent. Darkness and light externally 'set' our biological clock and help us determine our need to go to sleep or wake up.

As well as providing synchronized time between various rhythms, our circadian clock helps promote wakefulness. Whereas the homeostatic system has a tendency to make us more sleepy as we progress throughout our waking period, regardless of night or day, the circadian system is predisposed to keeping us more awake so long as it's daylight, and prompting us to go to sleep when it becomes dark. It is generally agreed that due to the complexity of these interactions, restfulness and sleep quality are ideal when our sleep schedules are regularly synchronized with our internal circadian rhythm and the external light-dark cycle. We should endeavour to go to sleep and wake up around a similar time every day, even on weekends and holidays. In particular, the circadian system is intolerant of major sleep and wake schedule alterations as attested by graveyard shift workers and cross-country flight travelers. More on jet lag hacks from PRYMD.



Sleep, Cognitive Performance and Mood

Evidence of the adverse effects of sleep deprivation on motor performance and cognition are disturbing. Investigations of the Chernobyl nuclear disaster, Exxon Valdez oil spill and the Space Shuttle Challenger explosion have all been linked to fatigue-related human error as a result of extended shift work.

One study reveals how subjects who had not slept for up to 19 hours, when scored on their performance, were substantially worse on alertness and performance than legally intoxicated subjects (blood alcohol level 0.05%). Loss of sleep and its adverse effects on mood are well documented. Growing medical evidence has found that anger, sadness and anxiety have been linked to inadequate sleep. Researchers at the University of Pennsylvania reported that subjects experienced sadness, anger and mental exhaustion when they were allowed only 4.5 hours sleep per night for a week. Their overall scores for vigour and mood declined steadily during this period. Mood scores improved dramatically once they were allowed to get sufficient sleep.

Hormones and Metabolism

Our bodies secrete many important hormones during sleep. These hormones regulate energy; affect growth and control endocrine and metabolic function. For instance, blood levels of cortisol, a stress hormone increases towards the end of a complete sleep cycle and this can promote wakefulness. During sleep, the growth hormone is secreted, it aids childhood growth and helps to regulate muscle mass in adults. Luteinizing and follicle stimulating hormones which are utilized in reproduction are also released during sleep; sleep-dependent luteinizing hormones are thought to be released in order to initiate puberty. Sleep cycles affect hormones that impact weight and appetite. Loss of sleep is powerfully implicated in the epidemic growth in recent years of obesity and diabetes.

Obesity and Diabetes

Approximately 69% of Americans are now overweight or obese according to the Centre for Disease Control and Prevention (CDC). Most experts believe it is caused by caloric intake combined with our sedentary lifestyle. But an important factor that is coming to light is that we are getting less sleep than ever before and this in turn affects weight gain and plays a role in obesity. A decrease in slow wave sleep in young males has been associated with decreased production of growth hormones. Since growth hormones affect the proportion of fat and muscle in adults, having less slow wave sleep may increase the likelihood of becoming overweight. Short-term studies have also shown a correlation between insufficient sleep and inadequate levels of leptin, a hormone which is involved in the regulation of carbohydrate metabolism. Leptin in low levels causes us to crave carbohydrates. Obesity is also linked to diabetes. In 1999, a study at the University of Chicago discovered how the impact of a few days of sleep debt impaired sugar metabolism and disrupted hormone levels. When eleven young healthy adults were allowed only four hours sleep for several nights, tests showed a declining ability to process blood glucose.

Immune system

There has been growing evidence, which scientifically points to the fact that sleep significantly impacts our immune system. This was demonstrated by a recent study which set out to show how the effectiveness of the flu vaccination is severely delayed in sleep-deprived individuals. Men who had had only four hours sleep for four nights were administered the flu shot as well as men who had normal sleep. Ten days later the sleep-deprived group had produced less than half of the flu-fighting antibodies and had a substantially lower immune response than those who got adequate sleep.

Cardiovascular Disease

Growing evidence supports the relationship between short and long-term loss of sleep and cardiovascular disease. This includes an increase in blood pressure, risk of stroke and other long-term health related consequences. Sleep deprivation is also associated with higher blood-pressure levels which rise during the night and last the following day. Evidence also suggests the association with too little or too much sleep increasing the coronary heart disease risk in women. There is a high occurrence of sleep apnea amongst cardiovascular problems and people with this sleep disorder have an increased risk of having hypertension and cardiac related sudden death during the night.

PRYMD SLEEP KEY TAKEAWAYS

By now you will all be aware of how important our sleep is to our optimal function, health and well-being. Here are PRYMD's tips to improve your sleep quality now!

1. Fine-tune your sleep routine
Reset your biological clock or circadian rhythm by trying to go to bed and waking up at the same time each day. Staying up late and sleeping in late on weekends can disrupt your body clock's sleep–wake rhythm. In a perfect world, limit the difference of bedtime or wake-up time to no more than an hour.
I know that at times we all tend to have late nights, catching up with friends until the early hours of the morning (But hey...rules were made to be broken!). In this case, ensure you strike a balance between sleep quantity and minimizing disruption to your natural circadian rhythm. This will be in the realm of approximately 6 hours of sleep. You can take a number of power naps to get you through the day, if necessary.

2. Optimize your sleep environment
Keep your bedroom quiet, cool and dark to reduce your time getting to sleep and improving the quality of your sleep.
How cool?... Keep your room temperature around 18.5°C (65° F). Temperatures below 12.2°C (54°F) and above 23.9°C (75°F) have been shown to be disruptive to sleep.
Avoid bright, artificial light (blue light) for the hour before sleep, such as from a TV, mobile phone or computer screen. Light from electronics has the potential to disrupt sleep, because it sends alerting signals to the brain. The circadian rhythm seems to be especially sensitive to light with short wavelengths, in particular, blue light in the 460 nanometer range of the electromagnetic spectrum.
This light, which is given off by electronics like computers and cell phones and also by energy-efficient bulbs, has been shown to delay the release of melatonin. In other words, electronics could keep you feeling charged past bedtime. Install F.lux on your computer (if you have to work before bed). It's a free computer program that reduces blue light emissions.

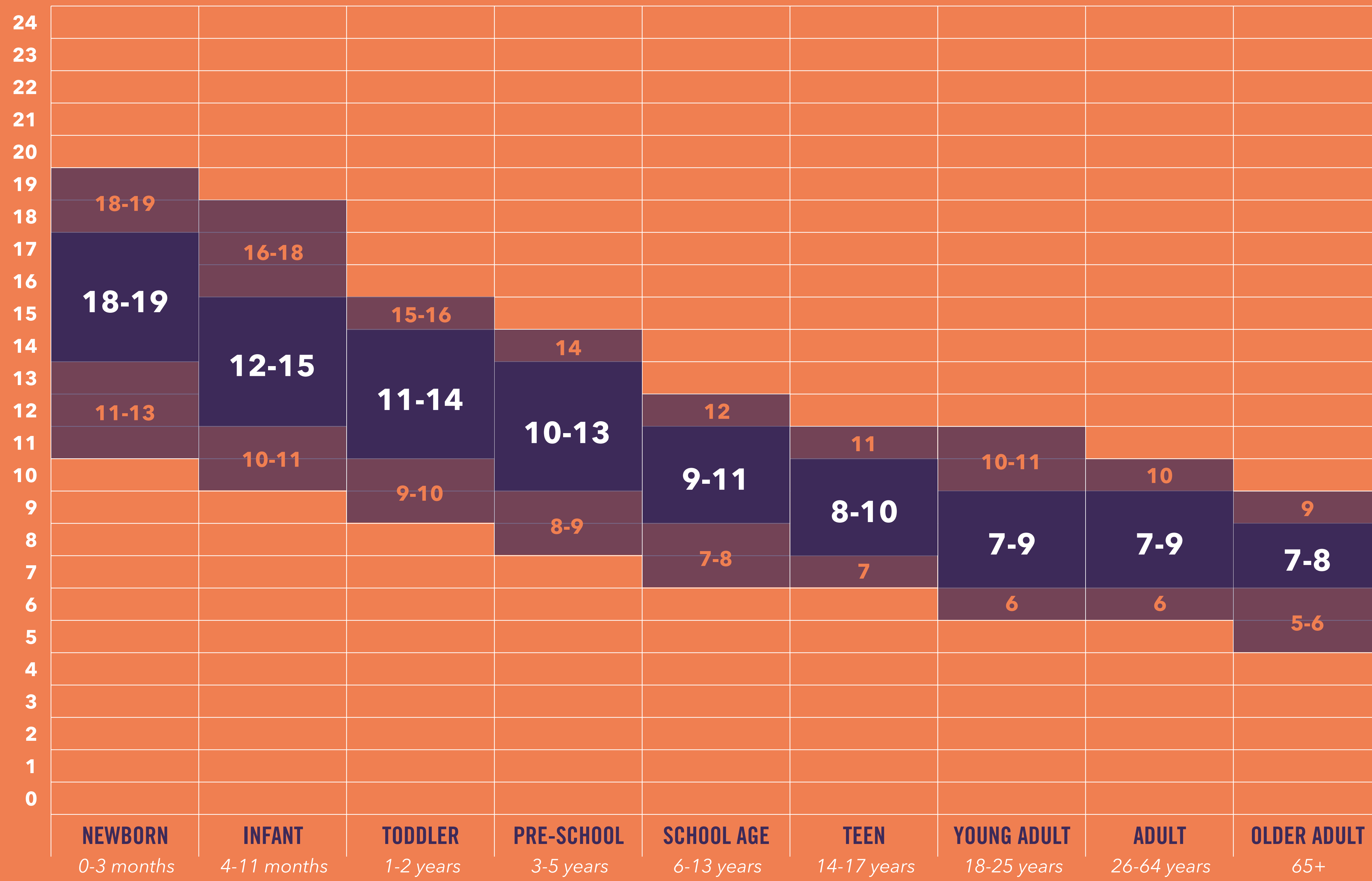
3. Time your stimulants
Avoid stimulants such as nicotine and caffeine after lunch time. The half-life of caffeine is 5-6 hours, so it can still have an impact on your sleep quality long after intake. Avoid heavy and/or large meals within a few hours of bedtime. Avoid alcoholic drinks at least 4 hours before bed.

4. Use light to your advantage
Make sure you have a minimum of 30 minutes of direct sunlight during the day (preferably in the morning). Sunlight detected by cells in the retina of the eye sends messages to the brain that keep us roughly in a 24-hour pattern. These light cues trigger all kinds of chemical events in the body, causing changes in our physiology and behavior. With the help of morning light, melatonin levels are low, body temperature begins to rise, and other chemical shifts, such as an increase in the activating hormone cortisol, occur to help us feel alert and ready for the day. Trade your alarm clock for a dawn simulator which works by gradually brightening the room over 30 minutes. Recent evidence suggests that light exposure during the last 30 minutes of habitual sleep can increase subjective alertness and improve both cognitive and physical performance after waking.

5. Get enough hours!
The image below outlines the latest guidelines on average sleep requirements for different age groups. Please note that individual requirements vary significantly.

PRYMD SLEEP KEY TAKEAWAYS

SLEEP DURATION RECOMMENDATIONS



The above sleep duration recommendations are based on a report of an expert panel convened by the US based National Sleep Foundation and published in 2015 in their journal Sleep Health.

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