



# STUDENT SLEEP GUIDE

THE IMPACT OF SLEEP ON LEARNING AND MEMORY





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# Introduction

For many students, staying awake all night to study is common practice. In recent surveys, 20% of students reported pulling all-nighters at least once a month, and 35 percent reported staying up past three in the morning once or more weekly. [1]

According to recent research, however, staying up all night to study is one of the worst things you can do for your grades. In fact, in October 2019, two MIT professors found a straight-line relationship between the average amount of sleep students were getting and their grades. [2] Sleep has a bigger impact on learning and memory than you might think.

In this guide, you'll learn everything there is to know about the relationship between sleep, learning, and memory. You'll learn how sleeping before studying can help you learn information and how sleeping after studying can help you remember what you learned. You'll even learn about how different sleep stages like REM sleep, light Non-REM, and deep Non-REM play a role in your ability to learn and remember. After reading this guide, you'll certainly think twice about pulling an all-nighter to study for an exam.



# The science of sleep

Before discussing the impact of sleep on memory and learning, it's important to understand the science of sleep.

From the moment you drift off into sleep until you reawaken the following morning, your body and mind are cycling through **four stages of sleep in approximately 90-minute sleep cycles**.

- Stage 1: Light Non-REM Sleep (falling asleep)
- Stage 2: Light Non-REM Sleep
- Stage 3: Deep Non-REM Sleep
- REM Sleep (dream sleep)

Each of these sleep stages provide unique benefits for the brain and body, as well as unique benefits for learning and memory. Light Non-REM sleep, for example, creates room in your memory. Deep Non-REM sleep helps transfer these memories to long-term storage. [3] We'll talk more about sleep stages and the benefits for learning in the following section. Image 1.0 demonstrates one complete 90-minute sleep cycle.

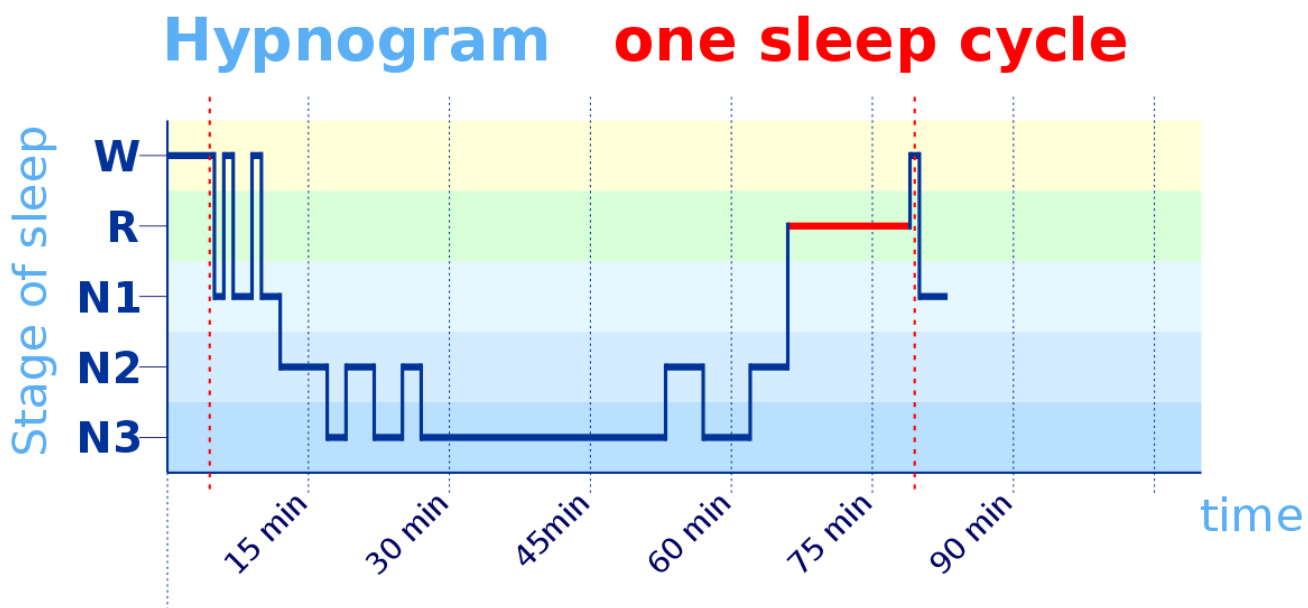


Image 1.0

That being said, **you don't experience all of the sleep stages evenly throughout the night.** If your sleep cycles are healthy and your sleep quality is good, you experience most of your deep sleep during the first half of the night and most of your light Non-REM sleep and REM sleep during the second half of your night.

Image 2.0 demonstrates how the first couple of sleep cycles we experience tend to contain more deep sleep, while the last few sleep cycles tend to be rich with REM.

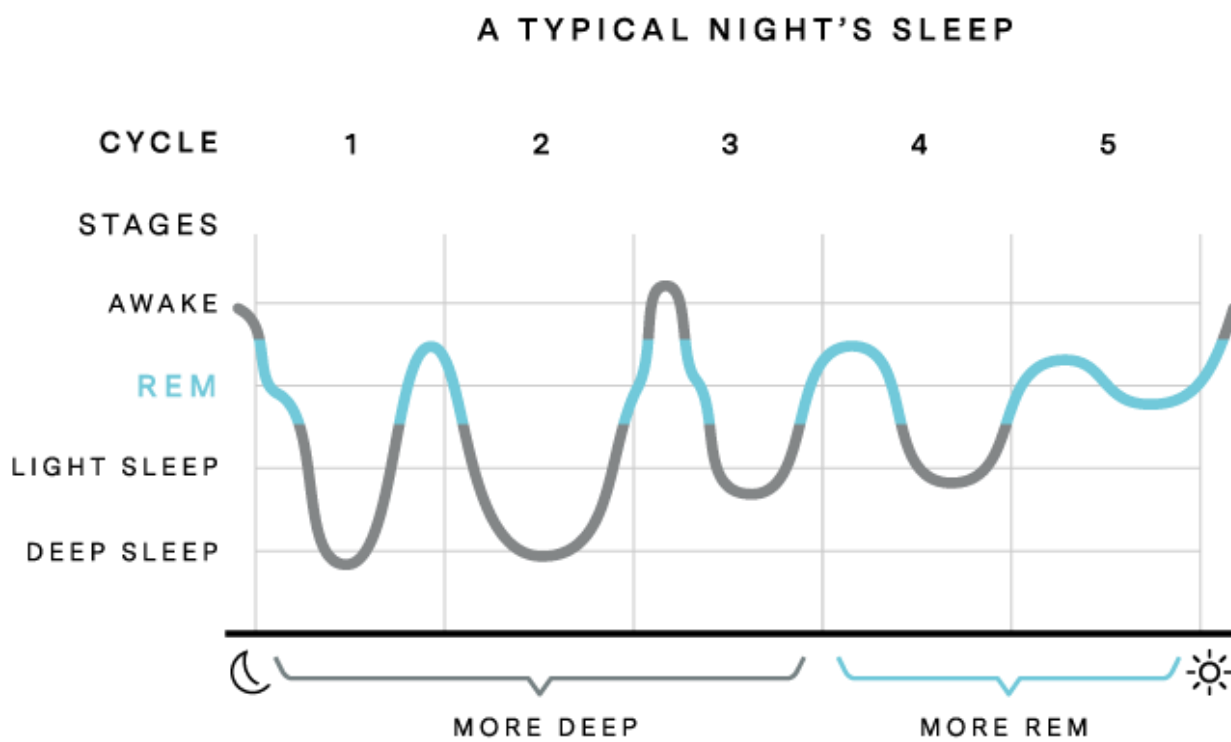


Image 2.0 from <https://ouraring.com/sleep-stages>

As mentioned, image 2.0 represents a typical night of sleep for someone with healthy sleep cycles and good sleep hygiene. Since students don't always have the best sleep hygiene, a typical night's sleep may look very different for students.

**Going to sleep later than usual**, for example, or pumping your body with caffeine can negatively impact deep sleep. **Waking up earlier than usual**, on the other hand, can negatively impact light sleep and REM sleep. [4]



Many students partake in one or more of these habits or behaviors on a regular basis. To make matters worse, many students partake in these habits with the intention of improving their grades, staying up extra late or waking up extra early to cram for exams.

It turns out, however, that **sacrificing your sleep to improve your grades may be one of the worst decisions you can make.**



## The importance of sleep for **learning** and **memory**

There are many benefits of sleep for learning and memory. **Getting a good night's sleep the night before learning** is crucial for your ability to learn and make new memories.

**Getting a good night's sleep the night after learning** is essential for recalling what you learned, transferring what you learned from your short-term to long-term memory, and drawing connections and associations between what you've learned - ultimately assisting with your understanding, memory, and application.

Let's take a look at each of these benefits in greater detail.

# 1. SLEEP FOR MAKING NEW MEMORIES



When you learn facts and information, like the facts and information in your textbook, **what you learn is temporarily stored in a region of your brain called the hippocampus**. The hippocampus is basically a storage site for all short-term memories.

Like most storage centers, **the hippocampus has limited storage capacity**. This means, once you learn a certain amount of facts, the hippocampus reaches full capacity. You're unable to learn new information without overriding some of the information that's already in there. Essentially, if your hippocampus is full, and you try to learn more information, you won't be able to. [5]

Fortunately, **sleep plays a major role in emptying your hippocampus**, transferring your memories to a more permanent storage site, so you have more room in the hippocampus to learn new information.

## RESEARCH

In one study, a group of healthy young adults was separated into a nap group and a no-nap group. The goal of the study was to **determine whether napping before learning helped the participants learn new information**. [6] Here's what happened:

Participants in **both groups underwent a rigorous session of learning** (one-hundred name-face pairs), intended to strain the hippocampus. **During this first learning session, both groups performed similarly.**

Then, the participants in the **nap group took a ninety-minute nap in a sleep laboratory** at the research center, with electrodes on their heads so researchers could later analyze their sleep. Participants in the no-nap group, on the other hand, spent their time browsing the internet, playing board games, or taking part in other mindless tasks.

Later that day, **both groups were instructed to learn a new set of facts**, another one hundred name-face pairs. Although concentration of both groups remained the same (tests were performed to ensure this), the nap group performed significantly better on second round testing than the no-nap group. In fact, **the nap-group experienced a 20% learning advantage.**

Later, researchers took a look at the electrical brain waves of the nap group to try to determine what stage of sleep contributed to the learning benefit. They found that **stage 2 light Non-REM sleep was responsible for most of the learning benefit**. More specifically, they found that frequency of sleep spindles (mostly present during stage 2 sleep) was the greatest predictor of learning benefit. The more sleep spindles the participants experienced while they slept, the greater restoration of their learning potential when they woke up.

***“Stage 2 light Non-REM sleep was responsible for most of the learning benefit.”***



It's clear that sleeping before learning can improve your ability to learn. It's also clear that **stage 2 light Non-REM sleep is the sleep stage most responsible for clearing the hippocampus** and making it easier to learn. It would make sense to aim to get enough Stage 2 Light Non-REM Sleep before classes or intensive study sessions.

As demonstrated in figure 2.0, **you experience most of your light Non-REM sleep in the last few sleep cycles of your night**, in between long periods of REM Sleep. With that said, if you want to boost your learning potential, sleeping between seven and nine hours each night is essential.



### Summary: The importance of sleep for making new memories

- Light Non-REM sleep (sleep spindles) creates more room in the hippocampus for short-term memory, making it easier to learn.
- You experience most of your light Non-REM sleep in the last few sleep cycles of your night, in between long periods of REM Sleep.
- If you want to improve your ability to learn and memorize information, you should make sure you're getting enough light Non-REM sleep, sleeping between 7 and 9 hours.
- You could also take a short 20-minute nap (heavy with light Non-REM sleep) before a study session to refresh your hippocampus and improve your ability to learn.

## 2. SLEEP FOR MEMORY RETENTION AND RECALL



Humans discovered the benefits of sleep for memory recall thousands of years ago. In fact, the first record of this revelation is from the first century AD. Rhetorician Quintilian stated, “It is a curious fact, of which the reason is not obvious, that the interval of a single night will greatly increase the strength of the memory.”

In the last century, scientists have tested this theory a number of times. Each time, they conclude that **sleep improves memory retention and recall by between 20 and 40 percent.** [7] They’ve also **tested which sleep stage contributes to memory retention and recall.**

### RESEARCH

In one study, participants were instructed to learn a list of facts. Then, half of the group was allowed to sleep for the first half of the night, experiencing mostly deep sleep with little light or REM sleep, while the second group was allowed to sleep for the second half of the night only, experiencing mostly light sleep and REM sleep with little deep sleep.

Scientists found that **stage 3 deep Non-REM sleep**, achieved in the earliest hours of the night, was **the sleep stage responsible for the improvement of memory retention and recall.** [8]

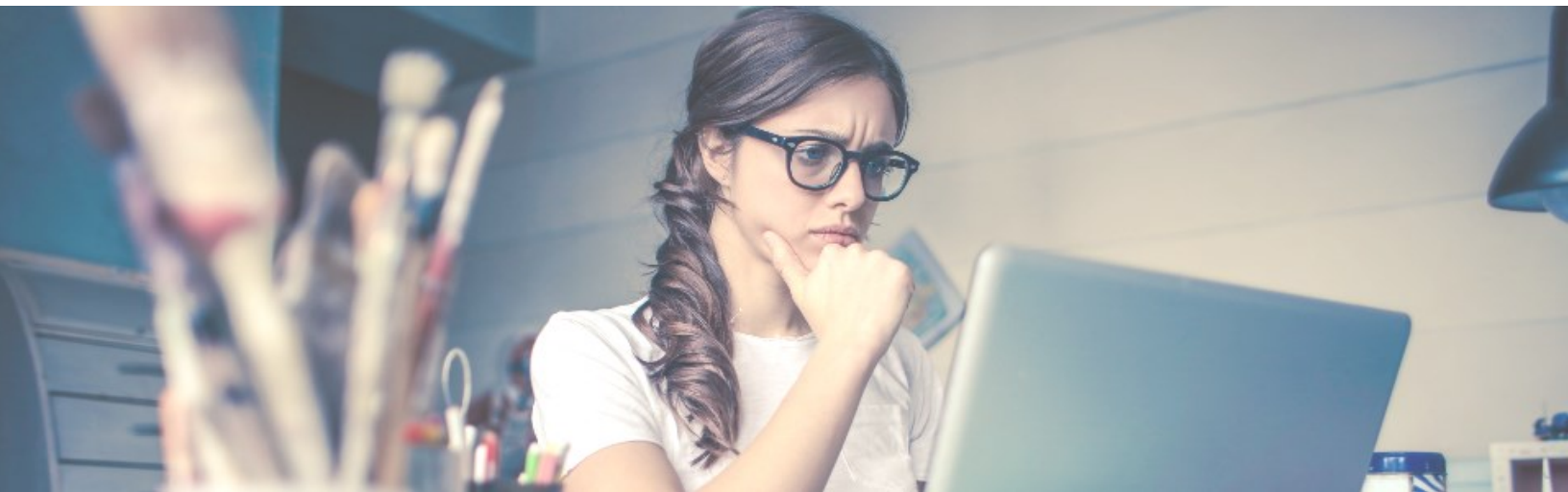
The science is clear, the more deep sleep you get, the more you remember the following day. With that said, if you have a big test coming up, the best thing you can do is make sure you get to sleep early - or at your usual time. **Going to sleep on time is the best way to ensure you get enough deep sleep to strengthen your memory.**

### Summary: The importance of sleep for memory recall

- Deep Non-REM sleep helps you remember information that you thought you forgot. The “tip of the tongue” feeling.
- You get most of your deep Non-REM sleep during your first few sleep cycles, in the earlier hours of the night.
- If you want to improve your memory retention and recall, make sure you go to sleep at a reasonable hour each night and keep a consistent sleep schedule.
- Going to sleep later than usual can seriously disrupt your deep sleep and hurt your memory retention and recall.

## 3. SLEEP FOR LONG-TERM MEMORY

We’ve already established that sleep spindles in stage 2 light Non-REM sleep help clear out the hippocampus (your short-term memory storage site) to make room to learn new information and make new memories. We haven’t discussed, however, where these memories go. **What happens to information you’ve learned once it’s cleared out of the hippocampus?**



The answer is: If you get enough stage 3 deep Non-REM sleep, **the facts and information you learn when you're awake are sent from your hippocampus (your short-term storage center) to your cortex** (your long-term memory storage site). [9]

In fact, according to sleep expert Mathew Walker, MRI scans indicate that the **slow brain waves of stage 3 deep Non-REM sleep** “serve as a courier service”, transporting memories from one brain region to the other. [10] [11]

Deep sleep doesn't just help you recall what you've learned in the short-term. It helps you recall what you've learned in the long-term as well. **If you're interested in performing well on your finals**, it's a good idea to **make sure you're getting enough deep sleep** throughout your semester.

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*“MRI scans indicate that the slow brain waves of stage 3 deep Non-REM sleep serve as a courier service, transporting memories from one brain region to the other.”*

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### Summary: The importance of sleep for long-term memory

- The slow brain waves of deep Non-REM sleep play a significant role in transferring fact-based memories from short-term to long-term storage.
- You get most of your deep Non-REM sleep during your first few sleep cycles, in the earlier hours of the night.
- If you want to make sure what you're learning transfers to your long-term memory, you should aim to go to sleep at a reasonable hour each night and keep a consistent sleep schedule.
- Going to sleep later than usual can seriously disrupt your deep sleep, negatively affecting the transfer of memories.

## 4. SLEEP FOR FILTERING INFORMATION

When you read a textbook, you don't try to learn every word, do you? You shouldn't. As previously mentioned, the hippocampus has limited storage capacity. If you try to learn every word, you'll fill up your capacity long before you finish the chapter.

Likewise, it wouldn't make sense to fill your cortex, your long-term memory storage site, with information that's not useful to you in the long run.

Fortunately, **sleep plays a major role** in helping you **retain only the information that**, presumably, **will be valuable to you** in the future. In other words, sleep not only helps you remember useful information, but it also helps you forget useless information.





## RESEARCH

In 2009, scientists set out to test sleep's role in forgetting information. [13] During the study, participants learned **a long list of words, paired with a command** (a large green "R" for *remember* or a large red "F" for *forget*).

**Half of the participants were allowed a ninety-minute nap** with electrodes on their heads for later analysis. The other half had to remain awake.

Later on that day, participants were **tested for how much of these words they remembered**. However, they were **instructed to try to remember** even the words that were marked as words that should be forgotten.

The results were clear. Sleep **powerfully boosted the retention for** words marked as ***remember*** and ***discarded memories for*** words marked as ***forget***. *Participants who didn't sleep showed no clear signs of memory filtering.*

Later, scientists analyzed the brain waves of participants to determine which sleep stage was responsible for this filtering of information. They found that **stage 2 Non-REM sleep**, and particularly the sleep spindles within this stage, was **the sleep stage most responsible for filtering memory**. The more sleep spindles an individual experienced, the more effectively they filtered information while asleep.



Since exams typically only test the most important information you learn, filtering important information is a key skill for students. If you want to improve your ability to remember only what's necessary, you should **make sure you're getting enough light sleep**. Likewise, since you get most of your light sleep during your last few sleep cycles, you should **aim to sleep between 7 and 9 hours each night**.



### Summary: The importance of sleep for filtering information

- Light Non-REM sleep (sleep spindles) helps filter out important information from non-important information, strengthening important memories and discarding unimportant ones.
- You experience most of your light Non-REM sleep in the last few sleep cycles of your night, in between long periods of REM Sleep.
- If you want to improve your ability to filter out important information from unimportant information (a crucial skill when studying for an exam), you should make sure you're getting enough light Non-REM sleep, sleeping between 7 and 9 hours.
- You could also take short 20-minute naps (heavy with light Non-REM sleep) in between study sessions to filter out useless information and, simultaneously, create more room in your hippocampus to learn more.

## 5. SLEEP FOR CREATIVE PROBLEM-SOLVING

If you're a student, you know that not all tests are designed to test your memory. Many tests are designed to test your **critical thinking and problem solving skills**. That is, although you've never been taught how to solve the problem you're looking at, **you have all of the tools and skills you need** to solve it. You just have to put the pieces together - **a skill that relies heavily on your associative memory**.



We all know that putting all of the pieces together isn't always easy. Fortunately, however, scientists have discovered that **sleep, particularly REM sleep, can do wonders for your associative memory**, ultimately **strengthening your critical thinking** and problem-solving skills.

### RESEARCH

In one study, scientists **tested the effect of REM sleep on the ability to solve anagram puzzles** - word scrambles like "EOUSM" for "MOUSE." [14] Anagram puzzles notoriously require both creative thinking and problem-solving skills.

In the study, participants solved a couple of anagram puzzles before going to sleep in a sleep laboratory with electrodes placed on their heads. The subjects **were woken up four times during the night to solve anagram puzzles**, twice during Non-REM sleep and twice during REM sleep.

The researchers found that **when participants were woken up during REM sleep, they could solve 15 to 35% more puzzles** than they could when woken up from Non-REM sleep and than they could during the day.

If your school subjects require enhanced creativity or critical thinking and problem-solving skills, it's a good idea to make sure you're getting enough REM sleep. Since **you obtain most of your REM sleep in your last few sleep cycles**, consistently **sleeping between 7 and 9 hours** is the best way to ensure you're getting the REM sleep you need to be your most creative self.

**CAUTION:** Alcohol consumption completely blocks REM sleep. As long as there is alcohol in your system, you won't be able to experience REM sleep. [15] If you want to be your most creative self, it's a good idea to limit your alcohol consumption.



### Summary: The importance of sleep for creative problem-solving

- REM sleep helps you build associations from what you've learned, which assists with creative thinking and problem-solving.
- Since you obtain most of your REM sleep in your last few sleep cycles, consistently sleeping between 7 and 9 hours is the best way to ensure you're getting the REM sleep you need to be your most creative self. In fact, in all likelihood, the longer you sleep, the more REM you'll experience.
- Alcohol consumption completely blocks REM sleep. If you want to be your most creative self, it's also a good idea to limit your alcohol consumption.

# The relationship between sleep and test scores

For many students, staying awake all night to study is common practice. In recent surveys, **20% of students reported pulling all-nighters** at least once a month, and 35% reported staying up past 3 am once or more weekly. [16]

Giving all of the information above, however, staying up all night to study is one of the worst things you can do for your grades. In fact, in a recent study at MIT, two MIT professors have found a strong **relationship between students' grades and how much sleep they were getting - the better their sleep habits, the better their scores.**

In the study, 100 students in an MIT engineering class were given Fitbits, in exchange for the researchers' access to a semester's worth of their activity data. [17] Here are some of their most interesting findings:

## INTERESTING FINDINGS

There was essentially a straight-line relationship between the average amount of sleep students got throughout the semester and their grades.

Individuals who went to bed after around 2 am, did worse on tests regardless of the total sleep they were getting. This is likely a result of impaired deep sleep and its impact on memory retention and recall.

There was no improvement in scores for those who made sure to get a good night's sleep right before a big test. Researchers concluded that sleep during learning is the sleep that matters most.

Students who got relatively consistent amounts of sleep each night did better than those who had greater variations from one night to the next, even if they ended up with the same average amount.



## Other benefits of sleep for students



Besides the benefits of sleep for students' academic performance, sleep benefits students in a plethora of other ways.

**Sleep improves motor learning and motor memory. [18] [19]**

**Sleep improves athletic performance. [20]**

**Sleep enhances emotional stability. [21] [22]**

**Sleep helps maintain a healthy weight. [23] [24]**

**Sleep enhances the immune system. [25] [26] [27]**

**Sleep improves reproductive health. [28] [29]**

**Sleep reduces the risk of some of the world's deadliest diseases. [30]**

# Sleep tips for students

It's **not always easy for students to get the sleep they need**. Oftentimes, they share a room with a roommate who has a different sleep schedule. They might also be subject to constant light or noise coming from the hallway of their dorm room or bedroom. Both can make it harder to fall asleep and lead to poor sleep quality. In addition, many students suffer from anxiety-related insomnia from the stress of exams or stress in their personal lives.

Nevertheless, **students of all ages should make an effort to prioritize their sleep** and improve both the quality and quantity of sleep they're getting. If you're a student, improving your sleep can improve both your grades and quality of life. Here are some of the most effective sleep tips for students:

1. **Go to sleep at a reasonable hour** - between 10 pm and 12 am.
2. **Set a consistent sleep schedule.**
3. Aim to sleep for **between 7 and 9 hours each night**.
4. **Do NOT sacrifice your sleep** in order to study.
5. It's not always easy to sleep with a roommate in the room or noise coming from the hallway. **Invest in a sleep mask** and **earplugs** (or sleep headphones) to block light and noise while you're trying to fall asleep.
6. Invest in a pair of **anti blue light glasses** for the nights when you're studying or doing homework on your computer past 8 pm.
7. Try **natural sleep solutions** to reduce anxiety and insomnia. Some ideas include natural sleep supplements, herbal infusions, or essential oils.
8. **Limit caffeine intake** (including energy drinks) **after 3 pm**. Any caffeine after 3 pm can disrupt your deep Non-REM sleep.
9. **Limit excessive alcohol intake**. Alcohol in your system will block your REM sleep and impair your creative thinking and problem-solving skills the following day.
10. **Invest in a sleep tracker**. Sleep trackers not only help you evaluate the quality of sleep you're getting, but they also help you prioritize your sleep as you aim for higher sleep scores.

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