Module 23

Sleep Patterns and Sleep Theories

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Module Learning Objectives

23-1 Describe how our biological rhythms influence our daily functioning.

23-2 Describe the biological rhythm of our sleeping and dreaming stages.

23-3 Explain how biology and environment interact in our sleep patterns.

23-4 Describe sleep's functions.

Sleep—the irresistible tempter to whom we inevitably succumb. Sleep—the equalizer of teachers and teens. Sleep—sweet, renewing, mysterious sleep. While sleeping, you may feel "dead to the world," but you are not. Even when you are deeply asleep, your perceptual window is open a crack. You move around on your bed, but you manage not to fall out. The occasional roar of passing vehicles may leave your deep sleep undisturbed, but a cry from a baby's room quickly interrupts it. So does the sound of your name. Electroencephalograph (EEG) recordings confirm that the brain's auditory cortex responds to sound stimuli even during sleep (Kutas, 1990). And when you are asleep, as when you are awake, you process most information outside your conscious awareness.

> "I love to sleep. Do you? Isn't it great? It really is the best of both worlds. You get to be alive and unconscious." -Comedian Rita Rudner, 1993

Many of sleep's mysteries are now being solved as some people sleep, attached to recording devices, while others observe. By recording brain waves and muscle movements, and by observing and occasionally waking sleepers, researchers are glimpsing things that a thousand years of common sense never told us. Perhaps you can anticipate some of their discoveries. Are the following statements true or false?

1. When people dream of performing some activity, their limbs often move in concert with the dream.
2. Older adults sleep more than young adults.
3. Sleepwalkers are acting out their dreams.
4. Sleep experts recommend treating insomnia with an occasional sleeping pill.
5. Some people dream every night; others seldom dream.

All these statements (adapted from Palladino & Carducci, 1983) are *false*. To see why, read on.

Biological Rhythms and Sleep

Like the ocean, life has its rhythmic tides. Over varying periods, our bodies fluctuate, and with them, our minds. Let's look more closely at two of those biological rhythms—our 24-hour biological clock and our 90-minute sleep cycle.

Circadian Rhythm

23-1 How do our biological rhythms influence our daily functioning?

The rhythm of the day parallels the rhythm of life—from our waking at a new day's birth to our nightly return to what Shakespeare called "death's counterfeit." Our bodies roughly synchronize with the 24-hour cycle of day and night by an internal biological clock called the **circadian rhythm** (from the Latin *circa,* "about," and *diem,* "day"). As morning approaches, body temperature rises, then peaks during the day, dips for a time in early afternoon (when many people take siestas), and begins to drop again in the evening. Thinking is sharpest and memory most accurate when we are at our daily peak in circadian arousal. Try pulling an all-nighter or working an occasional night shift. You'll feel groggiest in the middle of the night but may gain new energy when your normal wake-up time arrives.


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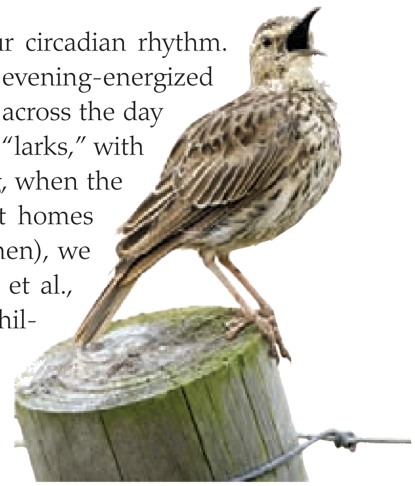
Age and experience can alter our circadian rhythm. Most teens and young adults are evening-energized "owls," with performance improving across the day (May & Hasher, 1998). Most older adults are morning-loving "larks," with performance declining as the day wears on. By mid-evening, when the night has hardly begun for many young adults, retirement homes are typically quiet. At about age 20 (slightly earlier for women), we begin to shift from being owls to being larks (Roenneberg et al., 2004). Women become more morning oriented as they have children and also as they transition to menopause (Leonhard & Randler, 2009; Randler & Bausback, 2010). Morning types tend to do better in school, to take more initiative, and to be less vulnerable to depression (Randler, 2008, 2009; Randler & Frech, 2009).


Peter Chadwick/Science Source

FYI

Dolphins, porpoises, and whales sleep with one side of their brain at a time (Miller et al., 2008).

Sleep Stages

23-2 What is the biological rhythm of our sleeping and dreaming stages?

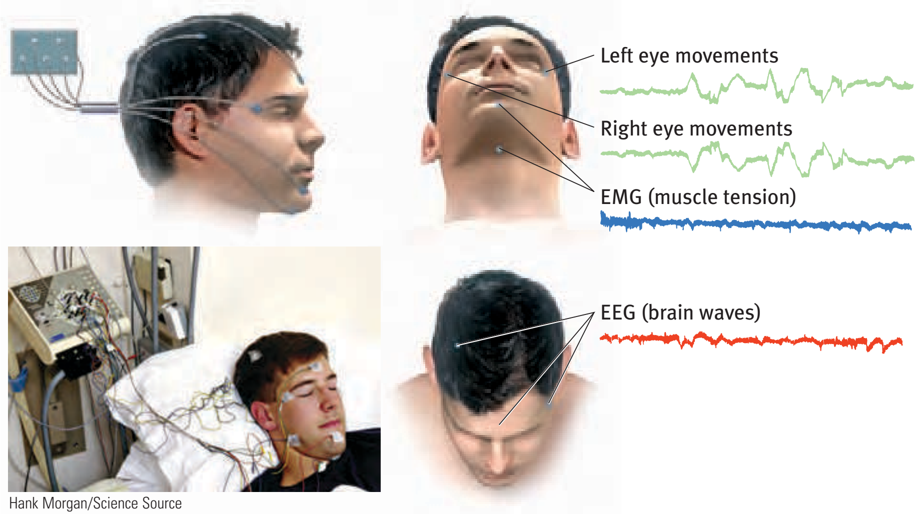
Sooner or later, sleep overtakes us and consciousness fades as different parts of our brain's cortex stop communicating (Massimini et al., 2005). Yet the sleeping brain remains active and has its own biological rhythm.

About every 90 minutes, we cycle through four distinct sleep stages. This simple fact apparently was unknown until 8-year-old Armond Aserinsky went to bed one night in 1952. His father, Eugene, a University of Chicago graduate student, needed to test an electroencephalograph he had repaired that day (Aserinsky, 1988; Seligman & Yellen, 1987). Placing electrodes near Armond's eyes to record the rolling eye movements then believed to occur during sleep, Aserinsky watched the machine go wild, tracing deep zigzags on the graph paper. Could the machine still be broken? As the night proceeded and the activity recurred, Aserinsky realized that the periods of fast, jerky eye movements were accompanied by energetic brain activity. Awakened during one such episode, Armond reported having a dream. Aserinsky had discovered what we now know as **REM sleep** (*r*apid *e*ye *m*ovement sleep).

Similar procedures used with thousands of volunteers showed the cycles were a normal part of sleep (Kleitman, 1960). To appreciate these studies, imagine yourself as a participant. As the hour grows late, you feel sleepy and yawn in response to reduced brain metabolism. (Yawning, which can be socially contagious, stretches your neck muscles and increases your heart rate, which increases your alertness [Moorcroft, 2003].) When you are ready for bed, a

circadian [ser-KAY-dee-an] **rhythm** the biological clock; regular bodily rhythms (for example, of temperature and wakefulness) that occur on a 24-hour cycle.

REM sleep rapid eye movement sleep; a recurring sleep stage during which vivid dreams commonly occur. Also known as *paradoxical sleep,* because the muscles are relaxed (except for minor twitches) but other body systems are active.



Hank Morgan/Science Source

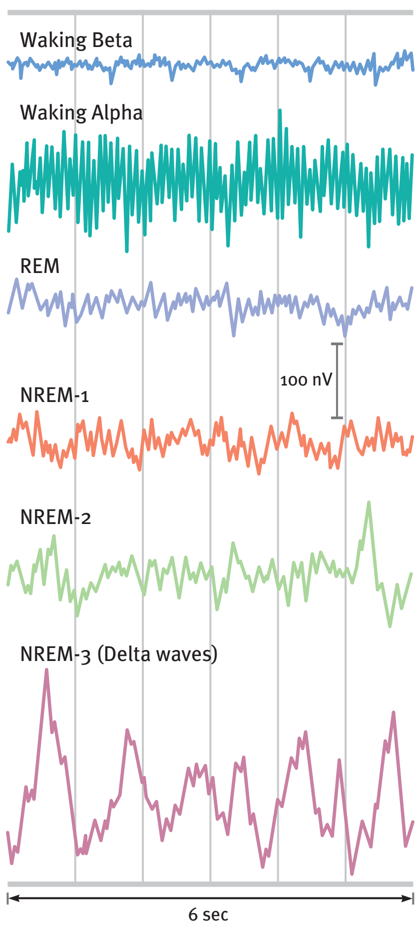
Figure 23.1

Measuring sleep activity Sleep researchers measure brain-wave activity, eye movements, and muscle tension by electrodes that pick up weak electrical signals from the brain, eye, and facial muscles. (From Dement, 1978.)

researcher comes in and tapes electrodes to your scalp (to detect your brain waves), on your chin (to detect muscle tension), and just outside the corners of your eyes (to detect eye movements) (**FIGURE 23.1**). Other devices will record your heart rate, respiration rate, and genital arousal.

When you are in bed with your eyes closed, the researcher in the next room sees on the EEG the relatively slow **alpha waves** of your awake but relaxed state (**FIGURE 23.2**). As you adapt to all this equipment, you grow tired and, in an unremembered moment, slip into **sleep** (**FIGURE 23.3**). The transition is marked by the slowed breathing and the irregular brain waves of non-REM stage 1 sleep. Using the new American Academy of Sleep Medicine classification of sleep stages, this is called NREM-1 (Silber et al., 2008).

In one of his 15,000 research participants, William Dement (1999) observed the moment the brain's perceptual window to the outside world slammed shut. Dement asked this sleep-deprived young man, lying on his back with eyelids taped open, to press a button every time a strobe light flashed in his eyes (about every 6 seconds). After a few minutes the young man missed one. Asked why, he said, "Because there was no flash." But there was a flash. He missed it because (as his brain activity revealed) he had fallen asleep for 2 seconds, missing not only the flash 6 inches from his nose but also the awareness of the abrupt moment of entry into sleep.



Rebecca Spencer, University of Massachusetts, assisted with this figure.

Figure 23.2

Brain waves and sleep stages The beta waves of an alert, waking state and the regular alpha waves of an awake, relaxed state differ from the slower, larger delta waves of deep NREM-3 sleep. Although the rapid REM sleep waves resemble the near-waking NREM-1 sleep waves, the body is more aroused during REM sleep than during NREM sleep.

alpha waves the relatively slow brain waves of a relaxed, awake state.

sleep periodic, natural loss of consciousness—as distinct from unconsciousness resulting from a coma, general anesthesia, or hibernation. (Adapted from Dement, 1999.)

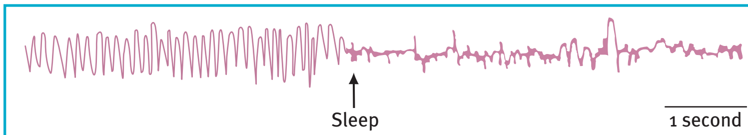


Figure 23.3

The moment of sleep We seem unaware of the moment we fall into sleep, but someone watching our brain waves could tell. (From Dement, 1999.)

hallucinations false sensory experiences, such as seeing something in the absence of an external visual stimulus.

delta waves the large, slow brain waves associated with deep sleep.

NREM sleep non–rapid eye movement sleep; encompasses all sleep stages except for REM sleep.

During this brief NREM-1 sleep you may experience fantastic images resembling **hallucinations**—sensory experiences that occur without a sensory stimulus. You may have a sensation of falling (at which moment your body may suddenly jerk) or of floating weightlessly. These *hypnagogic* sensations may later be incorporated into your memories. People who claim to have been abducted by aliens—often shortly after getting into bed—commonly recall being floated off of or pinned down on their beds (Clancy, 2005).

You then relax more deeply and begin about 20 minutes of NREM-2 sleep, with its periodic *sleep spindles*—bursts of rapid, rhythmic brain-wave activity (see Figure 23.2). Although you could still be awakened without too much difficulty, you are now clearly asleep.

Then you transition to the deep sleep of NREM-3. During this slow-wave sleep, which lasts for about 30 minutes, your brain emits large, slow **delta waves** and you are hard to awaken. Ever say to classmates, "That thunder was so loud last night," only to have them respond, "What thunder?" Those who missed the storm may have been in delta sleep. (It is at the end of the deep, slow-wave NREM-3 sleep that children may wet the bed.)

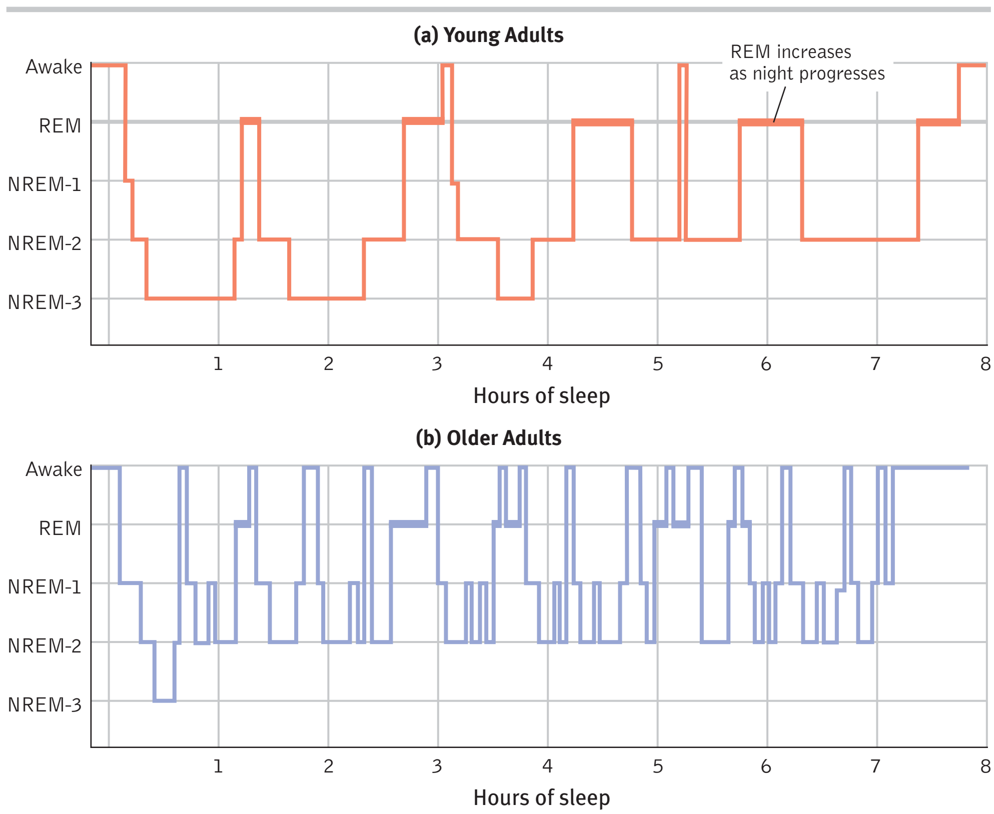
"Boy are my eyes tired! I had REM sleep all night long."

REM SLEEP

About an hour after you first fall asleep, a strange thing happens. You start to leave behind the stages known as **NREM sleep.** Rather than continuing in deep slumber, you ascend from your initial sleep dive. Returning through NREM-2 (where you spend about half your night), you enter the most intriguing sleep phase—REM sleep (**FIGURE 23.4**). For about 10 minutes, your brain waves become rapid and saw-toothed, more like those of the nearly awake NREM-1 sleep. But unlike NREM-1, during REM sleep your heart rate rises, your breathing becomes rapid and irregular, and every half-minute or so your eyes dart around in momentary bursts of activity behind closed lids. These eye movements announce the beginning of a dream—often emotional, usually story-like, and richly hallucinatory. Because anyone watching a sleeper's eyes can notice these REM bursts, it is amazing that science was ignorant of REM sleep until 1952.

Figure 23.4

The stages in a typical night's sleep People pass through a multistage sleep cycle several times each night, with the periods of deep sleep diminishing and REM sleep periods increasing in duration. As people age, sleep becomes more fragile, with awakenings common among older adults (Kamel et al., 2006; Neubauer, 1999).



AP® Exam Tip

Study this cycle of sleep carefully. One common mistake that students make is to believe that REM sleep comes directly after deep NREM-3 sleep. As you can see, it does not. Generally, NREM-2 follows NREM-3. Then comes REM.

Except during very scary dreams, your genitals become aroused during REM sleep. You have an erection or increased vaginal lubrication, regardless of whether the dream's content is sexual (Karacan et al., 1966). Men's common "morning erection" stems from the night's last REM period, often just before waking.

Your brain's motor cortex is active during REM sleep, but your brainstem blocks its messages. This leaves your muscles relaxed, so much so that, except for an occasional finger, toe, or facial twitch, you are essentially paralyzed. Moreover, you cannot easily be awakened. (This immobility may occasionally linger as you awaken from REM sleep, producing a disturbing experience of *sleep paralysis* [Santomauro & French, 2009].) REM sleep is thus sometimes called *paradoxical* sleep: The body is internally aroused, with waking-like brain activity, yet asleep and externally calm.

The sleep cycle repeats itself about every 90 minutes. As the night wears on, deep NREM-3 sleep grows shorter and disappears. The REM and NREM-2 sleep periods get longer (see Figure 23.4). By morning, we have spent 20 to 25 percent of an average night's sleep—some 100 minutes—in REM sleep. Thirty-seven percent of people report rarely or never having dreams "that you can remember the next morning" (Moore, 2004). Yet even they will, more than 80 percent of the time, recall a dream after being awakened during REM sleep. We spend about 600 hours a year experiencing some 1500 dreams, or more than 100,000 dreams over a typical lifetime—dreams swallowed by the night but not acted out, thanks to REM's protective paralysis.

FYI

People rarely snore during dreams. When REM starts, snoring stops.

FYI

Horses, which spend 92 percent of each day standing and can sleep standing, must lie down for REM sleep (Morrison, 2003).

Uriel Sinai/Getty Images

Safety in numbers? Why would communal sleeping provide added protection for those whose safety depends upon vigilance, such as these soldiers?

ANSWER: With each soldier cycling through the sleep stages independently, it is very likely that at any given time at least one of them will be awake or easily wakened in the event of a threat.

What Affects Our Sleep Patterns?

23-3 How do biology and environment interact in our sleep patterns?

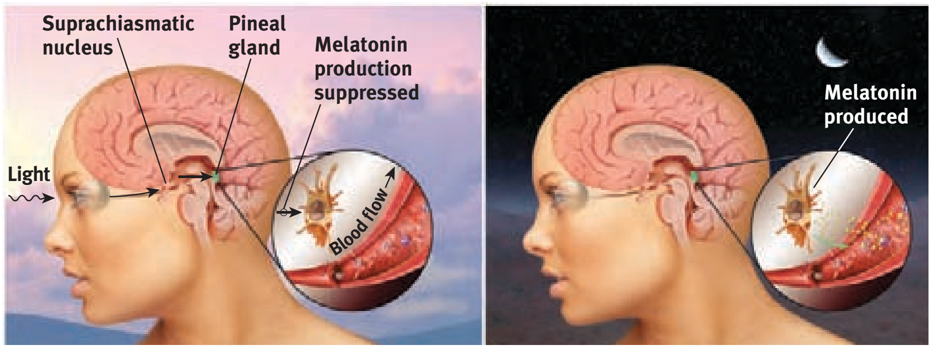
The idea that "everyone needs 8 hours of sleep" is untrue. Newborns often sleep two-thirds of their day, most adults no more than one-third. Still, there is more to our sleep differences than age. Some of us thrive with fewer than 6 hours per night; others regularly rack up 9 hours or more. Such sleep patterns are genetically influenced (Hor & Tafti, 2009). In studies of fraternal and identical twins, only the identical twins had strikingly similar sleep patterns and durations (Webb & Campbell, 1983). Today's researchers are discovering the genes that regulate sleep in humans and animals (Donlea et al., 2009; He et al., 2009).

Sleep patterns are also culturally influenced. In the United States and Canada, adults average 7 to 8 hours per night (Hurst, 2008; National Sleep Foundation, 2010; Robinson & Martin, 2009). (The weeknight sleep of many students and workers falls short of this average [NSF, 2008].) North Americans are nevertheless sleeping less than their counterparts a century ago. Thanks to modern lighting, shift work, and social media and other diversions, those who would have gone to bed at 9:00 P.M. are now up until 11:00 P.M. or later. With sleep, as with waking behavior, biology and environment interact.

Bright morning light tweaks the circadian clock by activating light-sensitive retinal proteins. These proteins control the circadian clock by triggering signals to the brain's **suprachiasmatic nucleus (SCN)**—a pair of grain-of-rice-sized, 10,000-cell clusters in the hypothalamus (Wirz-Justice, 2009). The SCN does its job in part by causing the brain's pineal gland to decrease its production of the sleep-inducing hormone *melatonin* in the morning and to increase it in the evening (**FIGURE 23.5** on the next page).

suprachiasmatic nucleus (SCN) a pair of cell clusters in the hypothalamus that controls circadian rhythm. In response to light, the SCN causes the pineal gland to adjust melatonin production, thus modifying our feelings of sleepiness.

Figure 23.5
The biological clock Light striking the retina signals the suprachiasmatic nucleus (SCN) to suppress the pineal gland's production of the sleep hormone melatonin. At night, the SCN quiets down, allowing the pineal gland to release melatonin into the bloodstream.



Try This

If our natural circadian rhythm were attuned to a 23-hour cycle, would we instead need to discipline ourselves to stay up later at night and sleep in longer in the morning?

FYI

A circadian disadvantage: One study of a decade's 24,121 Major League Baseball games found that teams who had crossed three time zones before playing a multiday series had nearly a 60 percent chance of losing their first game (Winter et al., 2009).

Being bathed in light disrupts our 24-hour biological clock (Czeisler et al., 1999; Dement, 1999). Curiously—given that our ancestors' body clocks were attuned to the rising and setting Sun of the 24-hour day—many of today's young adults adopt something closer to a 25-hour day, by staying up too late to get 8 hours of sleep. For this, we can thank (or blame) Thomas Edison, inventor of the light bulb. This helps explain why, until our later years, we must discipline ourselves to go to bed and force ourselves to get up. Most animals, too, when placed under unnatural constant illumination will exceed a 24-hour day. Artificial light delays sleep.

Sleep often eludes those who stay up late and sleep in on weekends, and then go to bed earlier on Sunday evening in preparation for the new school week (Oren & Terman, 1998). They are like New Yorkers whose biology is on California time. For North Americans who fly to Europe and need to be up when their circadian rhythm cries *"SLEEP,"* bright light (spending the next day outdoors) helps reset the biological clock (Czeisler et al., 1986, 1989; Eastman et al., 1995).

Sleep Theories

23-4 What are sleep's functions?

So, our sleep patterns differ from person to person and from culture to culture. But why do we have this need for sleep?

Psychologists believe sleep may have evolved for five reasons.

"Sleep faster, we need the pillows." -Yiddish proverb

1. ***Sleep protects.*** When darkness shut down the day's hunting, food gathering, and travel, our distant ancestors were better off asleep in a cave, out of harm's way. Those who didn't try to navigate around rocks and cliffs at night were more likely to leave descendants. This fits a broader principle: A species' sleep pattern tends to suit its ecological niche (Siegel, 2009). Animals with the greatest need to graze and the least ability to hide tend to sleep less. (For a sampling of animal sleep times, see **FIGURE 23.6.**)
2. ***Sleep helps us recuperate.*** It helps restore and repair brain tissue. Bats and other animals with high waking metabolism burn a lot of calories, producing a lot of *free radicals,* molecules that are toxic to neurons. Sleeping a lot gives resting neurons time to repair themselves, while pruning or weakening unused connections (Gilestro et al., 2009; Siegel, 2003; Vyazovskiy et al., 2008). Think of it this way: When consciousness leaves your house, brain construction workers come in for a makeover.

Figure 23.6
Animal sleep time Would you rather be a brown bat and sleep 20 hours a day or a giraffe and sleep 2 hours daily (data from NIH, 2010)?
Kruglov_Orda/Shutterstock; Courtesy of Andrew D. Myers; Utekhina Anna/Shutterstock; Steffen Foerster Photography/Shutterstock; The Agency Collection/Punchstock; Eric Isselée/Shutterstock; pandapaw/Shutterstock

3. ***Sleep helps restore and rebuild our fading memories of the day's experiences.*** Sleep consolidates our memories—it strengthens and stabilizes neural memory traces (Racsmány et al., 2010; Rasch & Born, 2008). People trained to perform tasks therefore recall them better after a night's sleep, or even after a short nap, than after several hours awake (Stickgold & Ellenbogen, 2008). Among older adults, more sleep leads to better memory of recently learned material (Drummond, 2010). After sleeping well, seniors remember more. And in both humans and rats, neural activity during slow-wave sleep re-enacts and promotes recall of prior novel experiences (Peigneux et al., 2004; Ribeiro et al., 2004). Sleep, it seems, strengthens memories in a way that being awake does not.
4. ***Sleep feeds creative thinking.*** On occasion, dreams have inspired noteworthy literary, artistic, and scientific achievements, such as the dream that clued chemist August Kekulé to the structure of benzene (Ross, 2006). More commonplace is the boost that a complete night's sleep gives to our thinking and learning. After working on a task, then sleeping on it, people solve problems more insightfully than do those who stay awake (Wagner et al., 2004). They also are better at spotting connections among novel pieces of information (Ellenbogen et al., 2007). To think smart and see connections, it often pays to sleep on it.
5. ***Sleep supports growth.*** During deep sleep, the pituitary gland releases a growth hormone. This hormone is necessary for muscle development. A regular full night's sleep can also "*dramatically* improve your athletic ability," report James Maas and Rebecca Robbins (see Close-up: Sleep and Athletic Performance). As we age, we release less of this hormone and spend less time in deep sleep (Pekkanen, 1982).

Given all the benefits of sleep, it's no wonder that sleep loss hits us so hard.

"Corduroy pillows make headlines." -Anonymous

Close-up

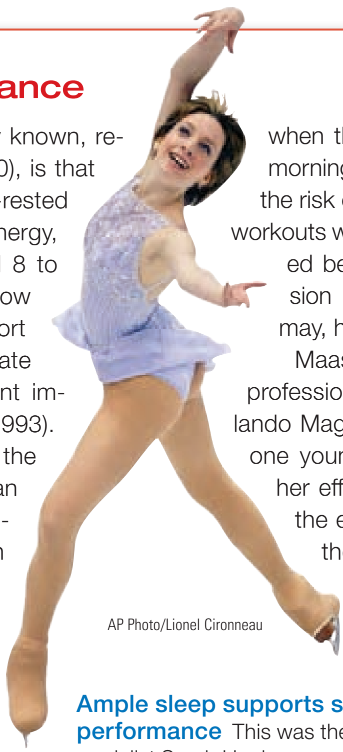
Sleep and Athletic Performance

Exercise improves sleep. What's not as widely known, report James Maas and Rebecca Robbins (2010), is that sleep improves athletic performance. Well-rested athletes have faster reaction times, more energy, and greater endurance, and teams that build 8 to 10 hours of daily sleep into their training show improved performance. Top violinists also report sleeping 8.5 hours a day on average, and rate practice and sleep as the two most important improvement-fostering activities (Ericsson et al., 1993).

Slow-wave sleep, which occurs mostly in the first half of a night's sleep, produces the human growth hormone necessary for muscle development. REM sleep and NREM-2 sleep, which occur mostly in the final hours of a long night's sleep, help strengthen the neural connections that build enduring memories, including the "muscle memories" learned while practicing tennis or shooting baskets.

The optimal exercise time is late afternoon or early evening, Maas and Robbins advise, when the body's natural cooling is most efficient. Early morning workouts are ill-advised, because they increase the risk of injury and rob athletes of valuable sleep. Heavy workouts within three hours of bedtime should also be avoided because the arousal disrupts falling asleep. Precision muscle training, such as shooting free throws, may, however, benefit when followed by sleep.

Maas has been a sleep consultant for college and professional athletes and teams. On Maas' advice, the Orlando Magic cut early morning practices. He also advised one young woman, Sarah Hughes, who felt stymied in her efforts to excel in figure-skating competition. "Cut the early morning practice," he instructed, as part of the recommended sleep regimen. Soon thereafter, Hughes' performance scores increased, ultimately culminating in her 2002 Olympic gold medal.



AP Photo/Lionel Cironneau

Ample sleep supports skill learning and high performance This was the experience of Olympic gold medalist Sarah Hughes.

Before You Move On

ASK YOURSELF

Would you consider yourself a night owl or a morning lark? When do you usually feel most energetic? What time of day works best for you to study?

TEST YOURSELF

What five theories explain our need for sleep?

Answers to the Test Yourself questions can be found in Appendix E at the end of the book.

Module 23 Review

23-1 How do our biological rhythms influence our daily functioning?

- Our bodies have an internal biological clock, roughly synchronized with the 24-hour cycle of night and day.
- This *circadian rhythm* appears in our daily patterns of body temperature, arousal, sleeping, and waking. Age and experiences can alter these patterns, resetting our biological clock.

23-2 What is the biological rhythm of our sleeping and dreaming stages?

- We cycle through four distinct *sleep* stages about every 90 minutes.
- Leaving the *alpha waves* of the awake, relaxed stage, we descend into the irregular brain waves of non-REM stage 1 sleep (NREM-1), often with the sensation of falling or floating.
- NREM-2 sleep (in which we spend the most time) follows, lasting about 20 minutes, with its characteristic sleep spindles.
- We then enter NREM-3 sleep, lasting about 30 minutes, with large, slow *delta waves.*
- About an hour after falling asleep, we begin periods of *REM (rapid eye movement) sleep.*
- Most dreaming occurs in this REM stage (also known as paradoxical sleep) of internal arousal but outward paralysis.
- During a normal night's sleep, NREM-3 sleep shortens and REM and NREM-2 sleep lengthens.

23-3 How do biology and environment interact in our sleep patterns?

- Biology—our circadian rhythm as well as our age and our body's production of melatonin (influenced by the brain's suprachiasmatic nucleus)—interacts with cultural expectations and individual behaviors to determine our sleeping and waking patterns.

23-4 What are sleep's functions?

- Sleep may have played a protective role in human evolution by keeping people safe during potentially dangerous periods.
- Sleep also helps restore and repair damaged neurons.
- REM and NREM-2 sleep help strengthen neural connections that build enduring memories.
- Sleep promotes creative problem solving the next day.
- During slow-wave sleep, the pituitary gland secretes human growth hormone, which is necessary for muscle development.

Multiple-Choice Questions

1. Which of the following represents a circadian rhythm?

a. A burst of growth occurs during puberty.
b. A full Moon occurs about once a month.
c. Body temperature rises each day as morning approaches.
d. When it is summer in the northern hemisphere, it is winter in the southern hemisphere.
e. Pulse rate increases when we exercise.

2. In which stage of sleep are you likely to experience hypnagogic sensations of falling?

a. Alpha sleep
b. NREM-1
c. NREM-2
d. NREM-3
e. REM

3. What is the role of the suprachiasmatic nucleus (SCN) in sleep?

a. It induces REM sleep approximately every 90 minutes during sleep.
b. It causes the pineal gland to increase the production of melatonin.
c. It causes the pituitary gland to increase the release of human growth hormone.
d. It causes the pituitary gland to decrease the release of human growth hormone.
e. It causes the pineal gland to decrease the production of melatonin.

4. Which of the following sleep theories emphasizes sleep's role in restoring and repairing brain tissue?

a. Memory
b. Protection
c. Growth
d. Recuperation
e. Creativity

Practice FRQs

1. Sleep serves many functions for us. Briefly explain how sleep can

- provide protection.
- promote physical growth.

Answer

1 point: Sleep kept our ancestors safe from nighttime dangers.

1 point: Sleep promotes the release of pituitary growth hormone.

2. Name and briefly describe three stages of sleep when rapid eye movements are not occurring.

(3 points)

Module 24

Sleep Deprivation, Sleep Disorders, and Dreams

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Module Learning Objectives

24-1 Describe the effects of sleep loss, and identify the major sleep disorders.

24-2 Describe the most common content of dreams.

24-3 Identify proposed explanations for why we dream.

Sleep Deprivation and Sleep Disorders

24-1 How does sleep loss affect us, and what are the major sleep disorders?

When our body yearns for sleep but does not get it, we begin to feel terrible. Trying to stay awake, we will eventually lose. It's easy to spot students who have stayed up late to study for a test or finish a term paper: They are often fighting the "nods" (their heads bobbing downward in seconds-long "microsleeps") as they fight to stay awake.

In the tiredness battle, sleep always wins. In 1989, Michael Doucette was named America's Safest Driving Teen. In 1990, while driving home from college, he fell asleep at the wheel and collided with an oncoming car, killing both himself and the other driver. Michael's driving instructor later acknowledged never having mentioned sleep deprivation and drowsy driving (Dement, 1999).

Effects of Sleep Loss

Today, more than ever, our sleep patterns leave us not only sleepy but drained of energy and feelings of well-being. After a succession of 5-hour nights, we accumulate a sleep debt that need not be entirely repaid but cannot be satisfied by one long sleep. "The brain keeps an accurate count of sleep debt for at least two weeks," reported sleep researcher William Dement (1999, p. 64).

Obviously, then, we need sleep. Sleep commands roughly one-third of our lives—some 25 years, on average. But why?

Allowed to sleep unhindered, most adults will sleep at least 9 hours a night (Coren, 1996). With that much sleep, we awake refreshed, sustain better moods, and perform more efficient and accurate work. The U.S. Navy and the National Institutes of Health have demonstrated the benefits of unrestricted sleep in experiments in which volunteers spent 14 hours daily in bed for at least a week. For the first few days, the volunteers averaged 12 hours of sleep a day or more, apparently paying off a sleep debt that averaged 25 to 30 hours.

That accomplished, they then settled back to 7.5 to 9 hours nightly and felt energized and happier (Dement, 1999). In one Gallup survey (Mason, 2005), 63 percent of adults who reported getting the sleep they needed also reported being "very satisfied" with their personal life (as did only 36 percent of those needing more sleep). And when 909 working women reported on their daily moods, the researchers were struck by what mattered little (such as money, so long as the person was not battling poverty), and what mattered a lot: less time pressure at work and a good night's sleep (Kahneman et al., 2004). Perhaps it's not surprising, then, that when asked if they had felt well rested on the previous day, 3 in 10 Americans said they had not (Pelham, 2010).

College and university students are especially sleep deprived; 69 percent in one national survey reported "feeling tired" or "having little energy" on several or more days in the last two weeks (AP, 2009). In another survey, 28 percent of high school students acknowledged falling asleep in class at least once a week (Sleep Foundation, 2006). The going needn't get boring before students start snoring. (To test whether you are one of the many sleep-deprived students, see **TABLE 24.1.**)

Sleep loss is a predictor of depression. Researchers who studied 15,500 young people, 12 to 18 years old, found that those who slept 5 or fewer hours a night had a 71 percent higher risk of depression than their peers who slept 8 hours or more (Gangwisch et al., 2010). This link does not appear to reflect sleep difficulties caused by depression. When children and youth are followed through time, sleep loss predicts depression rather than

MARK RALSTON/AFP/Getty Images

Sleepless and suffering These fatigued, sleep-deprived earthquake rescue workers in China may experience a depressed immune system, impaired concentration, and greater vulnerability to accidents.

FYI

In a 2001 Gallup poll, 61 percent of men, but only 47 percent of women, said they got enough sleep.

Table 24.1

Cornell University psychologist James Maas has reported that most students suffer the consequences of sleeping less than they should. To see if you are in that group, answer the following true-false questions:

True	False	
....	....	1. I need an alarm clock in order to wake up at the appropriate time.
....	....	2. It's a struggle for me to get out of bed in the morning.
....	....	3. Weekday mornings I hit snooze several times to get more sleep.
....	....	4. I feel tired, irritable, and stressed out during the week.
....	....	5. I have trouble concentrating and remembering.
....	....	6. I feel slow with critical thinking, problem solving, and being creative.
....	....	7. I often fall asleep watching TV.
....	....	8. I often fall asleep in boring meetings or lectures or in warm rooms.
....	....	9. I often fall asleep after heavy meals.
....	....	10. I often fall asleep while relaxing after dinner.
....	....	11. I often fall asleep within five minutes of getting into bed.
....	....	12. I often feel drowsy while driving.
....	....	13. I often sleep extra hours on weekend mornings.
....	....	14. I often need a nap to get through the day.
....	....	15. I have dark circles around my eyes.

If you answered "true" to three or more items, you probably are not getting enough sleep. To determine your sleep needs, Maas recommends that you "go to bed 15 minutes earlier than usual every night for the next week—and continue this practice by adding 15 more minutes each week—until you wake without an alarm clock and feel alert all day." (Sleep Quiz reprinted with permission from James B. Maas, "Sleep to Win!" (Bloomington, IN: AuthorHouse, 2013).)

vice versa (Gregory et al., 2009). Moreover, REM sleep's processing of emotional experiences helps protect against depression (Walker & van der Helm, 2009). After a good night's sleep, we often do feel better the next day. And that may help to explain why parentally enforced bedtimes predict less depression, and why pushing back school start time leads to improved adolescent sleep, alertness, and mood (Gregory et al., 2009; Owens et al., 2010).

Even when awake, students often function below their peak. And they know it: Four in five teens and three in five 18- to 29-year-olds wish they could get more sleep on weekdays (Mason, 2003, 2005). Yet that teen who staggers glumly out of bed in response to an unwelcome alarm, yawns through morning classes, and feels half-depressed much of the day may be energized at 11:00 P.M. and mindless of the next day's looming sleepiness (Carskadon, 2002). "Sleep deprivation has consequences—difficulty studying, diminished productivity, tendency to make mistakes, irritability, fatigue," noted Dement (1999, p. 231). A large sleep debt "makes you stupid."

AP® Exam Tip

Many students try to get by on less and less sleep to try to fit everything in. The irony is that if you stay up too late studying, it can be counterproductive. Sleep deprivation makes it difficult to concentrate and increases the likelihood you will make silly mistakes on tests. The impact on your immune system means you are more likely to get sick. To be the best student you can be, make sleep a priority.

It can also make you fatter. Sleep deprivation increases *ghrelin,* a hunger-arousing hormone, and decreases its hunger-suppressing partner, *leptin* (more on these in Module 38). It also increases cortisol, a stress hormone that stimulates the body to make fat. Sure enough, children and adults who sleep less than normal are fatter than those who sleep more (Chen et al., 2008; Knutson et al., 2007; Schoenborn & Adams, 2008). And experimental sleep deprivation of adults increases appetite and eating (Nixon et al., 2008; Patel et al., 2006; Spiegel et al., 2004; Van Cauter et al., 2007). This may help explain the common weight gain among sleep-deprived students (although a review of 11 studies reveals that the mythical college student's "freshman 15" is, on average, closer to a "first-year 4" [Hull et al., 2007]).

In addition to making us more vulnerable to obesity, sleep deprivation can suppress immune cells that fight off viral infections and cancer (Motivala & Irwin, 2007). One experiment exposed volunteers to a cold virus. Those who had been averaging less than 7 hours sleep a night were 3 times more likely to develop a cold than were those sleeping 8 or more hours a night (Cohen et al., 2009). Sleep's protective effect may help explain why people who sleep 7 to 8 hours a night tend to outlive those who are chronically sleep deprived, and why older adults who have no difficulty falling or staying asleep tend to live longer than their sleep-deprived agemates (Dement, 1999; Dew et al., 2003). When infections do set in, we typically sleep more, boosting our immune cells.

"So shut your eyes
Kiss me goodbye
And sleep
Just sleep."
-SONG BY MY CHEMICAL ROMANCE

Sleep deprivation slows reactions and increases errors on visual attention tasks similar to those involved in screening airport baggage, performing surgery, and reading X-rays (Lim & Dinges, 2010). Similarly, the result can be devastating for driving, piloting, and equipment operating. Driver fatigue has contributed to an estimated 20 percent of American traffic accidents (Brody, 2002) and to some 30 percent of Australian highway deaths (Maas, 1999). One two-year study examined the driving accident rates of more than 20,000 Virginia 16- to 18-year-olds in two major cities. In one city, the high schools started 75 to 80 minutes later than in the other. The late starters had about 25 percent fewer crashes (Vorona et al., 2011). Consider, too, the timing of four industrial disasters—the 1989 *Exxon Valdez* tanker hitting rocks and spilling millions of gallons of oil on the shores of Alaska; Union Carbide's 1984 release of toxic gas that killed thousands in Bhopal, India; and the 1979 Three Mile Island and 1986 Chernobyl nuclear accidents. All occurred after midnight, when operators in charge were likely to be drowsiest and unresponsive to signals requiring an alert response. Likewise, the 2013 Asiana Airlines crash landing at San Francisco Airport happened at 3:30 A.M. Korea time, after a 10-hour flight from Seoul. When sleepy frontal lobes confront an unexpected situation, misfortune often results.

Stanley Coren capitalized on what is, for many North Americans, a semi-annual sleep-manipulation experiment—the "spring forward" to "daylight savings" time and "fall backward" to "standard" time. Searching millions of records, Coren found that in both Canada and the United States, accidents increased immediately after the time change that shortens sleep (**FIGURE 24.1**).

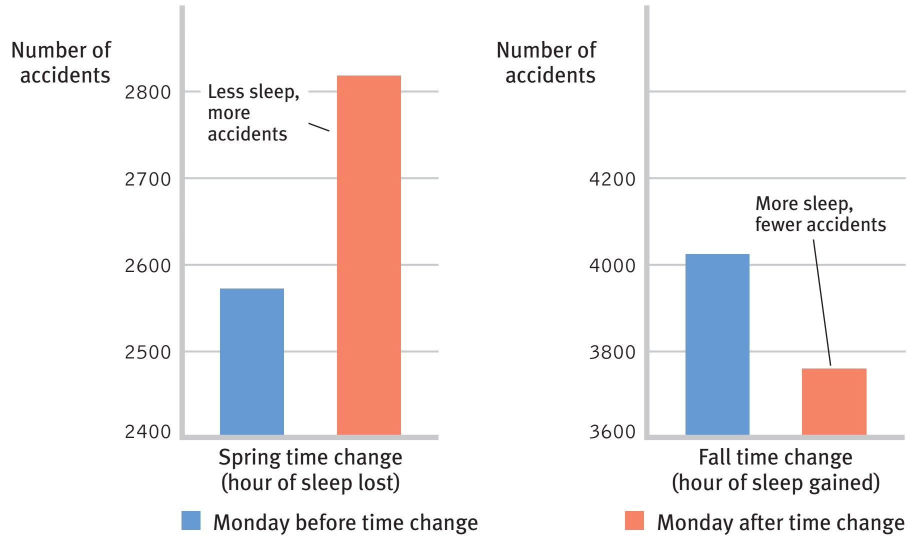


Figure 24.1
Canadian traffic accidents On the Monday after the spring time change, when people lose one hour of sleep, accidents increased, as compared with the Monday before. In the fall, traffic accidents normally increase because of greater snow, ice, and darkness, but they diminished after the time change. (Adapted from Coren, 1996.)

FIGURE 24.2 summarizes the effects of sleep deprivation. But there is good news! Psychologists have discovered a treatment that strengthens memory, increases concentration, boosts mood, moderates hunger and obesity, fortifies the disease-fighting immune system, and lessens the risk of fatal accidents. Even better news: The treatment feels good, it can be self-administered, the supplies are limitless, and it's available free! If you are a typical high school student, often going to bed near midnight and dragged out of bed six or seven hours later by the dreaded alarm, the treatment is simple: Each night just add 15 minutes to your sleep. Ignore that last text, resist the urge to check in with friends online, and succumb to sleep, "the gentle tyrant."

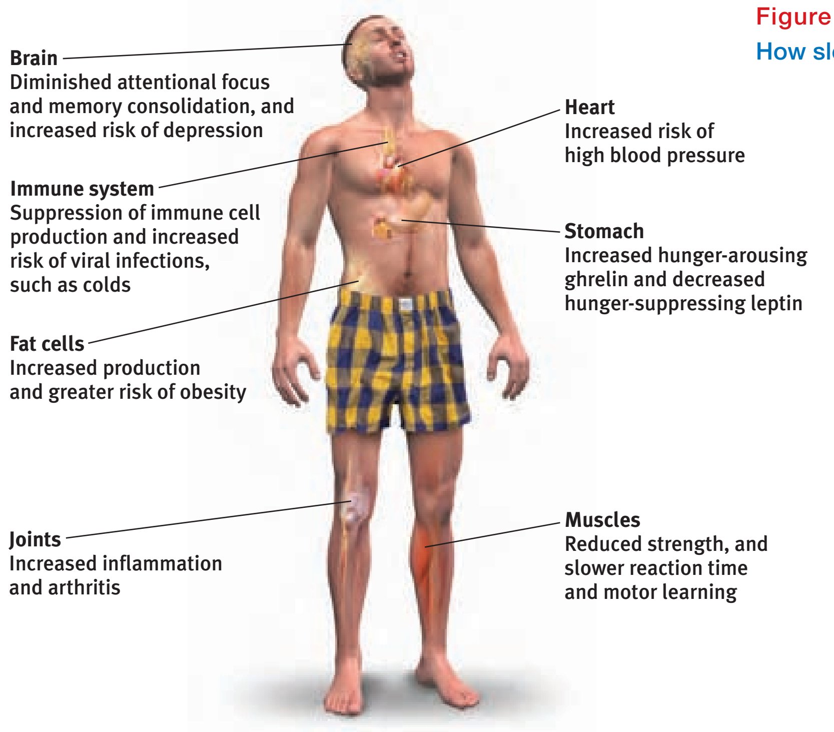


Figure 24.2
How sleep deprivation affects us

"The lion and the lamb shall lie down together, but the lamb will not be very sleepy." -Woody Allen, in the movie *Love and Death*, 1975

"Sleep is like love or happiness. If you pursue it too ardently it will elude you." -Wilse Webb, *Sleep: The Gentle Tyrant*, 1992

insomnia recurring problems in falling or staying asleep.

narcolepsy a sleep disorder characterized by uncontrollable sleep attacks. The sufferer may lapse directly into REM sleep, often at inopportune times.

MAJOR SLEEP DISORDERS

No matter what their normal need for sleep, 1 in 10 adults, and 1 in 4 older adults, complain of **insomnia**—not an occasional inability to sleep when anxious or excited, but persistent problems in falling or staying asleep (Irwin et al., 2006).

From middle age on, awakening occasionally during the night becomes the norm, not something to fret over or treat with medication (Vitiello, 2009). Ironically, insomnia is worsened by fretting about one's insomnia. In laboratory studies, insomnia complainers do sleep less than others, but they typically overestimate—by about double—how long it takes them to fall asleep. They also underestimate by nearly half how long they actually have slept. Even if we have been awake only an hour or two, we may *think* we have had very little sleep because it's the waking part we remember.

The most common quick fixes for true insomnia—sleeping pills and alcohol—can aggravate the problem, reducing REM sleep and leaving the person with next-day blahs. Such aids can also lead to *tolerance*—a state in which increasing doses are needed to produce an effect. An ideal sleep aid would mimic the natural chemicals that are abundant during sleep, without side effects. Until scientists can supply this magic pill, sleep experts have offered some tips for getting better quality sleep (**TABLE 24.2**).

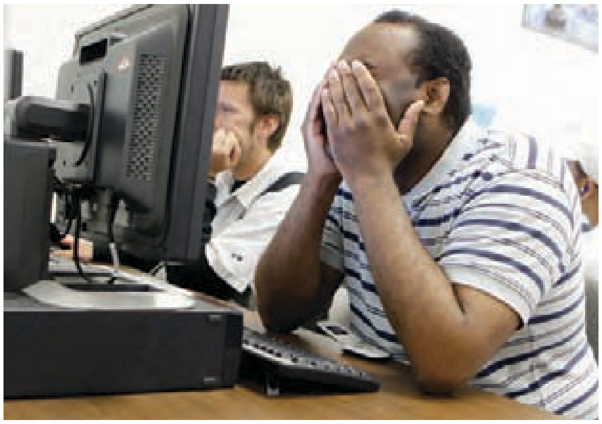
Falling asleep is not the problem for people with **narcolepsy** (from *narco,* "numbness," and *lepsy,* "seizure"), who have sudden attacks of overwhelming sleepiness, usually lasting less than 5 minutes. Narcolepsy attacks can occur at the most inopportune times, perhaps just after taking a terrific swing at a softball or when laughing loudly, shouting angrily, or having sex (Dement, 1978, 1999). In severe cases, the person collapses directly into a brief period of REM sleep, with loss of muscular tension. People with narcolepsy—1 in 2000 of us, estimated the Stanford University Center for Narcolepsy (2002)—must therefore live with extra caution. As a traffic menace, "snoozing is second only to boozing," says the American Sleep Disorders Association, and those with narcolepsy are especially at risk (Aldrich, 1989).

Researchers have discovered genes that cause narcolepsy in dogs and humans (Miyagawa et al., 2008; Taheri, 2004). Genes help sculpt the brain, and neuroscientists are searching the brain for narcolepsy-linked abnormalities. One team discovered a relative absence of a hypothalamic neural center that produces *orexin* (also called hypocretin), a neurotransmitter linked to alertness (Taheri et al., 2002; Thannickal et al., 2000). (That discovery has led to the clinical testing of a new sleeping pill that works by blocking orexin's arousing activity.)

Table 24.2 Some Natural Sleep Aids

- Exercise regularly but not in the late evening. (Late afternoon is best.)
- Avoid caffeine after early afternoon, and avoid food and drink near bedtime. The exception would be a glass of milk, which provides raw materials for the manufacture of serotonin, a neurotransmitter that facilitates sleep.
- Relax before bedtime, using dimmer light.
- Sleep on a regular schedule (rise at the same time even after a restless night) and avoid naps.
- Hide the clock face so you aren't tempted to check it repeatedly.
- Reassure yourself that temporary sleep loss causes no great harm.
- Realize that for any stressed organism, being vigilant is natural and adaptive. A personal conflict during the day often means a fitful sleep that night (Åkerstedt et al., 2007; Brissette & Cohen, 2002). And a traumatic stressful event can take a lingering toll on sleep (Babson & Feldner, 2010). Managing your stress levels will enable more restful sleeping. (See Modules 43, 44, and 84 for more on stress.)
- If all else fails, settle for less sleep, either by going to bed later or getting up earlier.

AP Photo/Paul Sakuma, File



Economic recession and stress can rob sleep A National Sleep Foundation (2009) survey found 27 percent of people reporting sleeplessness related to the economy, their personal finances, and employment, as seems evident in this man looking for work.

sleep apnea a sleep disorder characterized by temporary cessations of breathing during sleep and repeated momentary awakenings.

night terrors a sleep disorder characterized by high arousal and an appearance of being terrified; unlike nightmares, night terrors occur during NREM-3 sleep, within two or three hours of falling asleep, and are seldom remembered.

Narcolepsy, it is now clear, is a brain disease; it is not just "in your mind." And this gives hope that narcolepsy might be effectively relieved by a drug that mimics the missing orexin and can sneak through the blood-brain barrier (Fujiki et al., 2003; Siegel, 2000). In the meantime, physicians are prescribing other drugs to relieve narcolepsy's sleepiness in humans.

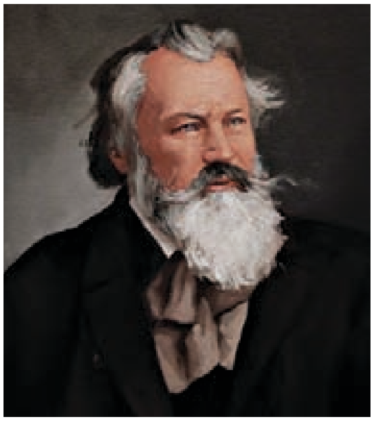
Although 1 in 20 of us have **sleep apnea,** it was unknown before modern sleep research. *Apnea* means "with no breath," and people with this condition intermittently stop breathing during sleep. After an airless minute or so, decreased blood oxygen arouses them and they wake up enough to snort in air for a few seconds, in a process that repeats hundreds of times each night, depriving them of slow-wave sleep. Apnea sufferers don't recall these episodes the next day. So, despite feeling fatigued and depressed—and hearing their mate's complaints about their loud "snoring"—many are unaware of their disorder (Peppard et al., 2006).

Sleep apnea is associated with obesity, and as the number of obese Americans has increased, so has this disorder, particularly among overweight men, including some football players (Keller, 2007). Other warning signs are loud snoring, daytime sleepiness and irritability, and (possibly) high blood pressure, which increases the risk of a stroke or heart attack (Dement, 1999). If one doesn't mind looking a little goofy in the dark (imagine a snorkeler at a slumber party), the treatment—a mask-like device with an air pump that keeps the sleeper's airway open—can effectively relieve apnea symptoms.

Unlike sleep apnea, **night terrors** target mostly children, who may sit up or walk around, talk incoherently, experience doubled heart and breathing rates, and appear terrified (Hartmann, 1981). They seldom wake up fully during an episode and recall little or nothing the next morning—at most, a fleeting, frightening image. Night terrors are not nightmares (which, like other dreams, typically occur during early morning REM sleep); night terrors usually occur during the first few hours of NREM-3.

Sleepwalking—another NREM-3 sleep disorder—and *sleep talking* are usually childhood disorders, and like narcolepsy, they run in families. (Sleep talking—usually garbled or nonsensical—can occur during any sleep stage [Mahowald & Ettinger, 1990].) Occasional childhood sleepwalking occurs for about one-third of those with a sleepwalking fraternal twin and half of those with a sleepwalking identical twin. The same is true for sleep talking (Hublin et al., 1997, 1998). Sleepwalking is usually harmless. After returning to bed on their own or with the help of a family member, few sleepwalkers recall their trip the next morning. About 20 percent of 3- to 12-year-olds have at least one episode of sleepwalking,

The Granger Collection, New York



Did Brahms need his own lullabies? Cranky, overweight, and nap-prone, Johannes Brahms exhibited common symptoms of sleep apnea (Margolis, 2000).

Brian Chase/Shutterstock

Now I lay me down to sleep For many with sleep apnea, a continuous positive airway pressure (CPAP) machine makes for sounder sleeping and better quality of life.

usually lasting 2 to 10 minutes; some 5 percent have repeated episodes (Giles et al., 1994). Young children, who have the deepest and lengthiest NREM-3 sleep, are the most likely to experience both night terrors and sleepwalking. As we grow older and deep NREM-3 sleep diminishes, so do night terrors and sleepwalking. After being sleep deprived, we sleep more deeply, which increases any tendency to sleepwalk (Zadra et al., 2008).

A dreamy take on dreamland The 2010 movie *Inception* creatively played off our interest in finding meaning in our dreams, and in understanding the layers of our consciousness. It further explored the idea of creating false memories through the power of suggestion—an idea we will explore in Module 33.

Photofest/Warner Bros. Pictures

Dreams

Now playing at an inner theater near you: the premiere showing of a sleeping person's vivid dream. This never-before-seen mental movie features captivating characters wrapped in a plot so original and unlikely, yet so intricate and so seemingly real, that the viewer later marvels at its creation.

Waking from a troubling dream, wrenched by its emotions, who among us has not wondered about this weird state of consciousness? How can our brain so creatively, colorfully, and completely construct this alternative world? In the shadowland between our dreaming and waking consciousness, we may even wonder for a moment which is real.

Discovering the link between REM sleep and dreaming opened a new era in dream research. Instead of relying on someone's hazy recall hours or days after having a dream, researchers could catch dreams as they happened. They could awaken people during or within 3 minutes after a REM sleep period and hear a vivid account.

dream a sequence of images, emotions, and thoughts passing through a sleeping person's mind. Dreams are notable for their hallucinatory imagery, discontinuities, and incongruities, and for the dreamer's delusional acceptance of the content and later difficulties remembering it.

"I do not believe that I am now dreaming, but I cannot prove that I am not." -Philosopher Bertrand Russell (1872–1970)

What We Dream

24-2 What do we dream?

Daydreams tend to involve the familiar details of our life—perhaps picturing ourselves explaining to a teacher why a paper will be late, or replaying in our minds personal encounters we relish or regret. REM **dreams**—"hallucinations of the sleeping mind" (Loftus & Ketcham, 1994, p. 67)—are vivid, emotional, and bizarre—so vivid we may confuse them with reality. Awakening from a nightmare, a 4-year-old may be sure there is a bear in the house.

We spend six years of our life in dreams, many of which are anything but sweet. For both women and men, 8 in 10 dreams are marked by at least one negative event or emotion (Domhoff, 2007). Common themes are repeatedly failing in an attempt to do something; of being attacked, pursued, or rejected; or of experiencing misfortune (Hall et al., 1982). Dreams with sexual imagery occur less often than you might think. In one study, only 1 in 10 dreams among young men and 1 in 30 among young women had sexual content (Domhoff, 1996). More commonly, the story line of our dreams incorporates traces of previous days' nonsexual experiences and preoccupations (De Koninck, 2000):

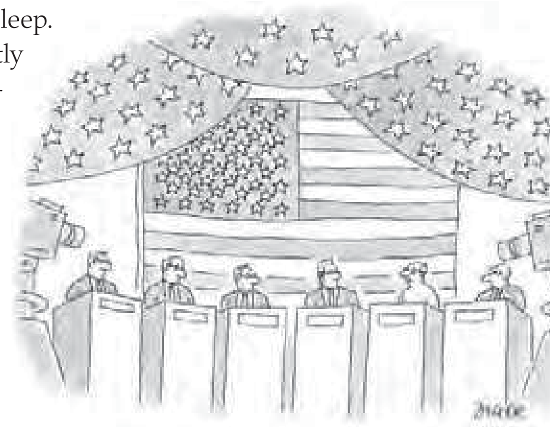
- After suffering a trauma, people commonly report nightmares, which help extinguish daytime fears (Levin & Nielsen, 2007, 2009). One sample of Americans recording their dreams during September 2001 reported an increase in threatening dreams following the 9/11 terrorist attacks (Propper et al., 2007).
- After playing the computer game *Tetris* for 7 hours and then being awakened repeatedly during their first hour of sleep, 3 in 4 people reported experiencing images of the game's falling blocks (Stickgold et al., 2000).
- Compared with city-dwellers, people in hunter-gatherer societies more often dream of animals (Mestel, 1997). Compared with nonmusicians, musicians report twice as many dreams of music (Uga et al., 2006).

FYI

Would you suppose that people dream if blind from birth? Studies in France, Hungary, Egypt, and the United States all found blind people dreaming of using their nonvisual senses—hearing, touching, smelling, tasting (Buquet, 1988; Taha, 1972; Vekassy, 1977).

"For what one has dwelt on by day, these things are seen in visions of the night." -Menander of Athens (342–292 B.C.E.), *The Principal Fragments*

Our two-track mind is also monitoring our environment while we sleep. Sensory stimuli—a particular odor or a phone's ringing—may be instantly and ingeniously woven into the dream story. In a classic experiment, researchers lightly sprayed cold water on dreamers' faces (Dement & Wolpert, 1958). Compared with sleepers who did not get the cold-water treatment, these people were more likely to dream about a waterfall, a leaky roof, or even about being sprayed by someone.



"Uh-oh. I think I'm having one of those dreams again."

So, could we learn a foreign language by hearing it played while we sleep? If only it were so easy. While sleeping we can learn to associate a sound with a mild electric shock (and to react to the sound accordingly). But we do not remember recorded information played while we are soundly asleep (Eich, 1990; Wyatt & Bootzin, 1994). In fact, anything that happens during the 5 minutes just before we fall asleep is typically lost from memory (Roth et al., 1988). This explains why sleep apnea patients, who repeatedly awaken with a gasp and then immediately fall back to sleep, do not recall the episodes. It also explains why dreams that momentarily awaken us are mostly forgotten by morning. To remember a dream, get up and stay awake for a few minutes.

"Follow your dreams, except for that one where you're naked at work." -Attributed to comedian Henny Youngman

Why We Dream

24-3 What are the functions of dreams?

Dream theorists have proposed several explanations of why we dream, including these:

To satisfy our own wishes. In 1900, in his landmark book *The Interpretation of Dreams,* Sigmund Freud offered what he thought was "the most valuable of all the discoveries it has been my good fortune to make." He proposed that dreams provide a psychic safety valve that discharges otherwise unacceptable feelings. He viewed a dream's **manifest content** (the apparent and remembered story line) as a censored, symbolic version of its **latent content,** the unconscious drives and wishes that would be threatening if expressed directly. Although most dreams have no overt sexual imagery, Freud nevertheless believed that most adult dreams could be "traced back by analysis to erotic wishes." Thus, a gun might be a disguised representation of a penis.

Freud considered dreams the key to understanding our inner conflicts. However, his critics say it is time to wake up from Freud's dream theory, which is a scientific nightmare. Based on the accumulated science, "there is no reason to believe any of Freud's specific claims about dreams and their purposes," observed dream researcher William Domhoff (2003). Some contend that even if dreams are symbolic, they could be interpreted any way one wished. Others maintain that dreams hide nothing. A dream about a gun is a dream about a gun. Legend has it that even Freud, who loved to smoke cigars, acknowledged that "sometimes, a cigar is just a cigar." Freud's wish-fulfillment theory of dreams has in large part given way to other theories.

To file away memories. The *information-processing* perspective proposes that dreams may help sift, sort, and fix the day's experiences in our memory. Some studies support this view. When tested the next day after learning a task, those deprived of both slow-wave and REM sleep did not do as well on their new learning as those who slept undisturbed (Stickgold et al., 2000, 2001). People who hear unusual phrases or learn to find hidden visual images before bedtime remember less the next morning if awakened every time they begin REM sleep than they do if awakened during other sleep stages (Empson & Clarke, 1970; Karni & Sagi, 1994).

Brain scans confirm the link between REM sleep and memory. The brain regions that buzz as rats learn to navigate a maze, or as people learn to perform a visual-discrimination

FYI

A popular sleep myth: If you dream you are falling and hit the ground (or if you dream of dying), you die. (Unfortunately, those who could confirm these ideas are not around to do so. Some people, however, have had such dreams and are alive to report them.)

"When people interpret [a dream] as if it were meaningful and then sell those interpretations, it's quackery." -Sleep researcher J. Allan Hobson (1995)

manifest content according to Freud, the remembered story line of a dream (as distinct from its latent, or hidden, content).

latent content according to Freud, the underlying meaning of a dream (as distinct from its manifest content).

task, buzz again during later REM sleep (Louie & Wilson, 2001; Maquet, 2001). So precise are these activity patterns that scientists can tell where in the maze the rat would be if awake. Others, unpersuaded by these studies, note that memory consolidation may also occur during non-REM sleep (Siegel, 2001; Vertes & Siegel, 2005). This much seems true: A night of solid sleep (and dreaming) has an important place in our lives. To sleep, perchance to remember.

This is important news for students, many of whom, observed researcher Robert Stickgold (2000), suffer from a kind of sleep bulimia—binge-sleeping on the weekend. "If you don't get good sleep and enough sleep after you learn new stuff, you won't integrate it effectively into your memories," he warned. That helps explain why high school students with high grades have averaged 25 minutes more sleep a night than their lower-achieving classmates (Wolfson & Carskadon, 1998).

FYI

Rapid eye movements also stir the liquid behind the cornea; this delivers fresh oxygen to corneal cells, preventing their suffocation.

To develop and preserve neural pathways. Perhaps dreams, or the brain activity associated with REM sleep, serve a *physiological* function, providing the sleeping brain with periodic stimulation. This theory makes developmental sense. As you will see in Unit IX, stimulating experiences preserve and expand the brain's neural pathways. Infants, whose neural networks are fast developing, spend much of their abundant sleep time in REM sleep (**FIGURE 24.3**).

To make sense of neural static. Other theories propose that dreams erupt from *neural activation* spreading upward from the brainstem (Antrobus, 1991; Hobson, 2003, 2004, 2009). According to one version, dreams are the brain's attempt to make sense of random neural activity. Much as a neurosurgeon can produce hallucinations by stimulating different parts of a patient's cortex, so can stimulation originating within the brain. These internal stimuli activate brain areas that process visual images, but not the visual cortex area, which receives raw input from the eyes. As Freud might have expected, PET scans of sleeping people also reveal increased activity in the emotion-related limbic system (in the amygdala) during REM sleep. In contrast, frontal lobe regions responsible for inhibition and logical thinking seem to idle, which may explain why we are less inhibited in our dreams than when awake (Maquet et al., 1996). Add the limbic system's emotional tone to the brain's visual bursts and—voila!—we dream. Damage either the limbic system or the visual centers active during dreaming, and dreaming itself may be impaired (Domhoff, 2003).

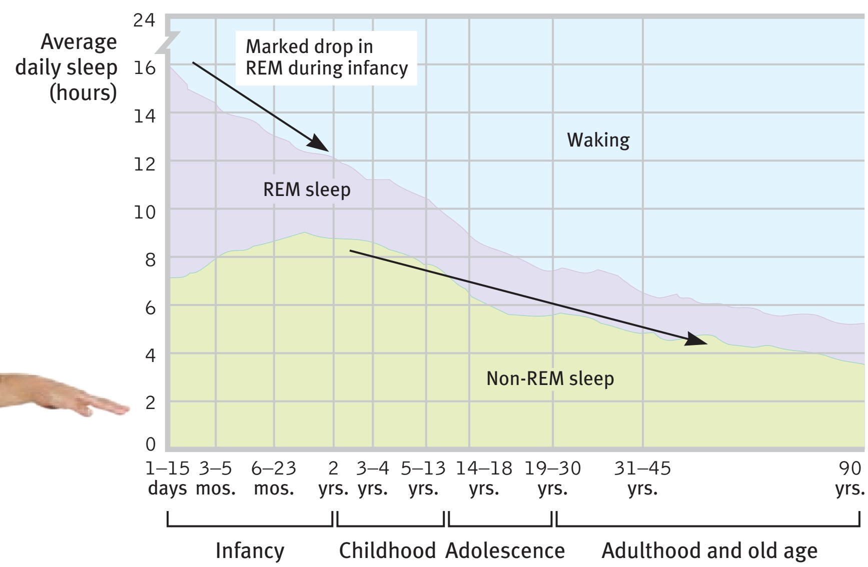
FYI

Question: Does eating spicy foods cause one to dream more? *Answer:* Any food that causes you to awaken more increases your chance of recalling a dream (Moorcroft, 2003).

Figure 24.3

Sleep across the life span As we age, our sleep patterns change. During our first few months, we spend progressively less time in REM sleep. During our first 20 years, we spend progressively less time asleep. (Adapted from Snyder & Scott, 1972.)

swissmacky/Shutterstock



To reflect cognitive development. Some dream researchers dispute both the Freudian and neural activation theories, preferring instead to see dreams as part of brain maturation and cognitive development (Domhoff, 2010, 2011; Foulkes, 1999). For example, prior to age 9, children's dreams seem more like a slide show and less like an active story in which the dreamer is an actor. Dreams overlap with waking cognition and feature coherent speech. They simulate reality by drawing on our concepts and knowledge. They engage brain networks that also are active during daydreaming. Unlike the idea that dreams arise from bottom-up brain activation, the cognitive perspective emphasizes our mind's top-down control of our dream content (Nir & Tononi, 2010).

TABLE 24.2 compares major dream theories. Although today's sleep researchers debate dreams' function—and some are skeptical that dreams serve any function—there is one thing they agree on: We need REM sleep. Deprived of it by repeatedly being awakened, people return more and more quickly to the REM stage after falling back to sleep. When finally allowed to sleep undisturbed, they literally sleep like babies—with increased REM sleep, a phenomenon called **REM rebound.** Withdrawing REM-suppressing sleeping medications also increases REM sleep, but with accompanying nightmares.

REM rebound the tendency for REM sleep to increase following REM sleep deprivation (created by repeated awakenings during REM sleep).

Most other mammals also experience REM rebound, suggesting that the causes and functions of REM sleep are deeply biological. That REM sleep occurs in mammals—and not in animals such as fish, whose behavior is less influenced by learning—also fits the information-processing theory of dreams.

So does this mean that because dreams serve physiological functions and extend normal cognition, they are psychologically meaningless? Not necessarily. Every psychologically meaningful experience involves an active brain. We are once again reminded of a basic principle: *Biological and psychological explanations of behavior are partners, not competitors.*

Table 24.2 Dream Theories

Theory	Explanation	Critical Considerations
Freud's wish-fulfillment	Dreams provide a "psychic safety valve"—expressing otherwise unacceptable feelings; contain manifest (remembered) content and a deeper layer of latent content—a hidden meaning.	Lacks any scientific support; dreams may be interpreted in many different ways.
Information-processing	Dreams help us sort out the day's events and consolidate our memories.	But why do we sometimes dream about things we have not experienced?
Physiological function	Regular brain stimulation from REM sleep may help develop and preserve neural pathways.	This does not explain why we experience meaningful dreams.
Neural activation	REM sleep triggers neural activity that evokes random visual memories, which our sleeping brain weaves into stories.	The individual's brain is weaving the stories, which still tells us something about the dreamer.
Cognitive development	Dream content reflects dreamers' cognitive development—their knowledge and understanding.	Does not address the neuroscience of dreams.

Before You Move On

▶ ASK YOURSELF

In some places, the school day for teenagers runs from 9:00 A.M. to 4:00 P.M. But in the United States, the teen school day often runs from 8:00 A.M. to 3:00 P.M., or even 7:00 A.M. to 2:00 P.M. Early to rise isn't making kids wise, say critics—it's making them sleepy. For optimal alertness and well-being, teens need 8 to 9 hours of sleep a night. So, should early-start schools move to a later start time, even if it requires buying more buses or switching start times with elementary schools? Or is this impractical, and would it do little to remedy the tired-teen problem?

▶ TEST YOURSELF

Are you getting enough sleep? What might you ask yourself to answer this question?

Answers to the Test Yourself questions can be found in Appendix E at the end of the book.

Module 24 Review

24-1 How does sleep loss affect us, and what are the major sleep disorders?

- Sleep deprivation causes fatigue and irritability, and it impairs concentration, productivity, and memory consolidation. It can also lead to depression, obesity, joint pain, a suppressed immune system, and slowed performance (with greater vulnerability to accidents).
- Sleep disorders include *insomnia* (recurring wakefulness); *narcolepsy* (sudden uncontrollable sleepiness or lapsing into REM sleep); *sleep apnea* (the stopping of breathing while asleep; associated with obesity, especially in men); *night terrors* (high arousal and the appearance of being terrified; NREM-3 disorder found mainly in children); sleepwalking (NREM-3 disorder also found mainly in children); and sleep talking.

24-2 What do we dream?

- We usually *dream* of ordinary events and everyday experiences, most involving some anxiety or misfortune.
- Fewer than 10 percent (and less among women) of dreams have any sexual content.
- Most dreams occur during REM sleep; those that happen during NREM sleep tend to be vague fleeting images.

24-3 What are the functions of dreams?

- There are five major views of the function of dreams.
- Freud's wish-fulfillment: Dreams provide a psychic "safety valve," with *manifest content* (story line) acting as a censored version of *latent content* (underlying meaning that gratifies our unconscious wishes).
- Information-processing: Dreams help us sort out the day's events and consolidate them in memory.
- Physiological function: Regular brain stimulation may help develop and preserve neural pathways in the brain.
- Neural activation: The brain attempts to make sense of neural static by weaving it into a story line.
- Cognitive development: Dreams reflect the dreamer's level of development.
- Most sleep theorists agree that REM sleep and its associated dreams serve an important function, as shown by the *REM rebound* that occurs following REM deprivation in humans and other species.

Multiple-Choice Questions

1. Sleep deprivation can lead to weight gain, reduced muscle strength, suppression of the cells that fight common colds, and most likely which of the following?

a Increased productivity
b. Depression
c. Decreased mistakes on homework
d. Increased feeling of well-being
e. Sleep apnea

2. What do we call the sleep disorder that causes you to stop breathing and awaken in order to take a breath?

a. Narcolepsy
b. Insomnia
c. Sleep apnea
d. Nightmares
e. Night terrors

3. Which of the following dream theories states that dreams help us sort out the day's events and consolidate our memories?

a. Information-processing
b. Wish-fulfillment
c. Physiological function
d. Neural activation
e. Neural disconnection

4. According to research, which of the following are we most likely to experience after sleep deprivation?

a. Night terrors
b. Sleep apnea
c. Manifest content dreams
d. Narcolepsy
e. REM rebound

Practice FRQs

1. Identify and briefly describe the three major sleep disorders experienced by adults.

Answer

2 points: Sleep apnea: stops breathing during sleep.

2 points: Narcolepsy: falls asleep suddenly.

2 points: Insomnia: can't fall asleep.

2. Explain the following two theories regarding why we dream. Include a criticism each faces:

- Freud's theory
- Neural activation theory

(4 points)