

Sleep Patterns and Sleep Theories



LEARNING TARGETS

23-1 What is *sleep*?

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. Although the roar of my [ND’s] neighborhood garbage truck leaves me undisturbed, my baby’s cry will shatter my sleep. The sound of your name can also cause your unconscious body to perk up. EEG recordings confirm that the brain’s auditory cortex responds to sound stimuli even during sleep (Kutas, 1990). And when you sleep, as when awake, you process most information outside your conscious awareness.

Now, by recording the brain waves and muscle movements of sleeping participants, and by observing and occasionally waking them, researchers are solving some of sleep’s deepest mysteries. 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 time 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

23-2 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 thanks to an internal biological clock called the **circadian rhythm** (from the Latin *circa*, “about,” and *diem*, “day”). As morning nears, body temperature rises; it then peaks during the day, dips for a time in early afternoon

- 23-1 Describe *sleep* as a state of consciousness.
- 23-2 Describe how our biological rhythms influence our daily functioning.
- 23-3 Describe the biological rhythm of our sleeping and dreaming stages.
- 23-4 Explain how biology and environment interact in our sleep patterns.
- 23-5 Describe sleep’s functions.

“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

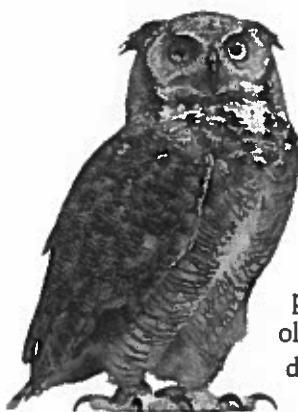
sleep a periodic, natural loss of consciousness—as distinct from unconsciousness resulting from a coma, general anesthesia, or hibernation. (Adapted from Dement, 1999.)

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

FYI

Some students sleep like the fellow who stayed up all night to see where the Sun went. (Then it dawned on him.)

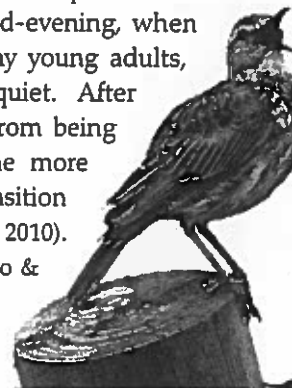
Eric Isselee/Shutterstock



(when many people take siestas or drink a caffeinated beverage and begins to drop again in the evening. Thinking and memor improve as we approach our daily peak in circadian arousal. Have you ever pulled an all-nighter? Do you recall feeling groggy in the middle of the night but with a sense of new alertness after the arrival of your normal wake-up time?)

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. After

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). In general, night owls tend to be smart and creative (Giampietro & Cavallera, 2007). Morning types tend to do better in school, take more initiative, be more punctual, and be less vulnerable to depression (Preckel et al., 2013; Randler, 2008, 2009; Werner et al., 2015).

**Sleep Stages****23-3** What is the biological rhythm of our sleeping and dreaming stages?

Sooner or later, sleep overtakes us all, 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 distinct sleep stages. This fact came to light when 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 machine 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** (rapid eye movement 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 is also socially contagious, stretches your neck muscles and increases your heart rate, which increases your alertness [Moorcroft, 2003].) When you are ready for bed, a 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 movement; **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

FYI

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

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.

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

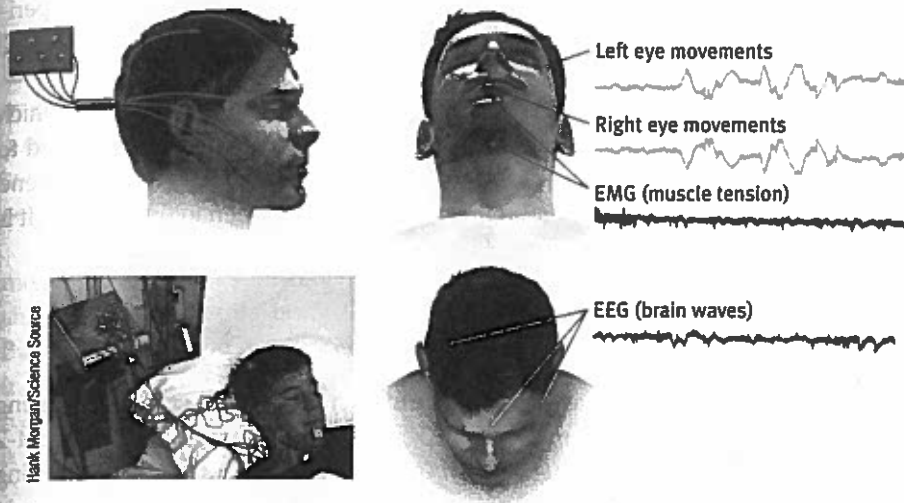


Figure 23.1
Measuring sleep activity

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

(Figure 23.3). This transition is marked by the slowed breathing and the irregular brain waves of non-REM stage 1 sleep. Using the American Academy of Sleep Medicine classification of sleep stages, this type of non-rapid eye movement sleep—NREM sleep—is called NREM-1 (Silber et al., 2007).

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 a sleep-deprived young man 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.

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 they were abducted by aliens—often shortly after getting into bed—commonly recall being floated off of or pinned down on their beds (Clancy, 2005; McNally, 2012).

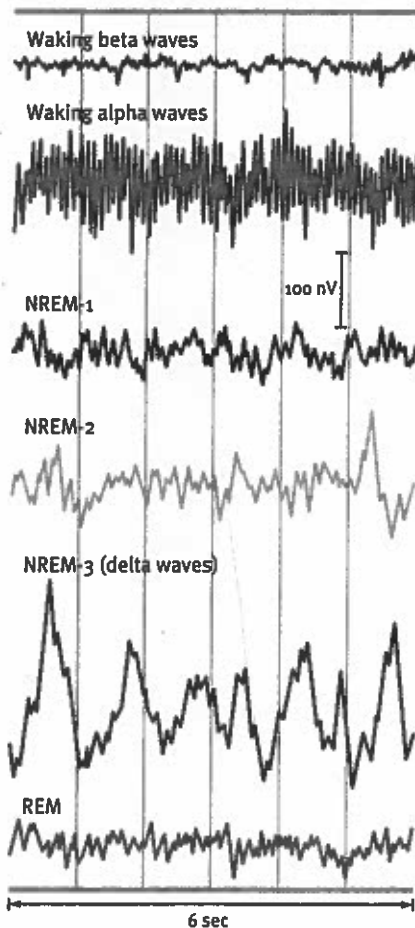


Figure 23.2
Brain waves and sleep stages

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 internally aroused during REM sleep than during NREM (non-REM) sleep.

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

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

hypnagogic sensations bizarre experiences, such as jerking or a feeling of falling or floating weightlessly, while transitioning to sleep.

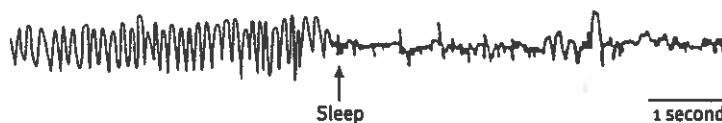


Figure 23.3
The moment of sleep

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

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

delta waves the large, slow brain waves associated with the deep sleep of NREM-3.

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. Although you could 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. Have you ever said, “That thunder was so loud last night!” only to have a friend respond, “What thunder?” Those who missed the storm may have been in delta sleep. (I bet at the end of this stage that children may wet the bed.)

REM Sleep

▶ Flip It Video: REM sleep

About an hour after you first fall asleep, a strange thing happens. Rather than continuing in deep slumber, you ascend from your initial sleep dive. Returning through NREM (where you’ll ultimately spend about half your night), you enter the most intriguing of the four sleep phases—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 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 closed eyes dart around in momentary bursts of activity. These eye movements announce the beginning of a dream—often emotional, usually story-like, and richly hallucinatory. Dreams are real, but REM sleep tricks your brain into responding as if you are actually watching a real scene (Andrillon et al., 2015). Because anyone watching a sleeper’s eyes can notice these REM bursts, it is amazing that science was ignorant of REM sleep until 1952.

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.

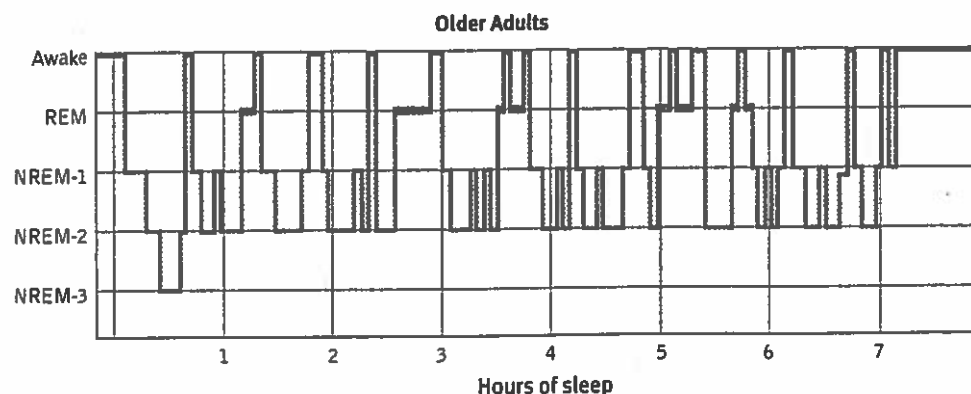
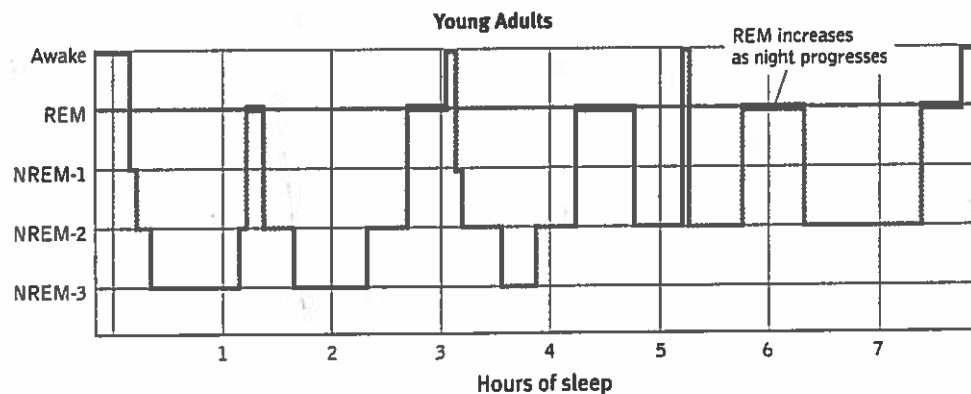


“Boy are my eyes tired! I had REM sleep all night long.”

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 & Gammack, 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. This clarification will help for the AP® exam.

During REM sleep, your brain's motor cortex is active, 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 for younger adults (with shorter, more frequent cycles for older adults). As the night goes on, deep NREM-3 sleep grows shorter and disappears, and 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. In sleep lab studies, 37 percent of participants have reported rarely or never having dreams that they “can remember the next morning” (Moore, 2004). Yet even they, more than 80 percent of the time, could 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.



Unhel Shal/Getty Images

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).

Safety in numbers? Communal sleeping provides added protection for those whose safety depends on vigilance. 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?

23-4 How do biology and environment interact in our sleep patterns?

True or false? “Everyone needs 8 hours of sleep.” *False*. Newborns often sleep two-thirds of their day, most adults no more than one-third (with some thriving on fewer than 6 hours nightly, others racking up 9 or more). There is more to our sleep differences than age. Some are awake between nightly sleep periods—sometimes called “first sleep” and “second sleep” (Randall, 2012). And some find that a 15-minute midday nap is as effective as another hour of nighttime sleep (Home, 2011).

Sleep patterns are genetically influenced. Researchers are tracking the sleep-regulating genes in humans and other animals (Hayashi et al., 2015; Mackenzie et al., 2015). Sleep patterns are also culturally influenced. In Britain, Canada, Germany, Japan, and the United States, adults average 7 hours of sleep a night on workdays, and 7 to 8 hours on other days (NSF, 2013). The weeknight sleep of many students and workers falls short of this average, however (NSF, 2008). Earlier school start times, more extracurricular activities, and a lack of parent-set bedtime leads American adolescents to get less sleep than their Australian counterparts (Short et al., 2013). Thanks to modern lighting, shift work, and social media diversions, many who might have gone to bed at 9:00 p.m. a century ago are now up until 11:00 p.m. or later. With sleep, as with waking behavior, biology and environment interact.

Whether for work or play, bright 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

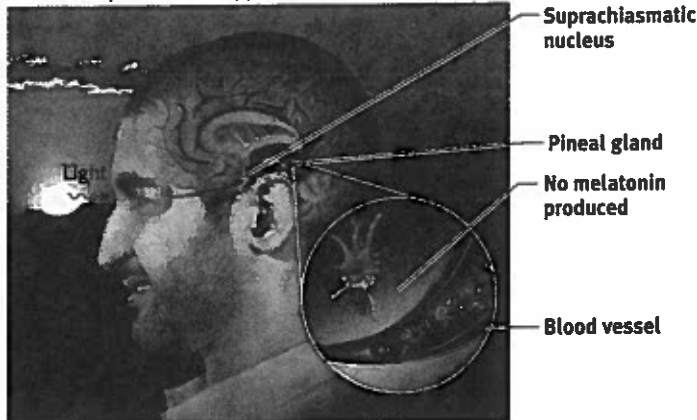
FYI

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?

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.

Melatonin production suppressed



Melatonin produced

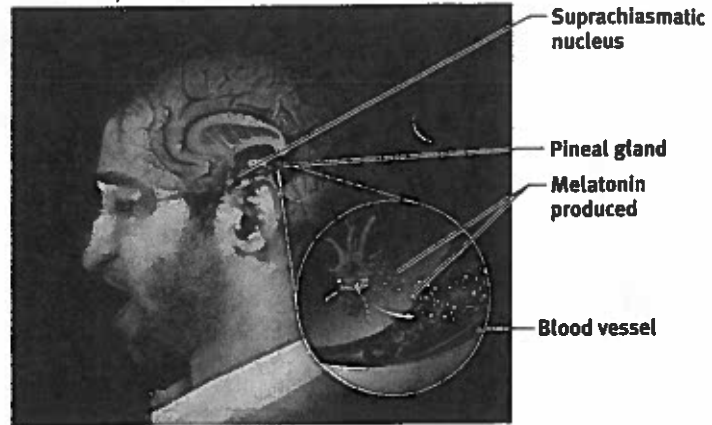


Figure 23.5

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.

clusters in the hypothalamus (Figure 23.5). The SCN does its job partly 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 (Chang et al., 2015; Gandhi et al., 2015).

Being bathed in (or deprived of) light disrupts our 24-hour biological clock (Czeisler et al., 1999; Dement, 1999). Night-shift workers may experience a chronic state of *desynchronization*. As a result, they become more likely to develop fatigue, stomach problems, heart disease, and, for women, breast cancer (Knutsson & Bøggild, 2010; Lin et al., 2015; Puttane et al., 2009). 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. Approximately 90 percent of Americans report using a light-emitting electronic device one hour before going to sleep (Chang et al., 2015). Such 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 & Termer, 1998). Like New Yorkers readjusting after a trip to California, they experience "social jet lag." 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).

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). A follow-up study found the greatest effect after eastbound travel (Song et al., 2017).

**Check Your Understanding****Ask Yourself**

► How does your need for sleep compare with that of others you know? Do you see age-related differences among your friends and family?

Test Yourself

- What are the four sleep stages, and in what order do we normally travel through those stages?
- Can you match the cognitive experience with the sleep stage?
- | | |
|-----------|----------------------|
| 1. NREM-1 | a. story-like dream |
| 2. NREM-3 | b. fleeting images |
| 3. REM | c. minimal awareness |
- The _____ nucleus helps monitor the brain's release of melatonin, which affects our _____ rhythm.

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

Why Do We Sleep?

23-5 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 offer five possible reasons:

1. **Sleep protects.** When darkness shut down the day's hunting, gathering, and travel, our distant ancestors were better off asleep in a cave, out of harm's way. Those who didn't wander around dark cliffs 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. Animals also sleep less, with no ill effects, during times of mating and migration (Siegel, 2012). (For a sampling of animal sleep times, see **Figure 23.6**.)
2. **Sleep helps us recuperate.** Sleep helps restore the immune system and repair brain tissue. Sleep gives resting neurons time to repair themselves, while pruning or weakening unused connections (Ding et al., 2016; Li et al., 2017). Bats and other animals with high waking metabolism burn a lot of calories, producing *free radicals*, molecules that are toxic to neurons. Sleep sweeps away this toxic waste (Xie et al., 2013). Think of it this way: When consciousness leaves your house, workers come in to clean, saying "Good night. Sleep tidy."
3. **Sleep helps restore and rebuild our fading memories of the day's experiences.** To sleep is to strengthen. Sleep *consolidates* our memories by replaying recent learning and strengthening neural connections (Pace-Schott et al., 2015; Yang et al., 2014). It reactivates recent experiences stored in the hippocampus and shifts them for permanent storage elsewhere in the cortex (Racsmány et al., 2010; Urbain et al., 2016). Adults, children, and infants trained to perform tasks therefore recall them better after a night's sleep, or even after a short nap, than after several hours awake (Friedrich et al., 2015; Sandoval et al., 2017; Seehagen et al., 2015). Older adults' more frequently disrupted sleep also disrupts memory consolidation (Boyce et al., 2016; Pace-Schott & Spencer, 2011). "Sleep less, think worse," summarizes one research team (Frenda & Fenn, 2016). After sleeping well, older people remember more of recently learned material (Drummond, 2010). Sleep, it seems, strengthens memories.
4. **Sleep feeds creative thinking.** Dreams can inspire noteworthy artistic and scientific achievements, such as the dreams that clued chemist August Kekulé to the structure of benzene (Ross, 2006) and inspired medical researcher Carl Alving (2011) to invent the vaccine patch. 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 difficult problems more insightfully than do those who stay awake (Barrett, 2011; Sio et al., 2013). They also are better at spotting connections among novel pieces of information (Ellenbogen et al., 2007; Whitehurst et al., 2016). To think smart and see connections, it often pays to ponder a problem just before bed and then sleep on it.

“Corduroy pillows make headlines.”

Anonymous

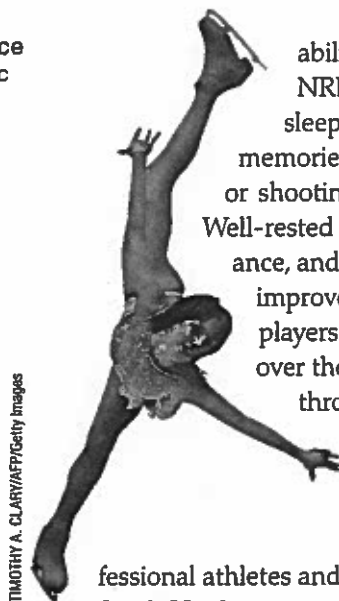
Figure 23.6
Animal sleep time

Would you rather be a brown bat and sleep 20 hours a day or a giraffe and sleep 2 hours a day? (Data from NIH, 2010.)



Ample sleep supports skill learning and high performance

This was the experience of Olympic gold medalist Sarah Hughes.



TIMOTHY A. CLARY/REUTERS/GETTY IMAGES

5. **Sleep supports growth.** During slow-wave sleep, which occurs mostly in the first half of a night's sleep, the pituitary gland releases human growth hormone, which is necessary for muscle development.

A regular full night's sleep can “dramatically improve your ability,” report James Maas and Rebecca Robbins (2010). REM sleep and NREM-2 sleep—which occur mostly in the final hours of a long night's sleep—also help strengthen the neural connections that build long-term memories, including the “muscle memories” learned while practicing tennis or shooting baskets. Sleep promotes both a strong body and a strong mind. 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 experience improved performance. One study of Stanford University men's basketball players found that when their average sleep increased 110 minutes per week over the course of several weeks, their sprint times decreased, and their free throw and 3-point shooting percentages both increased 9 percent (Lack et al., 2011). Swimmer Conner Jaeger, who won a silver medal at the 2016 Olympics, takes sleep seriously. “Part of our training that we really just started to focus on,” he said, “is sleep” (Mayberry, 2016).

Maas, who has been a sleep consultant for college and professional athletes and teams, also advised basketball's Orlando Magic and figure skater Sarah Hughes to cut their early-morning practices as part of a recommended sleep schedule. Soon thereafter, Hughes' performance scores increased, ultimately culminating in her 2002 Olympic gold medal.

✓ Check Your Understanding

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 are five proposed reasons for 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 What is *sleep*?

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

23-2 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.

23-3 What is the biological rhythm of our sleeping and dreaming stages?

- We cycle through four distinct sleep stages about 90 minutes:
 - NREM-1 sleep is the brief, near-waking sleep in which irregular brain waves we enter (after leaving the *waves* of being awake and relaxed); *hallucinations* (sensations such as falling or floating) may occur.
 - NREM-2 sleep, in which we spend about half our time, with its characteristic sleep spindles (bursts of rhythmic brain waves).
 - NREM-3 sleep is deep sleep, in which large, slow *waves* are emitted.

- REM (rapid eye movement) sleep is described as a paradoxical sleep stage because of internal arousal but external calm (near paralysis). It includes most dreaming and lengthens as the night goes on.

- During a normal night's sleep, NREM-3 sleep shortens and REM and NREM-2 sleep lengthens.

23-4 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.

- Being bathed in (or deprived of) light disrupts our 24-hour biological clock. Night-shift workers may experience a chronic state of desynchronization.

23-5 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.
- Sleep consolidates our memories by replaying recent learning and strengthening neural connections.
- Sleep promotes creative problem solving the next day.
- During slow-wave sleep, the pituitary gland secretes a human growth hormone necessary for muscle development.

Multiple-Choice Questions

- Which of the following represents a circadian rhythm?
 - A burst of growth occurs during puberty.
 - The sleep cycle is roughly 90 minutes long.
 - Our bodies sleep-wake on a roughly 24 hour schedule.
 - Our bodies become paralyzed when we enter REM sleep.
 - Pulse rate increases when we exercise.
- Shortly after falling asleep, James experiences the hypnagogic sensation of falling. It is most likely that he is in which stage of sleep?
 - Alpha
 - NREM-1
 - NREM-2
 - NREM-3
 - REM
- What is the role of the suprachiasmatic nucleus in sleep?
 - It induces REM sleep every 90 minutes.
 - It causes the pineal gland to increase the production of melatonin.
 - It causes the pituitary gland to increase the release of human growth hormone.
 - It causes the pituitary gland to decrease the release of human growth hormone.
 - It causes the pineal gland to decrease the production of melatonin.
- Which of the following sleep theories would best explain why athletes perform better after a full night's sleep?
 - Memory
 - Protection
 - Growth
 - Recuperation
 - Creativity
- Patrick has just entered REM sleep. Which of the following is he likely to experience?
 - Body paralysis
 - The sensation of falling
 - Delta waves
 - Alpha waves
 - Sleep spindles

Practice FRQs

1. Researchers have identified the brain waves associated with waking and sleeping stages. Explain which stage a person is in if researchers detect the following brain waves:

- Alpha waves
- Sleep spindles
- Delta waves

Answer

1 point: Alpha waves are present in an awake, relaxed state just before falling asleep. 🔄 Page 232

1 point: Sleep spindles appear during NREM-2 sleep. 🔄 Page 234

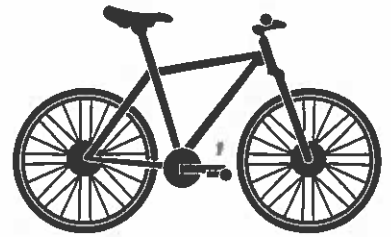
1 point: Delta waves appear during our deepest stage of sleep, NREM-3. 🔄 Page 234

2. A friend believes that sleep is not that important and that he can go several days without sleep with no ill effects. Use the following theories about why we sleep to explain some negative effects your friend might experience after missing a couple nights of sleep:

- Sleep helps us recuperate.
- Sleep helps us restore memories.
- Sleep supports growth.

(3 points)

Sleep Deprivation, Sleep Disorders, and Dreams



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: 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. This tiredness tendency has grown so steadily that some researchers have labeled current times the "Great Sleep Recession" (Keyes et al., 2015). After several 5-hour nights, we accumulate a sleep debt that 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. Allowed to sleep unhindered, most adults will sleep at least 9 hours a night (Coren, 1996). With that much sleep, we awaken refreshed, sustain better moods, and perform more efficiently and accurately. 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 or more per day, 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).

In one survey, 28 percent of high school students acknowledged falling asleep in class at least once a week (NSF, 2006). College and university students are also sleep deprived; 69 percent in one national survey reported "feeling tired" or "having little energy" on at least several days during the two previous weeks (AP, 2009). The going needn't get boring before students start snoring. For students, less sleep also predicts more conflicts in friendships and romantic

LEARNING TARGETS

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

24-2 Describe the most common content of dreams, and identify the functions theorists have proposed for dreams.



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FYI

In a 2013 Gallup poll, 40 percent of Americans reported getting 6 hours or less sleep a night (Jones, 2013).

Smartphones as sleep stealers:

“You wake up in the middle of the night and grab your smartphone to check the time — it’s 3 A.M. — and see an alert. Before you know it, you fall down a rabbit hole of email and Twitter. Sleep? Forget it.”

Nick Bilton, “Disruptions: For a Restful Night, Make Your Smartphone Sleep on the Couch,” 2014

**AP® EXAM TIP**

Make sure you get a good night’s sleep before the AP® exam!

relationships (Gordon & Chen, 2014; Tavernier & Willoughby, 2014). Tiredness triggers test anxiety (To assess whether you are one of the many sleep-deprived students, see Table 24.1.)

Sleep loss is also a predictor of depression (Baglioni et al., 2016). Researchers who surveyed 15,500 12- to 18-year-olds found that those who slept 5 or fewer hours a night had a 50 percent higher risk of depression than their peers who slept 8 hours or more (Gangwani et al., 2010). This link does not appear to reflect an effect of depression on sleep. When children and youth are followed through time, sleep loss predicts depression rather than 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 feel better the next day. And that may help to explain why parentally enforced bedtime rules predict less depression, and why pushing back school start times leads to improved adolescent sleep, alertness, and mood (Perkinson-Gloor et al., 2013; Winsler et al., 2015). Thus, European high schools rarely start before 9 A.M. (Fischetti, 2014). And the American Academy of Pediatrics (2014) advocates similarly delaying adolescents’ school start times to “allow students the opportunity to achieve optimal levels of sleep (8.5–9.5 hours).”

Sleep-deprived students often function below their peak. And they know it: Five out of five teens and three in five 18- to 29-year-olds wish they could get more sleep on weekdays (Mason, 2003, 2005). “Sleep deprivation has consequences—difficulty studying, diminished productivity, tendency to make mistakes, irritability, fatigue,” noted Dement (1999, p. 1). A large sleep debt “makes you stupid.” Yet that teen who staggers glumly out of bed in response to an unwelcome alarm, yawns through morning classes, and feels half-depressed

TABLE 24.1

Cornell University psychologist James Maas 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 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 and feel alert all day.” [Sleep Quiz reprinted with permission from James B. Maas, “Sleep to Win!” (Bloomington, IN: AuthorHouse, 2013).]

much of the day may be energized at 11:00 P.M. and unmindful of the next day's looming sleepiness (Carskadon, 2002).

Lack of sleep can also make you gain weight. Sleep deprivation

- increases *ghrelin*, a hunger-arousing hormone, and decreases its hunger-suppressing partner, *leptin* (Shilsky et al., 2012) (More on these in Module 38.)
- decreases metabolic (energy use) rate (Buxton et al., 2012).
- increases production of *cortisol*, a stress hormone that stimulates the body to make fat.
- enhances limbic brain responses to the mere sight of food and decreases cortical responses that help us resist temptation (Benedict et al., 2012; Greer et al., 2013; St-Onge et al., 2012).

Thus, children and adults who sleep less are heavier than average, and in recent decades people have been sleeping less and weighing more (Shiromani et al., 2012; Suglia et al., 2014). Moreover, experimental sleep deprivation increases appetite and eating; our tired brain finds fatty foods more enticing (Fang et al., 2015; Hanlon et al., 2015). So, sleep loss helps explain the weight gain common among sleep-deprived students (Hull et al., 2007).

Sleep also affects our physical health. When infections do set in, we typically sleep more, boosting our immune cells. Sleep deprivation can suppress immune cells that battle viral infections and cancer (Möller-Levet et al., 2013; Motivala & Irwin, 2007; Opp & Krueger, 2015). One experiment exposed volunteers to a cold virus. Those who averaged less than 5 hours' sleep a night were 4.5 times more likely to develop a cold than those who slept more than 7 hours a night (Prather et al., 2015). 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 (Dew et al., 2003; Parthasarathy et al., 2015; Scullin & Bliwise, 2015).

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 (Caldwell, 2012; Lim & Dinges, 2010). Slow responses can also spell disaster for those operating equipment, piloting, or driving. Drowsy driving has contributed to an estimated one in six American traffic accidents (AAA, 2010) and to some 30 percent of Australian highway deaths (Maas, 1999). One two-year study examined the driving accidents 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). 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 saving time and “fall back” to standard time. Searching millions of Canadian and U.S. records, Coren found that accidents increased immediately after the spring-forward time change, which shortens sleep (Figure 24.1).

The same spring-forward effect appeared in another study, which showed that tired people are more likely to “cyberloaf”—to fritter away time online. On the Monday after daylight saving time begins, entertainment-related Google searches have been 3.1 percent higher than on the preceding Monday, and 6.4 percent higher than on the following Monday (Wagner et al., 2012). On that “sleepy Monday,” U.S. judges also punish offenders with sentences that are 5 percent longer than average (Cho et al., 2017).

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, reduces obesity, fortifies the 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 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

“So shut your eyes
Kiss me goodbye
And sleep
Just sleep.”
My Chemical Romance, “Sleep”

Figure 24.1
Less sleep = more 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. (Data from Coren, 1996.)

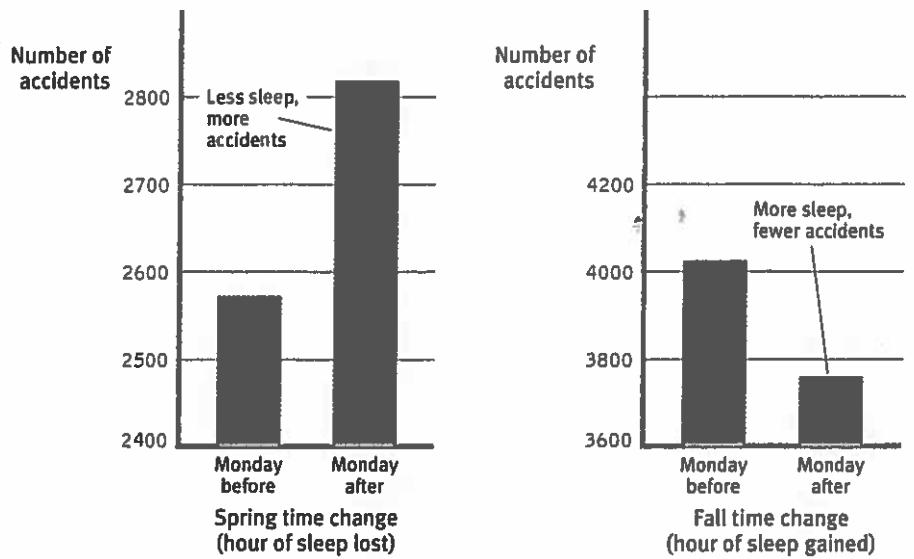
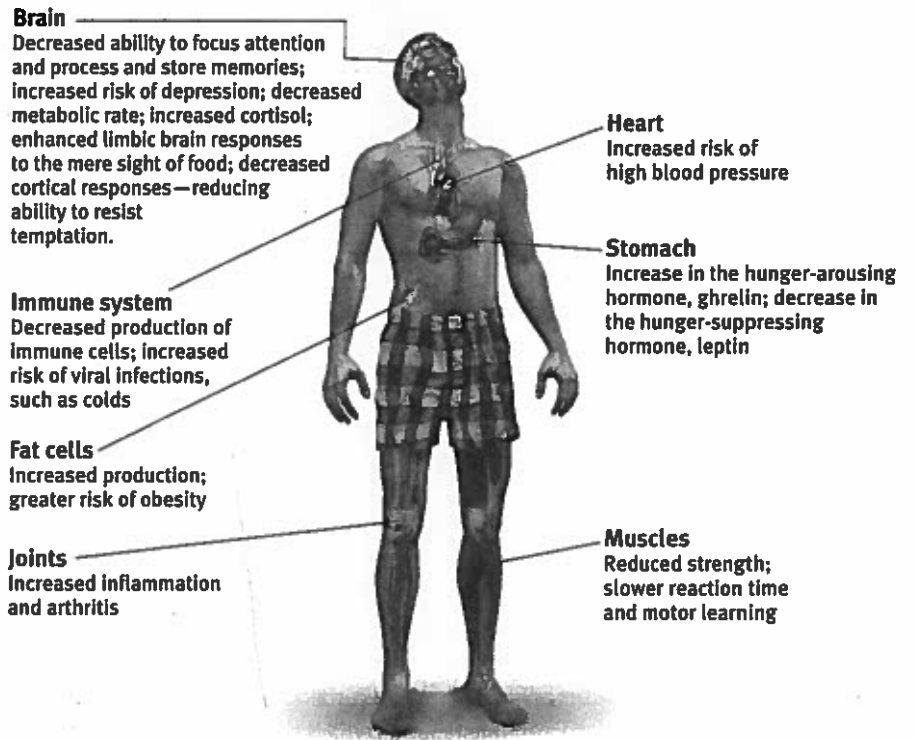


Figure 24.2
How sleep deprivation affects us



until you feel more like a rested and energized student and less like a zombie. Ignoring last text, resist the urge to check in with friends online, and succumb to sleep, the tyrant. For some additional tips on getting better quality sleep, see **Table 24.2**.

Major Sleep Disorders

Do you have trouble sleeping when anxious or excited? Most of us do. An occasional sleep is nothing to worry about. But about 1 in 10 adults, and 1 in 4 older adults, have **insomnia**—persistent problems in either falling or staying asleep (Irwin et al., 2006). This is tiredness and increased risk of depression (Baglioni et al., 2016). From middle age on, waking occasionally during the night becomes the norm, not something to fret over or treat with medication (Vitiello, 2009). Ironically, insomnia becomes worse when we fret about it. In laboratory studies, people with insomnia do sleep less than others. But they typically over-

Insomnia recurring problems in falling or staying asleep.

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 and avoiding screen time.
- Sleep on a regular schedule (rise at the same time even after a restless night) and avoid long naps.
- Hide time displays so you aren't tempted to check repeatedly.
- Reassure yourself that temporary sleep loss causes no great harm.
- Focus your mind on nonarousing, engaging thoughts, such as song lyrics or vacation travel.
- Manage stress. 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. Less stress = better sleep. (See Modules 43 and 44 for more on stress.)

How long it takes them to fall asleep and underestimate how long they actually have slept (Harvey & Tang, 2012). 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.

Falling asleep is not the problem for people with **narcolepsy** (from the Greek *narke*, “numbness,” and *lepsis*, “seizure”), who have sudden attacks of overwhelming sleepiness, usually lasting less than 5 minutes. Although treatable with medication and a sleep regimen, narcolepsy attacks can occur at the most inopportune times, often triggered by strong emotions—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).

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 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 sleep apnea, particularly among overweight men (Keller, 2007). Apnea-related sleep loss also contributes to obesity. In addition to loud snoring, other warning signs are daytime sleepiness, 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, the treatment—a masklike device with an air pump that keeps the sleeper's airway open (imagine a snorkeler at a slumber party)—can

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

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



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

Now I lay me down to sleep For many with sleep apnea, a continuous positive airway pressure (CPAP) machine applies mild air pressure to keep the airways open, making for sounder sleeping and better quality of life.



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.



AP® EXAM TIP

The AP® exam could have you identify and differentiate the sleep disorders. For example, you might be asked to explain the difference between a night terror and a nightmare.

effectively relieve apnea symptoms. By so doing, it can also alleviate the depression symptom that often accompany sleep apnea (Levine, 2012; Wheaton et al., 2012).

Unlike sleep apnea, **night terrors** target mostly children, who may sit up or stand around, talk incoherently, experience doubled heart and breathing rates, and appear terrified while asleep (Hartmann, 1981). They seldom wake up fully during an episode and remember little or nothing the next morning—at most, a fleeting, frightening image. Unlike 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 and *sleepwalking* are usually childhood disorders and, like narcolepsy, they run in families. Occasional childhood sleepwalking (also called *somnambulism*) occurs for about a third of those with a sleepwalking fraternal twin and half of those with a sleepwalking identical twin. The same is true for sleepwalking (Hublin et al., 1997, 1998). Sleepwalking happens during NREM-3 sleep. Sleepwalking—usually garbled or nonsensical—can occur during any sleep stage (Mahowald & Ettinger, 1990). 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, usually lasting 2 to 10 minutes; some 5 percent have repeated episodes (Giles et al., 1994). Young children who have the deepest and longest 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. (See Table 24.3 for a summary of these sleep disorders.)

TABLE 24.3 Sleep Disorders

Disorder	Rate	Description	Effects
<i>Insomnia</i>	1 in 10 adults; 1 in 4 older adults	Ongoing difficulty falling or staying asleep.	Chronic tiredness. Reliance on sleeping pills and alcohol, which reduce REM sleep and lead to tolerance—a state in which increasing doses are needed to produce an effect.
<i>Narcolepsy</i>	1 in 2000 adults	Sudden attacks of overwhelming sleepiness.	Risk of falling asleep at a dangerous moment. Narcolepsy attacks usually last less than 5 minutes, but they can happen at the worst and most emotional times. Everyday activities, such as driving, require extra caution.
<i>Sleep apnea</i>	1 in 20 adults	Stopping breathing repeatedly while sleeping.	Fatigue and depression (as a result of slow-wave sleep deprivation). Associated with obesity (especially among men).
<i>Sleepwalking and sleepwalking¹</i>	1–15 in 100 in the general population for sleepwalking; about half of young children for sleepwalking	Doing normal waking activities (sitting up, walking, speaking) while asleep. Sleepwalking can occur during any sleep stage. Sleepwalking happens in NREM-3 sleep.	Few serious concerns. Sleepwalkers return to their beds on their own or with the help of a family member, rarely remembering their trip the next morning.
<i>Night terrors</i>	1 in 100 adults; 1 in 30 children	Appearing terrified, talking nonsense, sitting up, or walking around during NREM-3 sleep; different from nightmares.	Doubling of a child's heart and breathing rates during the attack. Luckily, children remember little or nothing of the fearful event the next day. As people age, night terrors become more and more rare.

¹NSF, 2016; Reimão & Lefèvre, 1980.

✓ Check Your Understanding

Ask Yourself

► What did you know about sleep deprivation and sleep disorders before taking this course? Have you experienced any of the sleep loss effects or sleep disorders described?

Test Yourself

► A well-rested person would be more likely to have _____ (trouble concentrating/quick reaction times) and a sleep-deprived person would be more likely to _____ (gain weight/fight off a cold).

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

Dreams

24-2 What do we dream, and what functions have theorists proposed for dreams?

Soon playing at your inner theater: the premiere of a 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 you'll later marvel at its creation.

Daydreams tend to involve the familiar details of our life—perhaps picturing ourselves explaining to a teacher why an assignment will be late, or replaying in our minds personal encounters we relish or regret. Unlike daydreams, REM dreams are vivid, emotional, and often bizarre (Loftus & Ketcham, 1994). Waking from one, we may wonder how our brain can 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. Awakening from a nightmare, a 4-year-old may be sure there is a bear in the house.

Discovering the link between REM sleep and dreaming began a new era in dream research. Instead of relying on someone's hazy recall hours 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.



Photo: Warner Bros. Pictures

“I do not believe that I am now dreaming, but I cannot prove that I am not.”

Philosopher Bertrand Russell
(1872–1970)

dream a sequence of images, emotions, and thoughts passing through a sleeping person's mind.

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 discuss in Module 33.

What We Dream

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 include repeatedly failing in an attempt to do something; being attacked, pursued, or rejected; or 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, a dream's story line incorporates traces of previous days' experiences and preoccupations (De Koninck, 2000):

- **Trauma and dreams.** 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). Compared with Palestinian children living in a peaceful town in Galilee, those living in the conflict-ridden Gaza Strip more often dream of aggression (Punamäki & Joustie, 1998).

“For what one has dwelt on by day, these things are seen in visions of the night.”

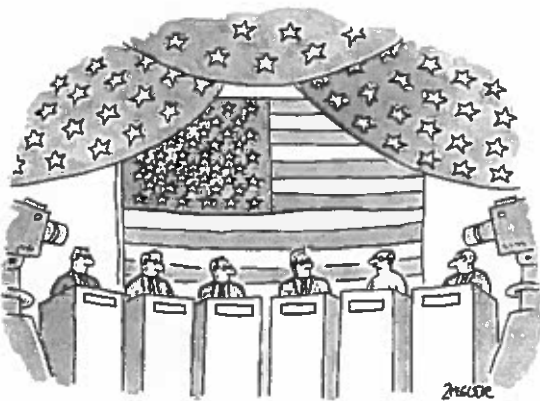
Menander of Athens (342–292 B.C.E.),
Fragments

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).

- **Musicians' dreams.** Compared with nonmusicians, musicians report twice as many dreams of music (Uga et al., 2006).
- **Blind people's dreams.** Studies in four countries have found blind people mostly dream of using their nonvisual senses (Buquet, 1988; Taha, 1972; Vekassy, 1977). But even native blind people sometimes “see” in their dreams (Bértolo, 2005). Likewise, people paralyzed below the waist sometimes dream of walking, standing, running, or cycling (Saurat et al., 2011; Voss et al., 2011).
- **Media experiences and dreams.** In a study of 1287 Turkish people, “participants who consumed violent media tended to have violent dreams, and participants who consumed sexual media tended to have sexual dreams” (Van den Buick et al., 2016).

© The New Yorker Collection, 2008, Jack Ziegler from cartoonbank.com. All Rights Reserved.



“Uh-oh. I think I’m having one of those dreams again.”

“Follow your dreams, except for that one where you’re naked at work.”

Attributed to comedian Henry Youngman

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.)

manifest content according to Freud, the symbolic, 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)

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

So, could we learn a foreign language by hearing it played while we sleep? If only. While sleeping we can learn to associate a sound with an electric shock (and to react to the sound accordingly). We can also learn to associate a particular sound with a pleasant or unpleasant odor (Domhoff et al., 2012). But we do not remember recorded information played while we are soundly asleep (Eich, 1990; Wyatt & Bootzin, 1994). In fact, any information 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 remember the episodes. Ditto someone who awakens momentarily, sends a text message, and then goes back to sleep; the next day can’t remember doing so. It also explains why dreams that momentarily awaken us are mostly forgotten by morning. To remember a dream, get up and stay awake for at least 15 minutes.

Why We Dream

▶ Flip It Video: Why Do We Dream?

Dream theorists have proposed several explanations of why we dream, including the wish-fulfillment theory. **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 that have 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 (often erotic) that would be threatened if expressed directly. Thus, a gun might be a disguised representation of a penis.

Freud considered dreams the key to understanding our inner conflicts. However, many modern critics say it is time to wake up from Freud’s dream theory, which they regard as a scientific nightmare. “There is no reason to believe any of Freud’s specific claims about the content of dreams and their purposes,” observed dream researcher William Domhoff (2003). Some critics maintain that even if dreams are symbolic, they could be interpreted any way one wished. “I will maintain that dreams hide nothing: A dream about a gun is a dream about a gun. I have had it that even Freud, who loved to smoke cigars, acknowledged that ‘sometimes, a dream 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 day after learning a task, those who had been deprived of both slow-wave and REM sleep did not do as well as those who had slept undisturbed (Stickgold, 2012). Other studies showed similar memory lapses for new material among people who were awakened every time they began REM sleep (Empson & Clarke, 1970; Karni & Sagi, 1994).

Brain scans confirm the link between REM sleep and memory. The brain regions that were active as rats learned to navigate a maze, or as people learned to perform a visual-discrimination task, became active again later during REM sleep (Louie & Wilson, 2001; Maquet, 2001). So precise were these activity patterns that scientists could tell where in the maze the rat would be if awake. 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—sleep deprived on weekdays and 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 slept about 25 minutes longer each night than their lower-achieving classmates (Wolfson & Carskadon, 1998; see **Figure 24.3**). Sacrificing sleep time to study actually *worsens* academic performance by making it harder the next day to understand class material or do well on a test (Gillen-O’Neel et al., 2013).

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 24.4**).

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 *activation-synthesis theory*, dreams are the brain’s attempt to synthesize 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. As Freud might have expected, PET scans of sleeping people also reveal increased activity in the emotion-related limbic system (in the amygdala) during emotional dreams (Schwartz, 2012). In contrast, frontal lobe regions responsible for inhibition and logical thinking seem to idle, which may explain why our dreams are less inhibited than we are when awake (Maquet et al., 1996). Add the limbic system’s emotional tone to the brain’s visual bursts and—Voilà!—we dream. Damage either the limbic system or the visual centers active during dreaming, and dreaming itself may be impaired (Domhoff, 2003).

“When people interpret [a dream] as if it were meaningful and then sell those interpretations, it’s quackery.”

Sleep researcher J. Allan Hobson (1995)

FYI

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

Figure 24.3
A sleeping brain is a working brain



(a)
 Learning

(b)
 Sleep consolidates our learning into long-term memory.

(c)
 Learning is retained.



swissmacky/Shutterstock

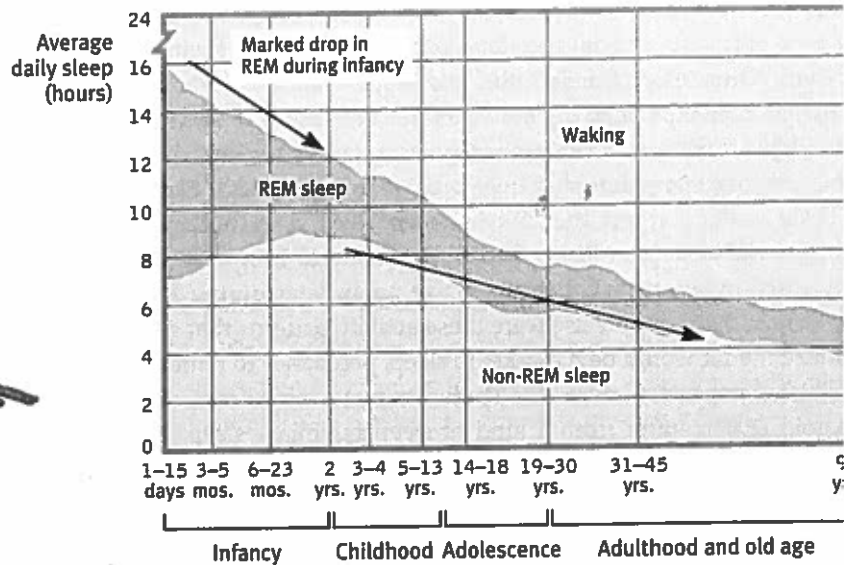


Figure 24.4
Sleep across the life span

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. (Data from Snyder & Scott, 1972.)

To reflect cognitive development. Some dream researchers prefer 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 action 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—and so may be viewed as intensified mind wandering, enhanced by visual imagery (Fox et al., 2013). 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). Dreams, says William Domhoff (2014), “dramatize our wishes, fears, concerns, and interests in striking scenarios that we experience as real events.”

Table 24.4 compares these major dream theories. Although today’s sleep researchers debate dreams’ function—and some are skeptical that dreams serve any function—it is one thing they agree on: We need REM sleep. Deprived of it by repeated awakenings,

TABLE 24.4 Dream Theories

Theory	Explanation	Critical Considerations
<i>Freud's wish-fulfillment</i>	Dreams preserve sleep and 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.
<i>Information-processing</i>	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 and about past events?
<i>Physiological function</i>	Regular brain stimulation from REM sleep may help develop and preserve neural pathways.	This does not explain why we experience <i>meaningful</i> dreams.
<i>Activation-synthesis</i>	REM sleep triggers neural activity that evokes random visual memories, which our sleeping brain weaves into stories.	But it’s <i>our</i> brain weaving the stories, so this still tells us something about ourselves.
<i>Cognitive development</i>	Dream content reflects dreamers’ level of cognitive development — their knowledge and understanding. Dreams simulate our lives, including worst-case scenarios.	Does not propose an adaptive function of dreams.

people return more and more quickly to the REM stage after falling back to sleep. When normally allowed to sleep undisturbed, they literally sleep like babies—with increased REM sleep, a phenomenon called **REM rebound**. 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—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.*

Dreams are a fascinating altered state of consciousness. But they are not the only altered states. As we will see next, psychoactive drugs also alter conscious awareness.

REM rebound the tendency for REM sleep to increase following REM sleep deprivation.

✓ Check Your Understanding

Ask Yourself

► In some countries, 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 switching start times with elementary schools? What do you think?

Test Yourself

- Are you getting enough sleep? What might you ask yourself to answer this question?
- What five theories propose explanations for why we dream?

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 *sleepwalking*.

24-2 What do we dream, and what functions have theorists proposed for dreams?

We usually *dream* of ordinary events and everyday experiences, most involving some anxiety or misfortune.

- Fewer than 10 percent of dreams among men, and fewer still among women, have any sexual content.
- Most dreams occur during REM sleep; those that happen during NREM sleep tend to be vague, fleeting images.
- 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.
 - Activation-synthesis: The brain attempts to make sense of neural static by weaving it into a story line.
 - Cognitive development: Dreams reflect the dreamer's cognitive development—their knowledge and understanding.
- 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

- 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?
 - Increased productivity
 - Depression
 - Decreased mistakes on homework
 - Increased feeling of well-being
 - Sleep apnea
- Shortly after falling asleep, and hundreds of times during the night, Paola wakes up after a loud "snore" of breath, because she has stopped breathing. With which sleep disorder would she most likely be diagnosed?
 - Narcolepsy
 - Insomnia
 - Sleep apnea
 - Nightmares
 - Night terrors
- Which of the following dream theories states that dreams help us sort out the day's events and consolidate our memories?
 - Information-processing
 - Wish-fulfillment
 - Physiological function
 - Neural activation
 - Neural disconnection
- After two nights without sleep, which of the following can be expected?
 - An increase in night terrors
 - Sleep apnea
 - Manifest content dreams
 - Narcolepsy
 - REM rebound
- Sigmund Freud believed that a dream's _____ content reflected the deep, underlying meaning of the dream.
 - manifest
 - dissociative
 - cognitive
 - latent
 - circadian

Practice FRQs

- Angelica was just hired for a new job in a day-care center. She has recently been under the care of her physician who is treating her for a sleep disorder. Indicate how her performance will be affected if she suffers from the following disorders:

- Sleep apnea
- Narcolepsy
- Insomnia

Answer

1 point: If Angelica suffers from sleep apnea, she may be tired and irritable at work because she is often waking up during the night to breathe. 🔄 Pages 245–246

1 point: If Angelica suffers from narcolepsy, she may suddenly fall asleep at work; this would most likely happen during an emotional moment. 🔄 Page 245

1 point: If Angelica suffers from insomnia, she will be tired during the day at work because she is having difficulty falling asleep or staying asleep at night. 🔄 Page 244

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

- Freud's wish-fulfillment theory
- Activation-synthesis theory

(4 points)