CONNECT CORE CONCEPTS IN HEALTH

SIXTEENTH EDITION

Claire E. Insel
California Institute of Human Nutrition

Walton T. Roth
Stanford University

Paul M. Insel
Stanford University

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PROVEN, SCIENCE-BASED CONTENT

Now in its Sixteen Edition, *Connect Core Concepts in Health* is written by experts who work and teach in the fields of exercise science, medicine, physical education, and health education. *Connect Core Concepts in Health* provides accurate, reliable, and current information on key health and wellness topics while also address issues related to mind-body health, research, diversity, and consumer health.

McGraw-Hill Education's digital and teaching learning tools are built on the solid foundation of *Connect Core Concepts in Health's* authoritative, science-based content. The Sixteenth Edition maintains important features on behavior change, personal reflection, critical thinking, and other key content and skills as well as the latest research, statistics, and a new chapter on sleep.

Assess Yourself provides assessments for students to use in analyzing their own health and health-related behavior.

Take Charge challenges students to take meaningful action toward personal improvement.

Critical Consumer helps students navigate the numerous and diverse set of health-related products currently available.

Diversity Matters discusses the ways that our personal and cultural backgrounds influence our health strengths, risks, and behaviors.

Wellness on Campus focuses on health issues, challenges, and opportunities that students are likely to encounter on a regular basis.

Behavior Change Strategy offers specific behavior management/modification plans related to the chapter topic.

Ask Yourself: Questions for Critical Thinking and Reflection encourages critical reflection on students' own health-related behaviors.

Quick Stats updated for the Sixteenth Edition, focus attention on particularly striking statistics related to the chapter content.

Tips for Today and the Future end each chapter with a quick, bulleted list of concrete actions readers can take now and in the near future.

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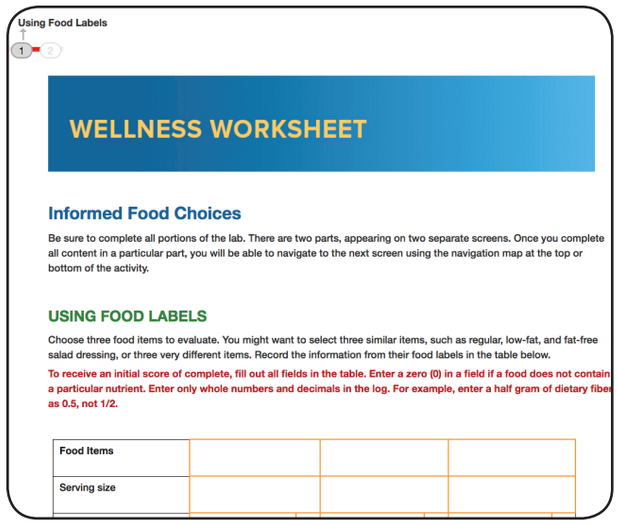

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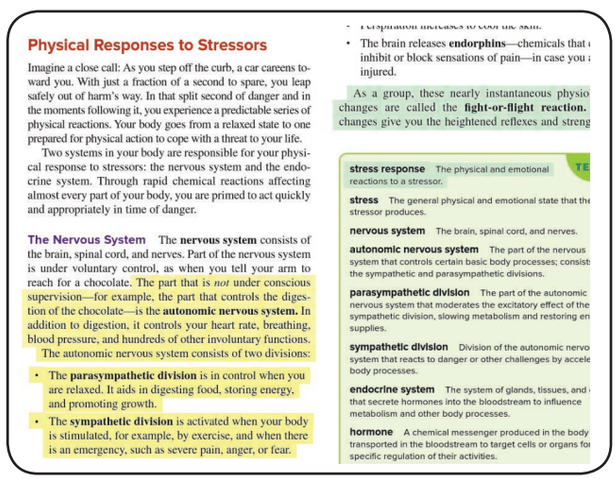
New to this edition, SmartBook is now optimized for phones and tablets. Its interactive features are also accessible for students with disabilities Just like our new ebook and ReadAnywhere app, SmartBook is available both online and offline.



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connect INSIGHT

Connect Insight® is Connect's one-of-a-kind visual analytics dashboard—available for both instructors and students—that provides at-a-glance information regarding student performance, which is immediately actionable. By presenting assignment, assessment, and topical performance results together with a time metric that is easily visible for aggregate or individual results, Connect Insight enables users to take a just-in-time approach to teaching and learning, which was never before available. Connect Insight presents data that empower students and help instructors to improve class performance in a way that is efficient and effective.

WHAT'S NEW IN *CONNECT CORE CONCEPTS IN HEALTH, SIXTEENTH EDITION?*

The Sixteenth Edition focuses on the following: new digital assets in Connect designed to help students succeed in the course, a new sleep chapter, and other current chapter content changes informed by student data.

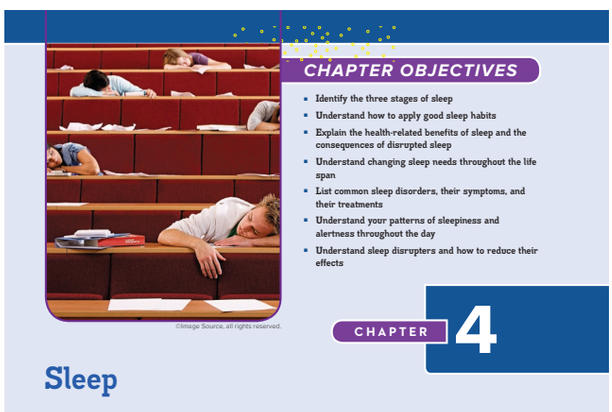
NEW DIGITAL ASSETS IN CONNECT

New to this edition are assignable and assessable **Concept Clips,** which help students to master key personal health concepts. Using colorful animation and easy-to-understand audio narration, Concept Clips provide step-by-step presentations to promote student comprehension. Topics include the stages of change model, diabetes types and metabolism, changes to the Nutrition Facts label, the cardiorespiratory system, and the stress response.

Also new are **NewsFlash** activities, which tie current news stories to key personal health concepts. After interacting with a contemporary news story, students are assessed on their understanding and their ability to make the connections between real-life events and course content. Examples of NewsFlash include topics such as hands-only CPR, reducing sun damage, and vaccination rates.

NEW SLEEP CHAPTER

A new chapter on sleep covers a comprehensive discussion of sleep stages, cycles, and drives; sleep across the life span; and the relationship between sleep and health. In addition, the chapter provides guidance for identifying sleep disrupters and addressing the social and biological influences on sleep.



CHAPTER-BY-CHAPTER CHANGES—INFORMED BY STUDENT DATA

The authors revised in response to student heat-map data derived from SmartBook that pinpointed the topics and concepts that students struggle with the most. This heat map–directed revision is reflected primarily in Chapters 6, 7, 11, 13, and 19.

Chapter 1: Taking Charge of Your Health

- New discussion of life span and life expectancy, including major genetic, environmental, and lifestyle factors.
- Updated explanation of the Affordable Care Act and changes to health care law.
- Expanded discussion of how to select health insurance, with a focus on the importance of the 10 essential benefits.
- Improved overview of environmental health factors.
- Updated "Vital Statistics" about public health, lifestyle factors, leading causes of death, and life expectancy.

Chapter 2: Stress: The Constant Challenge

- Enhanced discussion of personality and resilience.
- Revised explanations of the general adaptation syndrome and allostatic load.
- Updated discussion of the impact of stress on physical health.
- New discussions of social stressors, including the impact of digital technology, social media, and challenging social situations.
- New sections covering traumatic stressors and biofeedback.

Chapter 3: Psychological Health

- Updated discussion of developing a unified sense of self.
- Revised discussion of ethnicity, culture, and psychological self, including the topics of hybrid identity and multiculturalism.

Chapter 4: Sleep

- New chapter on sleep includes comprehensive discussion of sleep stages, cycles, and drives; sleep across the life span; sleep disorders, including insomnia, restless leg syndrome, sleep apnea, and narcolepsy; and the relationship between sleep and health.
- It also provides three detailed steps and accompanying tools to help students adopt a healthy sleep program.
- Includes guidance for identifying sleep disrupters and addressing social and biological influences on sleep.

Chapter 5: Intimate Relationships and Communication

- Updated discussion of social media and digital communication.
- Updated data on marriage, singlehood, and family living arrangements, and related attitudes.

Chapter 6: Sex and Your Body

- New content to address a spectrum of gender identities.
- New "Diversity Matters" box explores current, accepted language for genders and new discussion of transgender versus cisgender people.
- Updated section about gender roles and sexual orientation.
- Updated discussions of puberty, andropause, and sexual dysfunctions.

Chapter 7: Contraception

- Updated discussion of the relationship between unplanned pregnancy and college dropout rates.
- Updated discussion of long-acting reversible contraception and short-acting reversible contraception, including revised side effects and risks of oral contraceptives.

Chapter 8: Abortion

- Updated data on pregnancy, birth, and abortion rates, as well as data on women's age and gestation period.
- Updated discussion of potential physical effects of abortion and legality of abortion procedures.

Chapter 9: Pregnancy and Childbirth

- Updated data on the costs to raise a child.
- Revised discussion of pluripotency and the first trimester.
- Updated discussion of guidelines and recommendations for physical activity during pregnancy.

Chapter 10: Drug Use and Addiction

- Updated "Vital Statistics" on nonmedical drug use.
- Revised discussion of the APA's definition of addiction and the preferred terms.
- New information about the heroin and opioid epidemic, including an updated discussion of syringe-exchange programs and college-aid opioid users. Updated overdose and use addiction data.
- New discussion of kratom, a stimulant used to aid opioid withdrawal.

Chapter 11: Alcohol: The Most Popular Drug

- New material on alcoholic energy drinks and the effects of combining caffeine and alcohol.
- Updated data on alcohol-related deaths, trends, and risk factors.

Chapter 12: Tobacco Use

- Expanded data and discussion of young adult and LGBT tobacco use and trends.
- Updated discussion of hookah and smokeless tobacco, including snuff, snus, lozenges, and chewing tobacco.
- Added discussion of thirdhand smoke, including the toxicity, sources, and effects of tobacco residue.
- Updated discussion of the effects of smoking bans, cigarette taxes, and warning labels, including new references and updated data. New material on FDA regulations introduced in 2018.
- Updated information on cigarette-industry lobbying and political funding.

Chapter 13: Nutrition Basics

- Updated information about shelf-stable and processed foods, including those containing hydrogenated oils, saturated fats, and trans fats.
- Expanded discussion of vegetarian and plant-based diets.
- Updated information on new nutrition labels, including an explanation of changes regarding added sugars, calories from fat, nutrient daily values, and serving sizes.

Chapter 14: Exercise for Health and Fitness

- Expanded discussion of the FITTP model of exercise, which includes the significance of frequency, intensity, time, type, and progression of physical activity.
- Updated discussion of how individual differences influence physical fitness, body composition, and exercise capacity.

Chapter 15: Weight Management

- Updated data on the prevalence of obesity and the frequency of physical activity in the United States.

- Revised explanation of how body fat and body composition can differ among individuals and how this can be assessed.
- Updated discussion of how the hormones leptin and ghrelin influence appetite and body weight.

Chapter 16: Cardiovascular Health

- Updated discussion of cardiovascular disease, including symptoms, types, prevalence, and risk factors.
- Revised material on blood pressure readings to account for new guidelines and thresholds for elevated blood pressure and hypotension. Includes a discussion of how the new guidelines and targets affect public health trends.

Chapter 17: Cancer

- Updated discussion of the relationship between smoking rates and cancer death rates; updated data. Explanation of what this trend suggests and updated "Vital Statistics" about different types of cancer attributed to smoking.
- Revised explanation of PSA screening for prostate cancer, including how the test works, why it is controversial, and when it is appropriate.
- Updated discussion of specialized and experimental treatments, including immunotherapies, hormone therapies, and stem cell transplants. New discussion of targeted therapy, liquid biopsies, and the relationship between cancer and oxygen.

Chapter 18: Immunity and Infection

- Updated discussion of the different cell types in the immune system, including a new figure illustrating how antigens and immune cells work.
- Updated discussion of contagion, including an explanation of symptomatic and asymptomatic states.
- New material explaining the microbiome and the significance of gut microbiota.
- Updated information on vaccination, including for influenza, shingles, and hepatitis A and B.
- New information about the dangers of the raw water movement and the efficacy of the Safe Drinking Water Act and modern water treatment.
- Updated information about malaria, toxoplasmosis, and West Nile virus.

Chapter 19: Sexually Transmitted Infections

- Updated "Vital Statistics" on STI cases estimated annually. Updated prevalence data among high-risk groups and data on HIV-status awareness. New information about preexposure prophylaxis (PrEP).
- Updated chlamydia symptoms and treatment for epididymitis and proctitis. New section about lymphogranuloma vereneum (LGV) and trichomoniasis.
- Revised content on hepatitis C, including risk, public health trends, and history.

Chapter 20: Environmental Health

- Updated section on climate change and atmospheric ozone, including global political events, such as the U.S. withdrawal from the Paris Agreement.
- Updated information on water safety and efficiency, including a discussion of the Flint, Michigan, water crisis and the Cape Town, South Africa, water shortage.
- New information about the risks of pesticide exposure and the differences between organic and conventional produce.

Chapter 21: Conventional and Complementary Medicine

- Revised information about alternative medical treatments, including yoga, chiropractic, acupuncture, and other therapies. Includes updated trends on U.S. spending on complementary health approaches.
- Revised section on insurance and ACA coverage of complementary and alternative medicines (CAMs) and therapies.

Chapter 22: Personal Safety

- Updated content on the effects of prescription and over-the-counter medications and marijuana on driving. New material on the effects of drugs and alcohol on pedestrian behavior and safety.
- Revised section on defensive driving strategies.
- Updated information on workplace injuries and illnesses. New supporting statistics.
- New information about sexual abuse and risks on college campuses, including the role of peer support and misogyny.
- Updated content on hate crimes and the role of race in killings. New information on school violence and gun violence, including updated statistics.

Chapter 23: Aging: A Vital Process

- Updated explanation of the different types of aging humans experience (including biological, psychological, and social aging). Includes examples of these experiences and a discussion of their effects.
- Revised discussion of physical activity guidelines for different life stages.
- Revised discussion of chronic diseases in common among elderly people, including updated prevalence rates.
- New section about cognitive impairment, including updated material on Alzheimer's disease, vascular dementia, and Lewy-body dementia. Includes symptoms, prevalence rates, and risk factors for each.
- Updated statistics about poverty, lifestyle risks, and education levels among the elderly.

Chapter 24: Dying and Death

- Revised explanation of advance directives, living wills, and health care proxies, including guidelines for when each is appropriate and how to create them. Revised material about organ donation.

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INSTRUCTOR RESOURCES

Instructor resources available through Connect for *Connect Core Concepts in Health* include a Test Bank, Image Bank, and PowerPoint presentations for each chapter. All test questions are available within TestGen™ software. PowerPoint presentations are now WCAG compliant.

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ACADEMIC CONTRIBUTORS

Anna Altshuler, MD, MPH
California Pacific Medical Center
Abortion

Melissa Bernstein, PhD, RD, LD, FAND
Chicago Medical School
Nutrition Basics
Weight Management

Kamilee Christenson, MD
Stanford University
Contraception

Chwen-Yuen Angie Chen, MD, FACP, FASAM
Internal and Addiction Medicine, Stanford University
Drug Use and Addiction

Tom Fahey, EdD
California State University–Chico
Exercise for Health and Fitness

Nancy Kemp, MD, MA
Board Certified in Hospice and Palliative Medicine
Dying and Death

Christine Labuski, PhD
Virginia Tech
Sex and Your Body

Niklas Mattsson, MD, PhD
Lund University, Sweden
Aging: A Vital Process

Candice McNeil, MD, MPH
Wake Forest Health Sciences
Sexually Transmitted Infections

Michael Joshua Ostacher, MD, MPH, MMSc
Stanford University School of Medicine
Psychological Health

Johanna Rochester, PhD
The Endocrine Disruption Exchange
Alcohol: The Most Popular Drug
Environmental Health

Heidi Roth, MD
University of North Carolina–Chapel Hill
Sleep

Pir Rothenberg, PhD
California Institute of Human Nutrition
Conventional and Complementary Medicine
Personal Safety

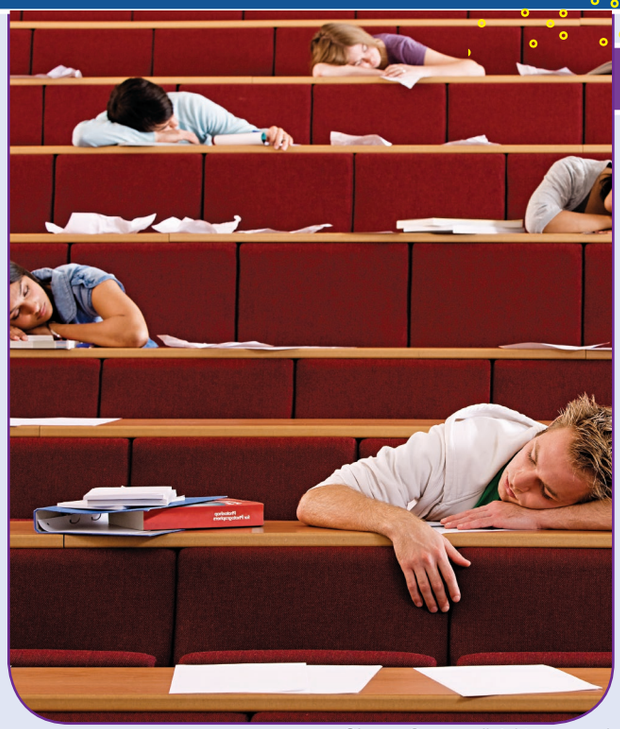
Jonathan Schwartz, MD
University of North Carolina–Chapel Hill
Cardiovascular Health

Jeroen Vanderhoeven, MD
Swedish Medical Center
Pregnancy and Childbirth

Martha Zuniga, PhD
University of California–Santa Cruz
Immunity and Infection

ACADEMIC ADVISORS AND REVIEWERS

Phoebe Ajibade, North Carolina A&T State University
Jeremy Barnes, Southeast Missouri State University
Dipavali Bhaya, Bucks County Community College
Amanda Brace, Towson University
Bruce Ferguson, Taft College
Kathy Lyn Finley, Indiana University, Bloomington
Dave Opon, Joliet Junior College
Natascha Romeo, Wake Forest University
Karla Rues, Ozarks Technical Community College
Marcia Seyler, California Institute of Human Nutrition
Sharon Woodard, Wake Forest University



CHAPTER OBJECTIVES

- Identify the three stages of sleep
- Understand how to apply good sleep habits
- Explain the health-related benefits of sleep and the consequences of disrupted sleep
- Understand changing sleep needs throughout the life span
- List common sleep disorders, their symptoms, and their treatments
- Understand your patterns of sleepiness and alertness throughout the day
- Understand sleep disrupters and how to reduce their effects

CHAPTER 4

Sleep

TEST YOUR KNOWLEDGE

1. **During sleep, the brain shuts down and remains inactive until awakening.**
   True or False?
2. **Adults need less and less sleep as they age.**
   True or False?
3. **Insufficient sleep is associated with which of the following conditions:**
   a. Depression
   b. Obesity
   c. Cardiovascular disease
4. **Staying awake for 20 hours impairs cognition to an extent comparable with a blood alcohol level of**
   a. 0.02%
   b. 0.04%
   c. 0.08%
5. **Humans are biologically programmed to be awake during the day and to sleep at night.**
   True or False?

ANSWERS

1. **FALSE.** The brain is highly active during sleep, strengthening important neural connections vital to memory, learning, and creative thinking.
2. **FALSE.** Adults need 7–9 hours of sleep each night throughout their lifetime. For many people, however, the ability to attain this much sleep each night becomes more difficult with age.
3. **ALL THREE.** Insufficient sleep is associated with psychiatric disorders, metabolism, and cardiovascular diseases.
4. **C.** Going without sleep for 20 hours is comparable to being legally drunk in most states.
5. **TRUE.** Those who work night shifts and sleep during the day are more prone to certain diseases and disorders.

We spend almost one-third of our lives asleep, but few of us understand what sleep is for and why it is necessary for our health. Since we are mostly unconscious during sleep, it is not uncommon to feel that we could be better off if we did not need sleep, and it can be tempting to cut back on sleep to make more time for entertainment or work. As we learn more about how sleep promotes all aspects of our health, however, we see that we should make every effort to avoid missing it. Recent data show that, like nutrition and physical fitness, sufficient sleep, in both quality and quantity, is vital to a healthy life. Developing good sleep habits and recognizing our own biological needs can enable each of us to develop sleep practices that will support our cognitive abilities, immune function, and general well-being.

SLEEP BIOLOGY

Sleep affects almost all systems of the body, including the respiratory, cardiovascular, endocrine, gastrointestinal, urinary, and nervous systems. When we fall asleep, our heart rate and respiratory rates slow, our blood pressure drops, and our body temperature declines. Our consciousness is also profoundly changed during sleep. We are less responsive to the surrounding environment, and we experience fantastical dreams.

Sleep Stages

Even though we are not conscious when we are sleeping, our brains are still active. Sleep is divided into distinct stages characterized by different patterns of electrical brain activity. The way these patterns come together is called *sleep architecture*, and it changes over the course of the life span.

Brain activity during sleep is typically measured by a monitoring device called an **electroencephalogram (EEG).** During wakefulness, when a person is quietly resting with eyes closed, the EEG shows a pattern called the alpha rhythm. This pattern is characterized by regular brain waves that occur 8–10 times per second. These brain waves change, and different parts of the brain are activated or suppressed as a person progresses through the three stages of sleep.

Sleep's resemblance to the loss of consciousness at the end of life was portrayed in Greek mythology. Sleep and death were personified by twin brothers Hypnos and Thanatos. ©akg-images/Newscom

Stages I–III: NREM Sleep The first three stages of sleep are grouped together as **non–rapid eye movement (NREM) sleep**. The purpose of NREM sleep remains mysterious, but theories suggest that it facilitates information processing and improves neural connections. NREM sleep is also thought to help with cell restoration and repair. Because all functions of the body are slowed, all stages of sleep are necessary for conserving energy and for providing time for the body to recover from activities that take place during wakefulness.

STAGE I When people first fall asleep, they enter the lightest stage of sleep, Stage I. The alpha rhythm of wakefulness gives way to a theta rhythm, characterized by slower brain waves and varying brain activity (Figure 4.1). Different people show different activity, and the same person's brain can act differently on different days. Sometimes it is hard to differentiate between a person's awake state and Stage I. A certain pattern of slowed roving eye movements behind closed eyelids can also be seen in Stage I sleep if, for example, you're driving and start to fall asleep. Respiration is more regular during Stage I sleep than during wakefulness. Muscles relax and may twitch. People do not respond quickly to the environment, but they may awaken easily and might not even be aware that they had fallen asleep.

STAGE II Deeper than Stage I but still a light sleep is the next stage of sleep, Stage II. At this point, the heart rate slows and body temperature drops. While sleeping, adults spend the most time in Stage II, which suggests that it is important, although researchers do not fully understand why. In Stage II sleep, the EEG shows different kinds of brain waves bursting in synchrony (see Figure 4.1). Some look like tight bunches of rapid spikes that last one or two seconds. These waves appear only during NREM sleep, and they occur most often in Stage II. Others are long, large waves that can occur spontaneously or as a reaction to some external stimulus, such as a noise in the room. But in this stage of sleep, sensory stimuli from the environment can no longer reach the higher-level brain centers, meaning people are not as responsive. If awakened, people in Stage II are more likely to know they had been asleep.

TERMS

electroencephalogram (EEG) A monitoring device that records brain activity.

non–rapid eye movement (NREM) sleep Of two main sleep phases, the phase that constitutes three substages, including one with the deepest sleep and with slow-wave brain activity.

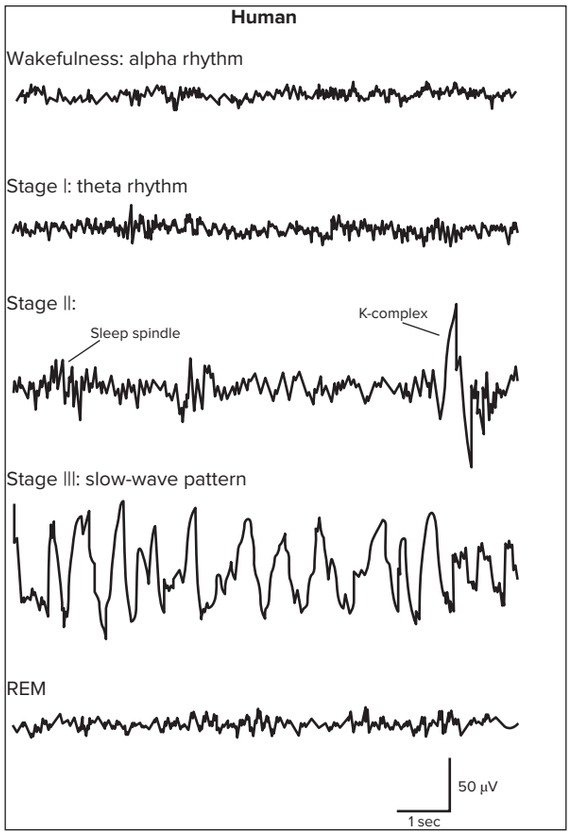


FIGURE 4.1 EEG patterns change with each stage of sleep.

STAGE III Stage III is the deepest stage of sleep and the one most necessary for feeling well rested upon waking. It is also believed to be the stage that supports the most restorative functions, such as rejuvenating actions like synthesizing proteins or managing stress. The length of this stage increases after physical exercise or extended periods without sleep.

In this **slow-wave sleep,** brain waves are synchronized and slow, like large waves in the ocean. In slow-wave sleep, or deep sleep, it is difficult for us to wake up quickly and, if awakened, we may at first be confused for several minutes. Parts of the brain associated with memory, learning, and other cognitive functions can become active during Stages II and III.

REM Sleep

The final stage of sleep is **rapid eye movement (REM) sleep**. REM sleep is named for periods during which the eyes under closed lids move quickly, similar to a person who is awake. This is when most dreaming occurs. Although it can be difficult to wake people from REM sleep, once awake they are usually oriented to their surroundings and not confused.

Unlike the synchronized brain waves of NREM sleep, in REM sleep the brain exhibits electrical activity that is indistinguishable from the alpha rhythm of relaxed or drowsy wakefulness or even the beta rhythm of a fully aroused person engaged in complex thinking. Some regions of the brain are up to 30% more active during REM than during wakefulness. This is especially evident in parts of the brain that are related to emotions. Blood pressure, respiration, and heart rates rise. In contrast, muscles in the limbs relax completely because the body is prevented from moving during dreaming, a form of paralysis.

Sleep Cycles

When people fall asleep, they first cycle through the three stages of NREM sleep, possibly repeating Stage II after completing Stage III. This is followed by a period of REM sleep, which is always the final stage in the sleep cycle. From beginning to end, the sequence lasts about 90 minutes, and then the cycle repeats (Figure 4.2). During one night of sleep, a person may go through four to five cycles, but the cycles differ somewhat over the course of the night. The slow-wave periods of Stage III are longer in the first part of the night, and the REM periods are longer in the last part of the night. Because people have more slow-wave sleep in the first part of the night, confusional awakening and sleepwalking are more likely to occur then. Because people have more REM sleep in the last part of the night, that is when dreaming most often occurs.

TERMS

slow-wave sleep Characteristic patterns of electrical brain activity measured by the electroencephalogram (EEG) during the deepest stage of sleep, Stage III.

rapid eye movement (REM) sleep One of two main phases of sleep, the final phase of a sleep cycle, when most dreaming occurs and eyes rapidly move under closed eyelids. Brain activity increases to levels equal to or greater than those during waking hours, and blood pressure, respiration, and heart rates rise.

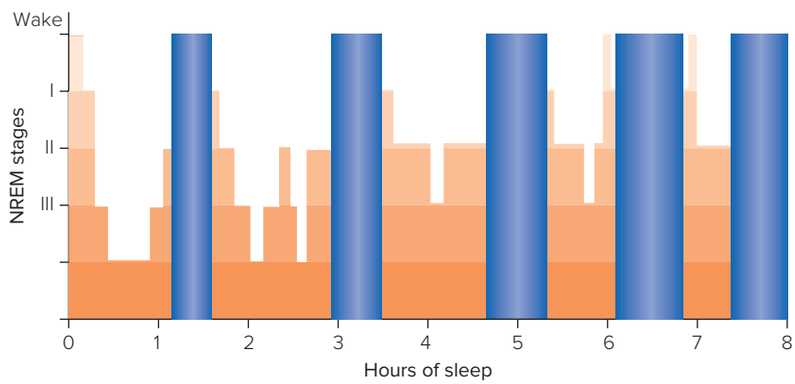


FIGURE 4.2 Sleep stages and cycles. During one night of sleep, the sleeper typically goes through four or five cycles of NREM sleep (three stages) followed by REM sleep.

SOURCE: Krejcar, O., J. Jirka, and D. Janckulik. 2011. Use of mobile phones as intelligent sensors for sound input analysis and sleep state detection. *Sensors* 11(6): 6037–6055.

Natural Sleep Drives

One key for understanding both how sleep can be disrupted and how it can be improved is to understand the natural biological sleep drives. There are two major biological sleep drives: the circadian rhythm and the homeostatic sleep drive.

Circadian Rhythm The **circadian rhythm** is the sleep-and-wake pattern coordinated by the brain's master internal clock, the **suprachiasmatic nucleus (SCN).** The SCN controls the sleep–wake cycle not only of the brain but also of the entire body. Every cell in every organ has a sleep–wake cycle, and the SCN sends signals not only to the rest of the brain, but also to organs such as the liver, gastrointestinal tract, pancreas, heart, skeletal muscles, and even cells in the blood and skin. Each cell has DNA machinery that produces an internal clock, and the SCN synchronizes these clocks with all the other clocks. The power of the circadian system for many different aspects of biology is being increasingly recognized, and the 2017 Nobel Prize in Physiology was awarded to Jeffrey Hall, Michael Rosbash, and Michael Young, scientists who helped explain the genetic mechanisms underlying clock timing on the cellular level (see Figure 4.3). Interestingly, different people have different tendencies with regard to their physiological clock times. The average clock time is about 24 hours.

CIRCADIAN RHYTHM DISRUPTIONS Anyone who has traveled to another time zone is probably familiar with jet lag, which occurs when the internal body clock is set to a different time from that of a new environment. People with jet lag commonly experience difficulty falling asleep and waking up at appropriate times. In the new location, it can also cause nausea and loss of appetite, which is related to the gastrointestinal system's being out of sync with the new time zone.

But jet lag is not the only disrupter of the circadian rhythm. Some people have habits that cause their internal body clocks to be set at a time that is different from the time zone where they live. An example is a person who stays up regularly until 4:00 a.m. and sleeps until noon, a pattern called *delayed sleep phase*. If this person occasionally has to wake up earlier—say, to attend a morning lecture or go to a morning appointment—the switch can be difficult, and the person may feel unwell, just like a person with jet lag will feel dysfunctional.

Are you a "night owl" or a "morning lark"? People may have a biological tendency to want to go to bed later or earlier. Differences in morningness and eveningness may be affected by differences in the clock mechanisms in the body.

Throughout the day, we also encounter external stimuli that can influence our master clock. Some of us are more sensitive

TERMS

circadian rhythm The body's sleep-and-wake pattern coordinated by the brain's master internal clock, the suprachiasmatic nucleus (SCN).

suprachiasmatic nucleus (SCN) Master clock that sets and controls—synchronizes—the sleep–wake cycle, sending signals to the brain and to every cell in every organ of the body.

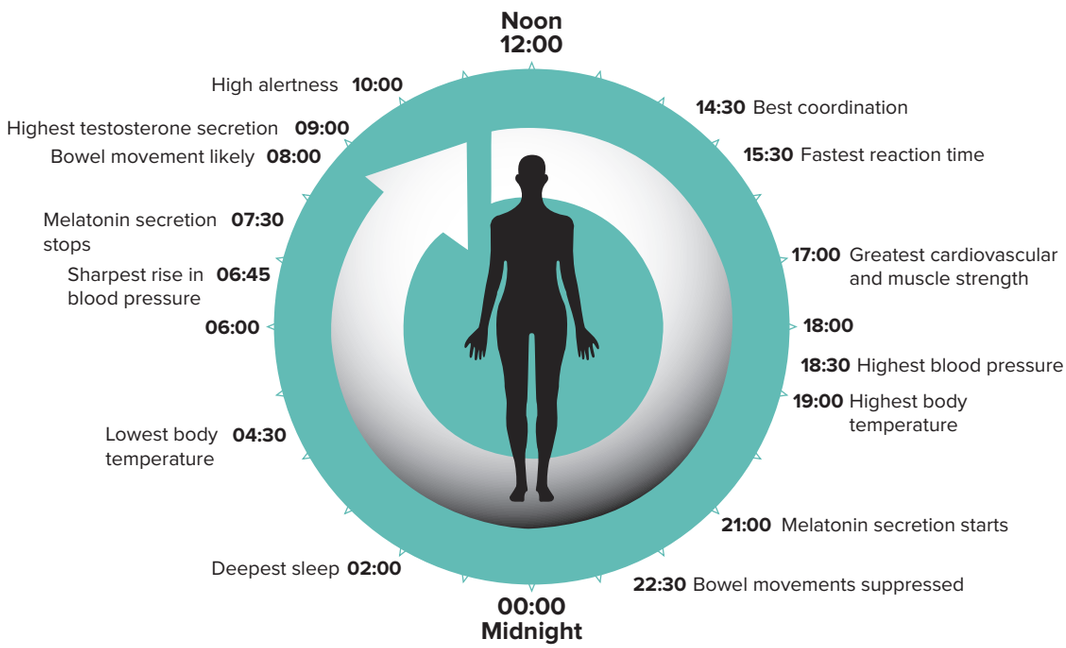


FIGURE 4.3 The circadian clock of a person who wakes up in the morning and sleeps at night.

SOURCE: School of Biological Sciences, Royal Holloway University of London, Matthew Ray/EHP

to these "time-givers," called **zeitgebers,** so it is important to be aware of how they can affect sleep quality, needs, and behavior. There are many zeitgebers, including activity, exercise, and eating, but the strongest and most important is light.

LIGHT Light has a direct connection to the SCN master clock via specific cells in the eye. Instead of processing vision, these cells send impulses directly to the SCN to allow it to measure light. If we are exposed to light in the morning at a certain time on a regular basis, this exposure signals the SCN that it should set the internal clock to wake around that time. This allows us to develop sleep habits that are naturally regulated.

But exposure to light can also reinforce unhealthy behavior. For example, if we are regularly exposed to it late at night, then the SCN will reset itself, shifting our sleep and wake periods to occur later. This is because the body responds to light in the evening by delaying the sleep phase. In contrast, when we are exposed to light in the morning, our body resets to an earlier clock time and earlier wake time, advancing the sleep phase.

The switching point, when the light no longer delays but advances a sleep phase, occurs at a point about two hours prior to our usual wake time. For example, let's say you usually get up at 10:00 a.m. You stay up late with the light on, and even though a 6:00 a.m. light gets you out of bed, your sleep phase the following evening is still delayed. That 6:00 a.m. light hit you too early, and you will still not feel like sleeping at an early bedtime.

A light exposure that would cause a morning reset of sleep time would be between 8:00 and 9:00. This exposure would advance your sleep phase, so that you feel like waking up a little earlier the next day. Interestingly, the reversal point at which the effect of light changes the SCN coincides with the time when body temperature is lowest.

Another mechanism involving the SCN detects the loss of light at the end of the day. When natural light fades at dusk, an impulse is conveyed via the SCN to the pineal gland in the brain to produce **melatonin,** which signals to systems that are involved in preparation for sleep (see Figure 4.4). People who are blind often have problems with sleep because they lack the visual light signals that help synchronize circadian rhythms.

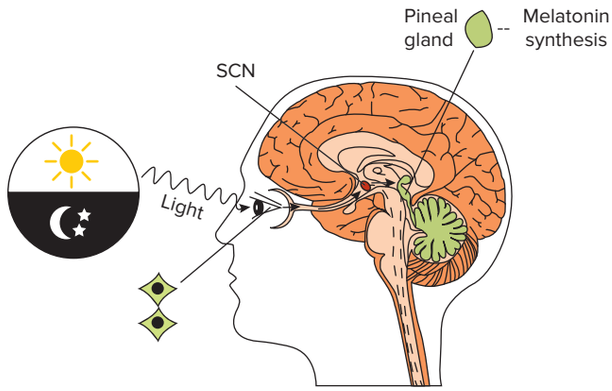


FIGURE 4.4 Light coming into the eye is conveyed via the SCN to the pineal gland, which produces melatonin.

SOURCE: Tan, Du-Xian, L. C. Manchester, Lorena Fuentes-Broto, S. D. Paredes, and Russel Reiter. (2011). Significance and application of melatonin in the regulation of brown adipose tissue metabolism: Relation to human obesity. *Obesity Review* 12(3): 167–188. Doi:

Ask Yourself

QUESTIONS FOR CRITICAL THINKING AND REFLECTION

Do you ever use a device right before going to sleep? Do you ever wake up at night to check your phone? How could you change your digital behavior to improve your sleep?

QUICK STATS

The best time to take a nap is between 1:00 and 2:30 p.m.

—The Better Sleep Council, 2018

TERMS

zeitgebers Phenomena that can influence and reset the body's master clock, such as light, activity, exercise, and eating. Light directly affects cells in the eye to send signals directly to the SCN to measure outside light.

melatonin A hormone secreted by the pineal gland, especially in response to darkness and in inverse proportion to the amount of light received by the retina. It helps control sleep-and-wake cycles and circadian rhythms.

homeostatic sleep drive Pressure to sleep that builds the longer one is awake, mainly driven by a neurochemical, adenosine, that accumulates in the brain as a by-product of the brain's energy metabolism and promotes sleep onset. Sleep clears the adenosine, thereby reducing the pressure to sleep.

adenosine An important neurochemical that appears to mediate the sleepiness that follows prolonged wakefulness, during which adenosine accumulates in the brain.

To strengthen the circadian rhythm, it can help to get good light exposure in the morning and throughout the day and to reduce exposure to light at night. The challenge is that, day and night, we are exposed to abundant sources of artificial light, which undermine our reliance on the sun's natural 24-hour cycle. Electronics compound our unnatural light exposure, especially by introducing blue light, which has a strong impact on melatonin production. We commonly use backlit electronic devices at night, even right before bed, which can affect the current night's sleep, and then in turn sleep on the following nights. See the box "Digital Devices: Help or Harm for a Good Night's Sleep?"

Homeostatic Sleep Drive The **homeostatic sleep drive** is the drive for sleep that builds up the longer you are awake. If you do not sleep all night, and you stay up the next day, you will feel an ever-increasing need to sleep. This is also sometimes referred to as a buildup of sleep pressure that accumulates the longer a person is awake. The homeostatic sleep drive is thought to be mediated biologically by the accumulation of the neurochemical **adenosine** in the brain. This

TAKE CHARGE
Digital Devices: Help or Harm for a Good Night's Sleep?

Many apps are promoted as sleep aids and trackers. Can they really improve sleep? Or can using digital devices hurt the body's natural sleep cycles?

Digital Devices and Sleep

Before we look at sleep apps, let's consider how your use of digital devices can negatively affect your sleep. Tablets, smartphones, and computers emit blue light, which impedes the release of melatonin, a hormone that affects sleep and wake cycles. In one study, researchers compared the sleep of people who read an e-book on a backlit digital device in the hours before bedtime with that of people who read a print book. Those who read the backlit digital book took longer to fall asleep, had reduced melatonin release, and were less alert the next morning.

Does heavy texting affect sleep? Psychologist Karla Murdock reported that texting was a direct predictor of sleep problems among first-year students in a study that examined links among interpersonal stress, text-messaging behavior, and three indicators of college students' health: burnout, sleep problems, and emotional well-being.

Murdock and other sleep experts suggest turning off your screens. Use them less during the day and also when preparing to sleep at night. If you have trouble relaxing and transitioning to sleep in the evenings, shut down all your devices an hour or more before you intend to sleep.

Now that you are resting in the dark, why would you consider using a sleep app or digital tracker? Ironically, a smartphone may help you get to sleep.

Digital Aids for Relaxation

Many free and low-cost apps provide aids for relaxation and for improving sleep. Some include music, white noise, or nature sounds (e.g., wind, rain, waves, or songbirds). Others offer specific techniques, such as guided meditation or breathing exercises, to promote relaxation to aid in falling asleep. Experiment to find the aids that work best for you.

Digital Sleep Trackers

More complicated technologies try to track and analyze sleep. Many are based on movement detectors inside smartphones. Others work with sensors attached to your mattress or pillow that estimate the amount and type of sleep you get based on your movements during the night. These apps may generate detailed graphs of your sleep quality and may time your wake-up alarm to go off at the point in your sleep cycle when you will feel the most refreshed. Some apps also include a sound recorder, which detects sleep talking, snoring, and other noises, providing further information about nighttime sleep behavior.

In addition to smartphone apps, specialized fitness wristbands such as those by Fitbit include sleep trackers. These rely on wearable movement detectors. Some incorporate heart-rate data as well, but evidence is meager that adding heart-rate data to movement data improves the accuracy of results. Certain fitness-focused wearables may combine sleep and exercise data to provide an overall picture of an individual's activity over the course of a day.

Apps and devices may be popular, but no current consumer technology can match a sleep lab when it comes to detecting sleep stages or diagnosing specific sleep disorders such as sleep apnea. If you enjoy the features of an app or wearable tracker, go ahead and use them, but don't rely on an app to diagnose the presence or absence of a serious sleep problem. One good effect of using a sleep tracker is simply the greater focus it places on sleep.

SOURCES: Chang, A. M., et al. 2015. Evening use of light-emitting eReaders negatively affects sleep, circadian timing, and next-morning alertness. *Proceedings of the National Academy of Sciences* 112(4): 1232–1237; Bhat, S., et al. 2015. Is there a clinical role for smartphone sleep apps? Comparison of sleep cycle detection by a smartphone application to polysomnography. *Journal of Clinical Sleep Medicine,* February 3; Gradisar, M., et al. 2013. The sleep and technology use of Americans. *Journal of Clinical Sleep Medicine* 9(12): 1291–1299; Behar, J., et al. 2013. A review of current sleep screening applications for smartphones. *Physiological Measurement* 34(7): R29–R46; Lewis, J. G. 2013. Sleep cycle app: Precise, or placebo? *Mind Read: Connecting Brain and Behavior* (http://www.nature.com/scitable/blog/mind-read/sleep_cycle_app_precise_or); Murdock, K. K. 2013. Texting while stressed: Implications for students' burnout, sleep, and well-being. *Psychology of Popular Media Culture* 2(4): 207-221; Ritterband, L. M., et al. 2009. Efficacy of an Internet-based behavioral intervention for adults with insomnia. *Archives of General Psychiatry* 66: 692–698.

is a by-product of energy metabolism in the brain and promotes sleep onset. So the more time one spends awake, the more this by-product accumulates and produces sleepiness. When one falls asleep, this by-product is cleared, and the pressure to sleep is reduced. Naps in the afternoon will clear adenosine and reduce pressure to sleep, as well as the sleep drive at night. Different people may have stronger or weaker homeostatic sleep pressure systems. Someone with insomnia, who has a problem falling asleep or staying asleep, might benefit from trying to increase sleep pressure and strengthen the homeostatic sleep drive. This can be done by setting a reasonably early wake time every morning and avoiding naps during the day, allowing enough wake time for the sleep drive to increase.

Caffeine blocks the homeostatic sleep drive by blocking adenosine receptors in the brain. If you have problems falling asleep, reduction of caffeine can be very important. In people with insomnia, it is important to bear in mind

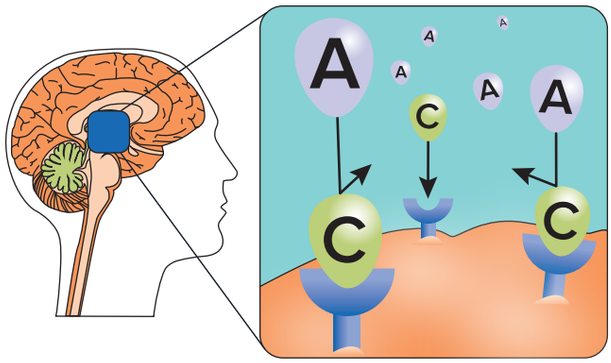


FIGURE 4.5 Caffeine blocks adenosine in the brain and delays the homeostatic sleep drive.

that caffeine can have effects for up to 24 hours; even if consumed in the morning, it can disrupt nighttime sleep. (See Figure 4.5.)

CHANGES IN SLEEP BIOLOGY ACROSS THE LIFE SPAN

Sleep rhythms and needs change throughout our lives. Babies need the most sleep and may sleep up to 14–18 hours per day (Figure 4.6). Toddlers and preschoolers need about 12–14 hours of sleep, while school-age children require closer to 10–12 hours of sleep. Teenagers typically need 9–10 hours of sleep nightly, but surveys of adolescents across the world make it clear that most teenagers get much less than the recommended amount. Some teens may try to restore their sleep deficit on the weekends, which can be a regular pattern, but even so, teenagers are often sleep deprived during the week.

In young adulthood and adulthood, many sleep experts suggest that 8–9 hours may be sufficient, but it is important to realize that the requirement for sleep depends on the individual. Some people require less and others need more. Genetics plays a role in how much sleep we need. Carriers of specific genes may be so-called short sleepers, who need only 4 to 6 hours of sleep per night to prevent sleep deprivation. Other individuals need 9 or 10 hours of sleep to feel their best. To determine if you are a shorter or longer sleeper, it can help to reflect on times in life when you felt like you were functioning well in the daytime and about how much sleep you were getting at that time.

Changes in Circadian Rhythm

Among the most prominent changes with respect to sleep patterns during the life span are circadian rhythm changes. Children need to go to bed quite a bit earlier than adults, and this should be reinforced by adults. Sufficient sleep schedules reduce problems with attention and learning as well as behaviors that occur in sleep-deprived children.

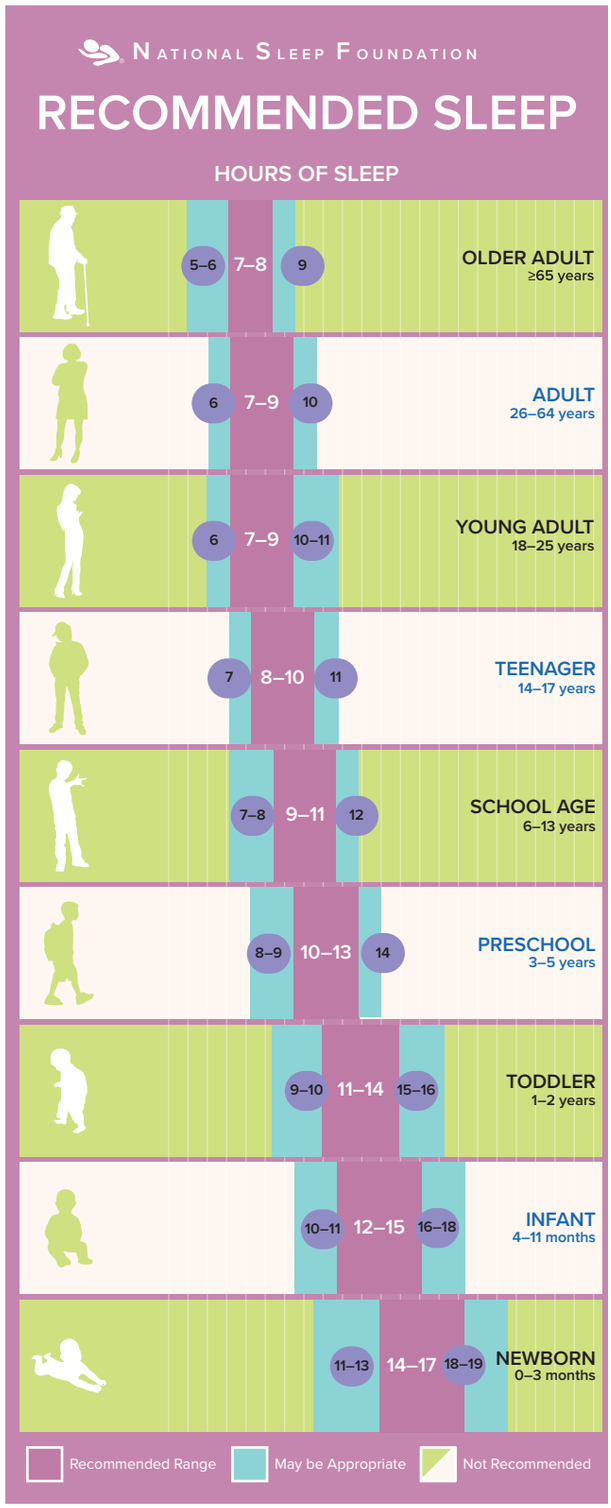


FIGURE 4.6 Sleep needs change over the course of the life span.

SOURCE: National Sleep Foundation

During adolescence and young adulthood, there is a delayed sleep phase, so that teenagers may not feel sleepy until late at night and have a natural drive to sleep longer in the morning. Like children and adults, sufficient sleep provides adolescents with cognitive and emotional benefits—specifically, it can positively affect grades and mood and reduce risk-taking behavior. Both high school and college students show a sleep deficit of 1–3 hours on school nights. Then they sleep much longer and later on weekends. College students tend to go to bed 75 minutes later than high school students. In a large study of college students, almost one-third reported poor sleep. According to the study's criteria, however, almost two-thirds were getting poor sleep—less than 7 hours of sleep per night and more than 30 minutes of time to fall asleep.

School start times often force students to rise during their biological night—their circadian period scheduled for sleep—and this results in serious sleep deprivation. Sleep is especially important during adolescence because parts of the brain in charge of higher-order thinking, problem solving, reasoning, and good judgment are still developing. School districts that have implemented later start times, allowing teens more sleep and biologically appropriate wake times, found a decrease in tardiness, absences, dropout rates, school nurse visits, and car accidents and improved alertness and behavior in class, better grades, and higher standardized testing scores.

A recent RAND Corporation study has estimated that delaying school start times until 8:30 a.m. would create a $9 billion economic gain for the country, primarily by greater lifetime earnings realized through better school performance—and by the reduction in car accidents caused by drowsy teens. Despite these gains, logistics and scheduling hurdles, as well as attitudes that mistakenly associate toughness and discipline with sleep duration, have prevented most school districts from implementing later start times; so far only 18% of the country's school districts have implemented 8:30 a.m. or later start times.

At some point, in our twenties, our circadian rhythms shift away from the "night owl" tendency so that we experience earlier sleep and wake times.

Sleep Cycles, Age, and Gender

As we get older, we can wake up more easily. The elderly generally wake up more often during the night, because they are in lighter stages of sleep. They have lost a lot of the deep sleep stage and so are more sensitive to external stimuli. The shift to earlier sleep and wake times, combined with sleep debt and reduced slow-wave sleep can cause inadvertent napping too late in the day, which can in turn prevent sleep when it is attempted at bedtime. Early-morning alerting signals then cause early morning arousals, which prevent catch-up sleep in the morning and lead to more sleepiness during the day. Children, on the other hand, can be hardest to rouse. Their increased amount of slow-wave sleep and greater threshold for transitioning from sleep to wakefulness may explain why sleepwalking is more common in children. Sleepwalking happens during slow-wave sleep, when the transition from sleep to wakefulness does not happen easily.

As we age, the duration and quality of our sleep decrease. In childhood, the slow waves seen in the EEG in Stage III sleep are larger, the slow-wave sleep periods are longer, and the total amount of slow-wave sleep in a night is much greater (e.g., up to 40–60% of the sleep period). In contrast, in young and middle-aged adults, the slow waves are of medium size and might constitute about 25–30% of the sleep period. In older people, slow-wave sleeps are further reduced in size and constitute only about 10–15% of total sleep time.

By our late twenties, we enter into deep sleep less. By our late forties, 60–70% of deep sleep is gone. By age 70, it has decreased 80–90%, and by age 74 it may be completely absent. Still, not all older adults suffer the same degree of sleep disruption. There are, for example, differences among the sexes: women over the age of 70 show much less disruption and impairment in slow-wave sleep than men over 70.

Age not only reduces the time spent in this restorative sleep stage, but it also diminishes the number, the amplitude, and the intensity of deep-sleep brain waves. Scientists don't yet know if reduced slow-wave sleep is a response to less physical activity and learning, or an indication that the brains of older adults lose the ability to sustain the slow, coordinated brain activity of deep sleep. Reduced or absent slow-wave sleep may also be linked to neurodegeneration. Due to their tendency to awaken more easily, older people should be aware of factors that can disrupt sleep at night.

Women in general report more symptoms of sleeplessness and are more likely to be diagnosed with insomnia; men report more snoring and are more likely to be diagnosed with **sleep apnea,** repeated involuntary breathing pauses during sleep. One reason women may notice changes in their sleep patterns is hormones. During the menstrual cycle, some women may experience increased sleepiness or disrupted sleep. Progesterone levels rise during the second half of the menstrual cycle, promoting sleep, but drop just before the cycle begins, causing sleep difficulty. During pregnancy, extra weight and the position of the fetus can make sleep difficult. During menopause, many women have additional sleep problems, such as hot flashes. Awareness of these

Ask Yourself

QUESTIONS FOR CRITICAL THINKING AND REFLECTION

Can you think of a time you had an early class and had difficulty focusing? Did you make adjustments to your schedule? What other actions improved the way you felt?

TERMS

sleep apnea The involuntary, repeated interruption of normal breathing during sleep, caused by blocked airways (for example, throat or trachea) or faulty brain signaling to muscles that support breathing.

changes in sleep can help women cultivate strategies to ensure that they meet their sleep needs, despite these hormonal influences.

SLEEP AND ITS RELATION TO HEALTH

Sleep directly influences our moods, creativity, and ability to learn, and it has an impact on immune function and longevity. College students who sleep enough hours and sleep efficiently have faster reaction times, higher grades, more optimism, and higher energy levels. They suffer less daytime sleepiness, a lower risk of traffic accidents, and fewer mental health complaints.

Mood and Depression

Depression and anxiety are common; most people will experience them at some point in their lives. Sleeping difficulty, especially insomnia, is often also present in people struggling with depression or mood disorders. Research shows that the risk for depression rises with insomnia, even when people were not depressed when sleep troubles began. Recent studies have also shown that when patients with depression specifically treat sleep problems, their depression also improves, even if the treatments are not medicinal. One explanation for this link is that the neurochemical changes associated with sleep problems make people more vulnerable to depression. A study of college students found that depression interfered with daytime functioning, and anxiety was associated with disturbed sleep and also with people who were taking sleep medications.

It is probably apparent to most people that a night of poor sleep can make them irritable the next day. This effect can compound over the course of many days or weeks. Lack of sleep can also affect emotions, making people more volatile and disinhibited, which can lead to behaviors people might regret or decisions that are not carefully thought out. In adolescence and young adulthood, risk-taking behaviors have been shown to increase with insufficient sleep.

Sometimes sleep problems are correlated with suicide risk, especially among young adults. A study of 438 female college students reports an important association between insomnia and suicidal thoughts. Other studies of college students found an association between nightmares and suicidal thoughts. Some students classified as suicidal also reported taking sleep medications and often feeling too cold while sleeping. Being aware of the connections between mood and sleep, and prioritizing sleep health, can contribute to better mental health.

Dementia

One major disease that can affect memory as we get older is dementia. Dementia is so common that up to 20% of us are likely to develop memory problems as we age. This is a devastating disease, but it turns out that better sleep may help prevent us from developing mild cognitive impairment and dementia. Studies in mice have revealed that there are changes in the fluid that surrounds the brain during sleep, such that the flow around the nerve cells or the cerebrospinal fluid increases by 90% in the tissues of the brain while we sleep. It appears that this increase in flow allows for by-products of nerve metabolism to clear out. These by-products include proteins such as amyloid, which can accumulate in the brain during the day and have been associated with the development of Alzheimer's disease, a form of dementia. The fluid-clearance system in the brain, called the glymphatic system, processes the waste from the brain. Without sleep, this system does not clear as efficiently. Epidemiological studies and cohort studies in humans provide further evidence that poor sleep, and particularly sleep disruption at night, increases the risk for dementia or causes it to develop earlier.

Athletic Performance

Because performance can be improved by changing our sleep habits, professional sports teams and athletes have started hiring sleep consultants. One researcher studying competitive college swimmers observed that after adhering to a more rigid sleep schedule, students performed their personal bests. The research was more formally developed to evaluate college basketball players, and it showed that shooting accuracy and sprint times improved after several weeks of instituting a 10-hour sleep schedule.

The amount of sleep is not the only influential factor: Circadian rhythms also affect performance. A study looking at 10 years of data found that Major League Baseball players who did not have to play with a change in time zones of three hours held a 60.6% advantage over those who did have to adjust time zones. This advantage actually exceeded that of being a home team. West Coast teams, regardless of which time zone they play in, perform better than their competitors in games that start after 8:00 p.m. Why? Because peak athletic performance generally occurs in later afternoon.

Among a number of other sleep-related physiological factors that affect performance are hormones. Growth hormones and testosterone, for example, are released during sleep, and their levels are reduced with sleep loss. When, for the purposes of a study, male college students restricted their sleep to only 4 hours and 48 minutes for a week, their daytime testosterone levels decreased 10–15%—the same

Ask Yourself

QUESTIONS FOR CRITICAL THINKING AND REFLECTION

Can you remember a time when you were sleep deprived and did something you regretted? How did you feel that day?

amount expected after aging 11 more years. The lowest levels occurred at 2:00 p.m. and 10:00 p.m., when it is likely their homeostatic sleep drive increased. Testosterone is important for muscular health, stamina, and energy, so sleep has a significant impact on men's health.

Finally, sleep is vitally important for intense skills training. Sleep can help consolidate the motor learning required to make new techniques more efficient and automated. For example, getting a night's sleep after learning to press a sequence on the keyboard enhanced study participants' speed and accuracy on the computer. Some studies have shown that there is only one opportunity to take advantage of this. If you do not get enough sleep the first night after learning, getting extra sleep on subsequent nights will not result in skills improvement.

Musculoskeletal Pain

Poor sleep can increase our risk for developing body pain and create a lower pain threshold. If someone is suffering from body pain, it is especially worthwhile to screen for sleep disorders. Improving a patient's sleep can improve pain symptoms. One challenge to this approach is that pain can interfere with sleep, creating a feedback loop; however, in some patients it may be easier to address sleep problems, which can ease pain symptoms and, in turn, lead to better sleep.

Obesity and Weight Management

Obesity is a big public health problem in the United States, and many more people who are not obese are overweight (see Chapter 15). Eating habits and exercise are necessary for maintaining a healthy weight, and attention to sleep is also helpful. In the past several decades, researchers have discovered neuroendocrine substances that regulate appetite. One of these, ghrelin, increases appetite and rises when we have not eaten; another, called leptin, rises after we eat, reducing hunger and making us feel full. Sleep affects these appetite-regulation factors. Normally leptin rises during sleep and after meals, two times when we would not expect to be eating. When people are sleep deprived, though, leptin levels are 20–30% lower. Meanwhile, ghrelin levels can increase 20–30% when a person is sleep deprived. As a result, lack of sleep makes it harder to adhere to normal eating plans.

The link between increased obesity and sleep deprivation has been documented in multiple longitudinal studies of children and young adults who experience reduced sleep time. Other studies have shown that reward centers in the brain are activated more by food stimuli when people are sleep deprived, an effect associated with increased sugar and fat intake. Other related consequences of sleep deprivation further compound the effects on weight gain. People who are sleep deprived tend to be more fatigued, which makes them more sedentary. It's no coincidence that increased use of electronic media—a sedentary activity—is associated with weight gain.

Cardiovascular Disease

The connection between sleep and cardiovascular disease has been studied extensively. The strongest connection is between sleep apnea, which is prevalent in people who snore, and to hypertension. One of the largest studies showed that people with mild sleep apnea had twice the risk of developing hypertension in the next four years, while those with moderate or severe apnea had three times the risk.

Hypertension is particularly worrisome because it is directly related to risks of other cardiac disorders, such as coronary artery disease, heart attacks, and strokes. In addition to causing hypertension, sleep apnea directly promotes inflammatory pathways that are thought to further contribute to the buildup of plaques that narrow the arteries of the heart and brain. Cardiac arrhythmias, including atrial fibrillation, which is a major risk factor for stroke, can also be promoted by sleep apnea.

People who sleep less or who have insomnia also appear to have increased cardiovascular risk. In men with insomnia and sleep duration of less than six hours, there was an increased risk of mortality over 14 years of 400%. If these men also had hypertension, the risk rose to 700%. A study of more than 6000 people showed that insomnia in midlife led to a threefold greater risk of mortality over 13–15 years. How helpful are sleep medications? Several large studies suggest that the use of sleep medications is associated with a higher mortality risk.

Diabetes

Diabetes is also a common condition, and it increases the risk for other disorders, including cardiovascular diseases such as coronary artery diseases and stroke. According to the Centers for Disease Control and Prevention (CDC), prediabetes is present in over one-third of people aged 18 or older and in nearly half of people 65 or older. Diabetes mellitus is also listed as the seventh most common cause of death in the United States. While obesity is by far the major risk factor for the development of diabetes after childhood, sleep can affect the risk of diabetes as well. In studies of short sleep duration, the risk for type 2 diabetes was shown to rise, especially in men. Men with short sleep durations had twice the risk for developing diabetes. In another series of studies in which people were asked about their sleep quality, those who reported problems falling asleep or staying asleep had a 50% increased risk for developing diabetes.

When sleep apnea goes untreated, people appear to have problems with glucose regulation also seen in diabetes. In young, healthy people, when slow-wave sleep was disrupted by low-grade noise, even when the total sleep time remained the same, the ability of insulin to regulate glucose was impaired.

Public Health Impact

Because we consistently underestimate how sleep deprived we are, we risk our own and others' lives without realizing it.

One misconception is that we can recover from missed sleep with one or two good nights' rest. But even three nights of recovery sleep does not bring us back to full functioning. How many errors are committed on the road, in the skies, or while controlling hazardous materials because the operator falls asleep? What can we do about this?

You can notice a sleep debt with the following signs: difficulty getting out of bed in the morning and missed alarm clocks, an ability to fall back asleep at 10:00 or 11:00 a.m., an inability to feel alert before noon without caffeine, grogginess that lasts more than a half hour after waking or continues after the natural circadian post-lunch dip, and a tendency to fall asleep while reading or watching a movie. Frequent movement during sleep as recorded by a wearable device can indicate awakenings and fragmented sleep you may not even be aware of and can thus be an indication of sleep debt. While brief naps at certain times of the day can renew alertness, the ability to fall asleep during the day can also be a sign of sleep debt.

Auto Accidents Do not get behind the wheel without enough sleep. In driving simulations, study participants who slept only four hours a night drove off the road six times more often than people who had slept eight hours. The number of errors committed by the sleep-deprived matched the number committed by another group of participants who had slept eight hours but were legally drunk. A fourth group, both sleep-deprived and drunk, drove off the road almost 30 times more than the rested, sober group. This means that the combination of alcohol and sleep deprivation are exponentially lethal; unfortunately, people tend to drink alcohol at nighttime, when sleep pressure is greatest.

In many states, driving while sleepy is considered driving while impaired, and people can be fully liable for the consequences (see Chapter 22). The National Highway Traffic Safety Administration conservatively estimates that sleepiness accounts for 72,000 traffic accidents per year. The CDC, which believes much drowsy driving is underreported, estimates sleep-deprived drivers are responsible for nearly 6000 fatal crashes each year.

QUICK STATS

40% of U.S. adults unintentionally nod off during the day at least once a month.

— National Heart, Lung, and Blood Institute, 2018

A **microsleep,** or momentary lapse in concentration, can last just a few seconds. That brief moment, however, is time enough to fatally crash your vehicle. During a microsleep, your brain loses perception of the outside world. You lose sight, your eyelids closing partially or all the way, and you lose control of your motor skills. Most of the time you don't even realize you've had a microsleep.

People who are most at risk for falling asleep driving are those who regularly get less than seven hours of sleep. They include young people aged 18–29 and men slightly more often than women. Other candidates are parents with small children, shift workers, people who have accumulated sleep debt, or those who have other untreated sleep disorders such as sleep apnea or insomnia. Although they can occur at any time, the peak period for drowsiness-related accidents is 4:00 to 6:00 a.m. Sleepiness can increase when people take substances such as muscle relaxants, antihistamines, cold medicines, or alcohol.

The good news is that accidents due to sleepiness can be prevented. First and foremost, it is important to ensure adequate sleep time and avoid extremes of sleep deprivation and ensure that any disorder of sleep, like sleep apnea, is properly treated. If you feel drowsy while driving, it is best to immediately pull over and stop driving.

You can prepare for an anticipated period of sleep deprivation by napping. Studies found that pilots who napped early in the evening before a red-eye flight could protect themselves from lapses in concentration that are so dangerous in the last 90 minutes of the flight. Caffeine can provide a short-term burst of alertness if needed, but it shouldn't be used excessively because it can promote sleep deprivation. Ensuring that windows are open and there is sufficient noise from a radio for stimulation may help. It is always important to remember that only a few seconds of losing consciousness on the road can lead to tragedy, and the best course of action is always to stop driving when drowsy.

Workplace Accidents Workplace accidents and even major environmental disasters have been attributed to human error that was related to sleepiness. Such errors contributed to the 1989 *Exxon Valdez* oil spill in Alaska, the 1986 Chernobyl nuclear disaster in the Soviet Union, the 1979 Three Mile Island nuclear disaster in the United States, and even the 1986 space shuttle *Challenger* disaster each of which was related to sleep-deprived workers. The U.S. Navy has reevaluated the schedules of crews to ensure they get enough sleep while at sea. Sleep deprivation is a suspected cause of at least four major incidents in 2017 alone that resulted in the deaths of 17 sailors.

TERMS

microsleep a momentary lapse in which some parts of the brain lose consciousness

GETTING STARTED ON A HEALTHY SLEEP PROGRAM

This chapter attempts to show some ways sleep can affect our health and well-being, which helps highlight the reasons that it can be important to prioritize sleep health.

Step I: Take an Inventory

Use the sleep questionnaire in the Assess Yourself box to get a general idea of whether you are getting enough sleep.

ASSESS YOURSELF
Questionnaire: Do I Get Enough Sleep?

Think about your sleep habits and sleep patterns.

Here is a brief sleep questionnaire to help you analyze and reflect upon the interpretation of your total score.

Directions: For each description, choose the number under the heading (Usually, Sometimes, Rarely, Never) that corresponds most closely to your experience. Notice that the numbers vary in each column.

	USUALLY	SOMETIMES	RARELY	NEVER
1. I sleep soundly.	1	2	3	4
2. I feel that I get enough sleep.	1	2	3	4
3. I go to bed at about the same time each night.	1	2	3	4
4. I engage in a stimulating activity just before bedtime.	4	3	2	1
5. I drink coffee a few hours before bedtime.	4	3	2	1
6. My snoring wakes me up.	4	3	2	1
7. I take a nap during the day.	4	3	2	1
8. I feel sleepy during the day.	4	3	2	1
9. I fall asleep reading or watching TV.	4	3	2	1
10. I wake up more than once during the night.	4	3	2	1
11. I have difficulty falling asleep.	4	3	2	1
12. I wake up feeling rested.	1	2	3	4
13. I remember that I had dreams when I wake up.	1	2	3	4
14. I have a problem waking in the morning.	4	3	2	1
15. I drink alcohol a few hours before or near to bedtime.	4	3	2	1
16. I look at the clock several times before getting up.	4	3	2	1
17. I have to get up to use the bathroom.	4	3	2	1
18. I take medication to sleep.	4	3	2	1
19. If I wake up during the night, I have trouble going back to sleep.	4	3	2	1
20. I feel sleep deprived.	4	3	2	1

Scoring

To calculate your score, total the numbers you selected. The result is your total score.

If your score is above 40 you should track your sleep in the diary below. This chapter describes many coping strategies that can help you improve the quality of your sleep. Your school's counseling center can also provide valuable support.

You can then use the sleep diary for a closer look at your sleep habits. There may be some obvious problems you may have recognized, or there may be some that you notice when reviewing your sleep schedule and your amount of sleep time. Most people can identify several issues that might be improved. Especially if you have trouble falling asleep or staying asleep, this list should be scrutinized.

TERMS

sleep disrupters Factors that interfere with the ability to fall asleep or stay asleep that can usually be corrected if they are targeted specifically. Examples are caffeine, reflux, nasal congestion, cough, urination, anxiety or stress, pain, and environmental factors, among others.

Step II: Identify Sleep Disrupters

Sleep disrupters are factors that interfere with the ability to fall asleep or stay asleep that can usually be corrected if they are targeted specifically. Some of them might seem simple or trivial, but they can have marked effects over time on your sleep.

SLEEP DISRUPTER CHECKLIST

- Do I have symptoms of apnea or risk for apnea (snoring or gasping even if healthy weight)?
- Do I have symptoms of restless leg syndrome, or do I kick in my sleep frequently?

Sleep Diary

	Name							
Complete in the Morning	Today's date (include month/day/year):	**Mon**	**Tues**	**Wed**	**Thurs**	**Fri**	**Sat**	**Sun**
	Time I went to bed last night: Time I woke up this morning: No. of hours slept last night:							
	Number of awakenings and total time awake last night:							
	How long I took to fall asleep last night:							
	How awake did I feel when I got up this morning? 1—Wide awake 2—Awake but a little tired 3—Sleepy							
Complete in the Evening	Number of caffeinated drinks (coffee, tea, cola) and time when I had them today:							
	Number of alcoholic drinks (beer, wine, liquor) and time when I had them today:							
	Naptimes and lengths today:							
	Exercise times and lengths today:							
	How sleepy did I feel during the day today? 1—So sleepy had to struggle to stay awake during much of the day 2—Somewhat tired 3—Fairly alert 4—Wide awake							

FIGURE 4.7 A sleep diary can help you discover your sleep pattern.

SOURCE: National Heart, Lung, and Blood Institute (NHLBI)

- Do I have frequent rhinitis or nasal congestion?
- Do I have reflux?
- Do I often have to get up to use the bathroom at night?
- Do I have discomfort or pain at night?
- Is there something in the bedroom that wakes me up at night?

Physical Disrupters There are certain medical and health conditions or other outside disrupters of sleep that can physiologically affect sleep and that could be contributing to sleep problems. The following are common sleep disrupters.

REFLUX Reflux, a common hidden sleep disrupter, occurs when a small amount of fluid from the acidic contents of the stomach rises into the esophagus, irritating the upper airway. This can cause impaired sleep quality and awakenings. Reflux is worsened by caffeine, chocolate, and mint, which cause the muscle that closes the stomach opening (the gastroesophageal sphincter) to relax. Most people have experienced reflux symptoms, which can also be more common at night when lying down.

Even babies and small children can have reflux that pauses their breathing and disrupts sleep. One sign of reflux can be a dry cough at night or a hoarse voice during the day, even when there is no sensation of acid. For anyone suffering disrupted sleep, it is worthwhile to consider avoiding food and fluid for at least three hours before bedtime. Take vitamins, medicines, or supplements during the day so they do not aggravate reflux problems at night.

NASAL CONGESTION AND COUGH Many people suffer from allergies that cause a runny or stuffy nose. Even when mild, this can lead to changes in breathing at night and cause sleep disruption. Measures that can be taken to reduce this problem include having anti-allergy pillow covers and ensuring clean bedsheets. There are also nasal saline sprays, and if needed, over-the-counter nasal anti-inflammatory steroid types of medications. It is important not to take medications that have ephedrine on a long-term basis since these can

worsen nasal congestion. Nasal saline and nasal steroid sprays do not cause these problems. If nasal obstruction is more severe, it can sometimes be beneficial to discuss this with an ear, nose, and throat specialist. Coughing can cause sleep disruption at night. Common causes of coughing at night are postnasal drip, asthma, and reflux. It is best to avoid using cough suppressants if possible. It is generally better to find and treat the cause of the cough.

URINATION People can be awakened by needing to use the bathroom at night. One simple remedy can be to avoid all fluids in the three hours prior to bedtime. You have to calculate the time after which you should not drink fluid. For example, if you typically go to bed at 10:30, then fluids should be avoided after 7:30. If problems with increased urination at night persist, then further evaluation with a health care provider may be needed.

ANXIETY AND STRESS Stress and worry can make sleeping more difficult. (See Chapter 2 to learn about how to manage stress.) Daytime exercise can be helpful for reducing stress and may reduce anxiety at night. It is important not to engage in stimulating or stressful activities right before bed. Students are often studying and working in the evening, and it can be better to stop these about an hour before bedtime to have a "wind-down" period. Sometimes people are busy all day, and they find that the only time they have to reflect or consider things is at night. To avoid having to deal with problems left until nighttime, set aside some time during the day to allow for planning. Meditation and other relaxation strategies in the evening can also help to clear one's mind before bedtime. If anxiety and stress are more severe, it can be helpful to seek the advice of a counselor or medical professional.

PAIN Pain can be a significant sleep disrupter. Lack of sleep can worsen pain symptoms. There are some commonsense interventions that may be helpful in alleviating pain at night. Replace the mattress if it promotes pain. Pillows should be of appropriate thickness for optimal neck positioning. Mattress toppers, including the memory foam type, may be beneficial for joint pain. Be cautious with pain medications (see the box "Sleep-Improving and Sleep-Disrupting Medications"). If pain persists, it should always be evaluated by a health care provider.

Environmental Disrupters

Many common sleep disrupters can come from the environment. These external factors can lead to problems sleeping.

THE BEDROOM To sleep well, you need a physical environment that is comfortable and does not interfere with normal physiological sleep processes. Ideal room temperature is warm enough for a person to be comfortable but cool enough to allow body temperature to decline as a person falls asleep. Some people tend to have cold feet or hands before going to bed, and for those people it may be beneficial to take a bath or be adequately warmed before getting into bed. A bedroom should also be quiet and dark, without television and pets. Pets should generally be trained to stay off the bed, though good sleepers may like to have them in the bedroom.

Table 4.1 Caffeine Content of Common Beverages and Chocolate

FOOD	SERVING SIZE	CAFFEINE (MG)
Coffee, Starbucks, brewed	8 fl. oz	160
Coffee, regular, brewed	8 fl. oz	130
Frappuccino beverage, Starbucks	9.5 fl. oz	115
Red Bull	8.3 fl. oz	80
Ice cream, coffee	8 fl. oz	50–80
Espresso, Starbucks	1 fl. oz	75
Vault	12 fl. oz	70
Mountain Dew	12 fl. oz	55
Tea, regular, brewed	8 fl. oz	50
Tea, latte, Starbucks Tazo Chai	8 fl. oz	50
Espresso, regular	1 fl. oz	40
Coca-Cola/Pepsi, regular, flavored, diet	12 fl. oz	35–40
Tea, fruited, Snapple	8 fl. oz	20
Dark chocolate, Hershey's	1.45 oz	20
Milk chocolate, Hershey's	1.55 oz	10
Sprite/7-Up	12 fl. oz	0

SOURCE: Insel, P., et al. 2017. *Nutrition*. 6th ed. Burlington, MA: Jones & Bartlett Learning.

TOO MUCH CAFFEINE If you have problems falling or staying asleep, you should consider the possibility that caffeine is interfering with sleep. When you try to fall asleep at night, you may have enough sleep pressure to do so quickly; however, as your sleep pressure is relieved, the effects of caffeine consumed earlier in the day may grow more pronounced. It is important to be aware of the many hidden sources of caffeine and the variability in caffeine content in these sources (Table 4.1). It pays to scrutinize all the beverages that you may consume and to consider whether you should be having chocolate at night.

NEXT STEPS

- Sleep log—keep a sleep diary to discover your sleep pattern. It is best when doing the sleep diary to fill it out just once per day following the night of sleep. The sleep time should be an estimate and does not have to be exact, since it is best not to have any clocks visible at night in the bedroom.
- Choose some principles to implement or sleep disrupters to target.
- Which sleep disrupters did you identify as potential problems?
- After implementing some new sleep principles for a week, did you notice any difference in your sleep quality or patterns?
- Which healthy sleep principles helped address your sleep problems, if you have any?
- What was the impact of implementing these principles on your daytime function?

WELLNESS ON CAMPUS: Sleep-Improving and Sleep-Disrupting Medications

Should I take a sleeping aid?

Most sleep medications sold over the counter contain diphenhydramine (the active ingredient in Benadryl) or a similar antihistamine product. Histamine is a normal wake-promoting neurochemical in the brain, so antihistamines will tend to induce sleepiness. Over-the-counter sleep aids (Tylenol PM, Advil PM) contain twice the amount of diphenhydramine found in most allergy medications. These can slow down cognitive function and cause forgetfulness—they should rarely be taken on a regular basis. Melatonin is an over-the-counter medicine with relatively few side effects, making it a better choice than diphenhydramine and cetirizine. Taking a low dose several hours before bedtime mimics the natural release of the melatonin that occurs at dusk. If possible, prescription sleep medications should be avoided. They have been associated with a variety of problems, including sleepwalking, incoordination and falls, sleep-eating, car accidents, and in some studies, dementia and earlier mortality. These are generally not intended for long-term use, and studies have shown that nonmedicinal interventions are as effective and have longer-term benefits without the side effects of prescription medications.

Alcohol and Tobacco

Some people think that an alcoholic drink at night helps with sleep. Although alcohol may help with sleep onset in some people, most find that it has a negative effect later in the night, resulting in nighttime awakenings and poor-quality sleep. Even if people are not aware of this overnight, they will feel the effects the next day. Alcohol also worsens sleep-related breathing disorders.

Tobacco also has adverse effects on sleep. Tobacco is a stimulant and can directly interfere with sleep. In heavier users, it also has withdrawal effects that can wake them up.

Medications

Many medications cause insomnia or interfere with sleep, and other medications cause sleepiness. If you are having trouble sleeping and are taking medications prescribed by a doctor, it may be important to review these medications to ensure that none is responsible for the sleep difficulty or increased sleepiness. For medications that can promote insomnia, it might be helpful to discuss alternative medications that cause less sleep disruption or to discuss dosing these at earlier times of the day. Medications that cause sleepiness should be taken later in the day.

Common medications that may cause insomnia include many antidepressants, beta-blockers for high blood pressure, steroid medications, and over-the-counter medications labeled for daytime use. In susceptible people, medications for thyroid disorders or attention disorders can reduce sleep quality if these are taken in the afternoon or evenings.

Pain medications can also be bad for sleep. Opioids, in particular, cause a large number of problems, including addiction and sleep disruption. These medications negatively affect breathing and cause sleep apnea.

Opioids also directly cause sleepiness in almost 75% of people. Muscle relaxants can also affect respiration at night and can cause considerable sleepiness. While these may be prescribed for short periods, there are almost always alternatives.

Step III: Improve Sleep Fitness

In general, once sleep disrupters have been addressed, improving sleep often comes down to consolidating sleep or identifying the best sleep window for your biological rhythms, and as much as possible trying to adhere to that optimal frame for obtaining good sleep.

Lack of Sleep Daytime sleepiness is a major problem for college students. It can act as a roadblock to good grades, wellness, and achieving the optimal college experience, which is a foundation for later independence, employment, and social well-being.

What do big meals, boring classes, warm rooms, monotonous textbooks, long drives, and alcohol have in common? The answer is that none is a root cause of sleepiness. Instead, they are situations that each reduce the stimulation that normally holds an existing sleep debt at bay. Barring a major sleep disorder, you will not fall asleep playing basketball, weeding a garden, or painting a house. But remove the physical exertion, and sleep can occur rapidly—especially if your brain and body are yearning for much more than you are getting. Dull sedentary situations do not cause but rather unmask feelings of sleepiness; they are therefore a good sign that your waking hours are impaired by a sleep debt.

It's important to understand that the physiological tendency to sleep has only one primary cause, which is the ever-building pressure to sleep exerted by the homeostatic sleep drive. Knowing this, we won't be tempted to blame our sleepiness on the factors just discussed. With adequate and quality sleep, and little sleep debt, alertness, energy, motivation, and optimal functioning should continue throughout the day.

If your drowsiness is related to insufficient sleep, start by thinking about your baseline sleep needs. People are different in terms of how much sleep they need. Start with a trial of simply increasing the time that is allowed for sleep to see what amount provides you with optimal functioning. This is the type of exercise that was instituted in some of the studies of athletes that led to better athletic performance, but increasing sleep time has also been shown to enhance school

TAKE CHARGE
Delayed Sleep Phase

Common to young adults and college students is the delayed sleep phase. This problem can be identified if you notice that you get to bed much later than you intend and then have great difficulty getting up in the morning. People who have a biologically based night-owl tendency are more likely to fall into this pattern. A variety of tactics can be used to keep delayed sleep phase problems under control.

1. Bedtime Goal

A bedtime goal can be calculated by figuring out what your individual sleep need is. It may be helpful to identify a time in your life when you felt you were sleeping well and were able to function and engage well during the day with less difficulty getting up. Once you consider how many hours of sleep you were getting at that time, you can set up a goal sleep time frame. If you function best with 8.5 hours of sleep and have to get up at 7:00 a.m., then the goal bedtime might be 10:30. People with delayed tendencies should be realistic about setting an attainable schedule.

For people who do not have early morning obligations, it might be possible to have a 2:00 a.m. bedtime if the wake time is not before 10:00 a.m. Once the goal bedtime is set, people with delayed sleep phase need to think very carefully about factors that could alter their bedtimes to push this time later. For this goal you need to think about how to help strengthen your circadian rhythm to help you get sleepy around the goal bedtime.

2. Winding Down

You should give yourself a wind-down time of about an hour before bedtime. In the wind-down time, there should be no engagement with work or electronic devices; instead this time might be spent arranging things in the house or setting things up to make yourself ready for the next morning when people are typically less alert. Some people find that taking a low dose of melatonin a few hours before their wind-down time is helpful.

3. Getting an Early Start

For people with delayed sleep tendencies it is also helpful to get good sunlight in the early part of the day, to start the circadian period. Also, it may be helpful to eat a snack or a light breakfast to start the circadian clock. Delayed types of people tend to eat late, so it is important to count back three hours before your intended bedtime to try to finish eating.

Similarly, physical activity should occur during the day and not in the evening. Strengthening the circadian rhythm will not be effective if a reasonably consistent wake time is not also adhered to. In a person with delayed sleep phase tendencies it can be especially important not to let the wake time drift later, since that will also make it harder to fall asleep the next night. Keeping the wake times in a set range as was initially planned when the bedtime was selected will help reinforce the realignment of the circadian rhythm.

4. Limit Caffeine and Napping

A few things can sabotage progress on counteracting delayed sleep phase tendencies. These include caffeine—people with delayed sleep phase can be sensitive to caffeine because it will block the buildup of sleep pressure, and if keeping a set bedtime continues to be a problem, it is worth trying to taper off the use of caffeine, including in the morning.

As discussed earlier, if delayed sleep phase continues to be a problem, consider the potential negative effect of napping. Naps absorb the sleep pressure that accumulates during the day, in the natural homeostatic sleep drive. If a nap is necessary, it would be better to take it before 2:00 p.m. and limit it to 20 minutes.

performance. To implement a 9- or 10-hour sleep opportunity, first identify a consistent time to wake up that would allow enough time to meet obligations in the morning. If an 8:00 a.m. wake-up time is appropriate, then the goal bedtime would be 10:00 p.m. for a 10-hour sleep period. Depending on your sleep needs, even trying to ensure an 8-hour sleep opportunity might change your life.

In people who do not have a delayed sleep phase or insomnia, a nap might help compensate for some sleep loss. Several college campuses now have napping centers to give college students a place to get extra sleep during the day. College students may also compensate for lost sleep by allowing for longer sleep times on the weekends. Bear in mind that in some people this can contribute to sleep problems like delayed sleep phase, insomnia, or post-weekend jet-lag-like symptoms.

Social Jet Lag If you are someone who regularly sleeps until noon on the weekends, it may be difficult to sleep when you are trying to get up and ready for the work or school week, which for most people is on Sunday night. The weekend schedule may also cause difficulty getting up and functioning well on Monday. For some, this may not be a problem. For others, it can cause weekdays to go off the natural circadian schedule.

This turnabout can lead to a jet-lag type of feeling throughout the week, when alertness needs are high. When a circadian rhythm is out of sync between the weekdays and weekends, the effects can be profound. Remember that every cell in the body and every organ has a circadian rhythm, and when these are not in sync, people can experience not only sleepiness but also nausea, changes in mood, and changes in alertness and in their ability to learn, think, and work. In general, it may be better to avoid sleeping late two days in a row or sleeping much later than usual. For those people with insomnia or delayed sleep phase tendencies, it may be especially important to avoid changing the wake times too much on the weekends, even if people might stay up a little later in the evening.

WELLNESS ON CAMPUS: Learning While Sleeping

The connection of sleep to memory and learning is exciting and is a relatively recent area of sleep science research. Around 100 years ago, the first sleep-memory experiments asked their subjects to learn a list of nonsense syllables. The researchers found that when the subjects slept after learning the list, they could recall more syllables than if they stayed awake. In a Harvard study, students learned to navigate a complex maze. Some napped for 90 minutes; others stayed awake. When the students tried to solve the maze again, only the few who dreamed about it during their naps did better. These results suggest that dreaming may reactivate and reorganize recently learned material, which would help memory and boost performance.

How does sleeping help us learn? Our memories develop in three stages: encoding, consolidation, and retrieval. When we first experience information, it is encoded, or converted from sensory stimuli into a representation stored in the area of the brain called the hippocampus. When we then sleep, some of the newly encoded memories are consolidated, or stabilized in the cerebral cortex, where they become more permanent. The information we recently learned is selected to be rehearsed and becomes more ingrained and available for later retrieval, or reactivation.

Some studies indicate that NREM sleep is especially important for learning of certain types, like learning a new motor sequencing task or learning new word associations. But REM sleep might be better for other types of learning consolidation and problem solving. Researchers gave 77 participants a list of creative problems in the morning. Everyone was asked to think about solutions, and half of the participants took a nap before being tested.

All of the nappers were monitored during sleep. Only those who took longer naps entered REM sleep, which occupied about 14 minutes of the 73-minute naps. NREM napping did not boost creative problem solving, but people who entered REM sleep enhanced their performance by nearly 40%, as compared with both non-nappers and NREM nappers. The improvement was specific for problems that were introduced before napping; rather than simply boosting alertness and attention, REM sleep allowed the brain to work creatively on problems posed before sleep.

When sleep is disrupted, we can develop problems with attention, which can interfere with learning. Children and young adults who have trouble sleeping at night are especially prone to developing problems during the day—not so much that they are sleepy, but that they have trouble focusing their attention. One study looked at sleep apnea in first graders who were performing at the 10th percentile or below. Among the group who screened positive for sleep apnea, some followed a treatment plan. In the next grade, those children who were treated increased their performance to the 50th percentile; those who did not receive treatment remained at the 10th percentile or below.

Pulling all-nighters does not help grades and learning. Subjects who stayed awake 35 hours managed performances on memory tests that would earn them the equivalent of two letter grades lower than subjects who had slept.

SOURCES: Harvard Men's Health Watch. 2012. Learning while you sleep: Dream or reality. Harvard Health Publishing, Harvard Medical School (https://www.health.harvard.edu/staying-healthy/learning-while-you-sleep-dream-or-reality); Hershner, S. D., and R. D. Chervin. 2014. Causes and consequences of sleepiness among college students. *Nature and Science of Sleep* 6: 73–84; Vorster, A. P., and J. Borna. 2015. Sleep and memory in mammals, birds and invertebrates. *Neuroscience & Biobehavioral Reviews* 50: 103–119.

SLEEP DISORDERS

Although many of us can attribute the lack of sleep to long workdays and family responsibilities, as many as 70 million Americans suffer from chronic sleep disorders—medical conditions that prevent them from sleeping well. Some of the most common ones are described in the sections that follow.

Chronic Insomnia

Many people have trouble falling asleep or staying asleep—a condition called **insomnia.** About 30% of U.S. adults have some symptoms of insomnia, and as many as 10% suffer from pure insomnia.

TERMS

insomnia A sleep problem involving the inability to fall or stay asleep.

Insomnia Symptoms

People with pure insomnia, who do not have circadian rhythm issues or a sleep disrupter, typically do not feel sleepy in the daytime because they tend to have a higher arousal tendency. That is, they have trouble sleeping not only at night, but also in the day (even though they may feel fatigued). A person is considered to have chronic insomnia if sleep disruption occurs at least three nights per week and lasts at least three months.

Insomnia Treatment

Behavioral intervention and treatment of insomnia relies on addressing sleep disrupters or circadian rhythm factors. Examples of sleep disrupters are caffeine, reflux, congestion, cough, urination, anxiety or stress, pain, and environmental factors, among others. Even if those are not the sole reason for sleeplessness, it is helpful to treat those first or at least simultaneously; otherwise an insomnia treatment is unlikely to succeed. Most people can overcome insomnia by discovering the cause of poor sleep

and taking steps to remedy it. If your insomnia lasts more than six months and interferes with daytime functioning, you should probably talk to a sleep specialist in a medical center. Sleeping pills are not recommended for chronic insomnia because they can be habit-forming; they also lose their effectiveness over time.

SLEEP ROUTINE If you suffer from insomnia, changing your sleep schedule can bring relief. Counterintuitively, the core behavioral approach for treating insomnia is based on shortening the sleep period slightly and setting a very strict sleep window. Go to bed at the same time every night and, more important, get up at the same time every morning, seven days a week, regardless of how well you slept. This increases the homeostatic pressure to drive sleep onset (a longer time to build up sleepiness in the day) and also sets a consistent wake time and sleep time to establish circadian synchrony. When the sleep-window approach fails, it's usually because people tend to go to bed earlier than their sleep frame bedtime, or they sleep later in the morning. Sleep restriction or consolidation approaches to treating insomnia are very effective.

Another important component of a sleep routine is that naps during the day need to be limited. Typically naps should be limited to 20 minutes and taken before 2:00 p.m. Because this treatment is meant to produce sleepiness, naps should be taken only if absolutely necessary. Daytime sleepiness means the treatment is working! It can be tempting to try to stock up on sleep, but there are no biological benefits to oversleeping. In fact, it can extend your homeostatic sleep drive and delay your sleep phase, leading to another bout of insomnia.

QUICK STATS

30% of U.S. adults suffer from insomnia symptoms.

—American Academy of Sleep Medicine, 2018

Some mindset tips are useful. If you find yourself lying in bed, unable to fall asleep, that is okay. Disregard occasional setbacks and remember that light dozing or daydreaming have restorative value. You do not need to be completely unconscious, as long as you are relaxed. If you get anxious and start to worry, you might need to leave the bedroom and engage in a quiet activity to relax again. It is better to return to the bedroom when you feel sleepy again. Finally, it is important not to look at the clock. Try to forget about time once you are in bed.

ENVIRONMENTAL AND OTHER FACTORS After addressing your sleep patterns, turn your attention to other factors that influence your sleep. First, create a healthy sleep environment. While sleeping, keep your space quiet, dark, and at a comfortable temperature. Use your bed only for sleep; don't eat, read, study, or watch television there. This helps you associate your bed with sleep, which can support your routine.

Exercise every day, but not too close to bedtime. Your metabolism takes up to six hours to slow down after exercise, so you may feel more awake during that time.

Everyone is different with respect to how they respond to caffeine, but people who are light sleepers can be much more sensitive. As bedtime approaches, relax with a bath, a book, music, or relaxation exercises. Try to avoid screen-based technology to limit your exposure to blue light.

PROFESSIONAL HELP If sleep problems persist, visit your physician for help. If you take any medications (prescription or not), ask if they interfere with sleep. If you and your physician cannot identify potential problems, ask for a referral to a sleep specialist. You may be a candidate for a sleep study—an overnight evaluation of your sleep pattern that can uncover sleep-related disorders.

Restless Leg Syndrome

Restless leg syndrome (RLS) is an important sleep disrupter to identify because it is common and may be treatable with some simple interventions. RLS affects about 5% of the adult population and can affect as many as 25% of pregnant women. People are more susceptible to developing it if they have a family member who has it, and as many as 50% of people with RLS can identify another family member who has similar symptoms.

Restless Leg Syndrome Symptoms

RLS is characterized by a feeling of discomfort or body tension, often affecting the legs (the exact kind of discomfort can vary from person to person; it is often a feeling of something crawling under the skin, but it can be an ache, a tingling feeling, or a deep or sharp pain). The symptoms are related to the time of day, and they happen more in the evening or when lying down at night. Symptoms are helped by walking around or moving the legs, and they are worsened by sitting still, like during long airplane or car rides. RLS can be associated with small kicking movements during the night while sleeping that can cause arousals, even if one is not aware of them. If the person is awakened, the symptoms can make it harder to fall back to sleep.

Restless Leg Syndrome Treatment

Simple measures that help RLS include getting more exercise during the day, avoiding all caffeine, stretching legs and muscles before bedtime, and ensuring that iron levels are in the middle range. Certain substances such as diphenhydramine (Benadryl), a common ingredient in over-the-counter sleeping pills (e.g., Tylenol PM, Advil PM), paradoxically worsen this symptom and can worsen sleep. Medications can sometimes be needed to treat RLS when the behavioral interventions and elimination of triggers have not been successful. In cases that are resistant to these types of interventions, a health care provider may need to offer specialized expertise for treatment.

TERMS

restless leg syndrome (RLS) A sleep disrupter characterized by a feeling of discomfort or body tension, often affecting the legs.

Sleep Apnea

Sleep apnea is probably the most common disrupter of sleep. The risk for sleep apnea increases with age, and up to 50% of people may have sleep apnea after age 65. In younger and middle-aged groups, the rate is approximately 10–15%. Like RLS, sleep apnea can run in families, and if a person has a primary relative or is a loud snorer with sleep problems, that person should probably seek evaluation.

Ask Yourself

QUESTIONS FOR CRITICAL THINKING AND REFLECTION

You or someone you know has insomnia, but the sleep window is not working. Are you:

- Sleeping late—past the end of the sleep window time frame in the morning?
- Drinking a coffee in the morning?
- Having an alcoholic drink at night?
- Going to bed too early—before the sleep time frame starts at night?
- Making sure you don't have RLS, or sleep apnea, or another sleep disrupter you have not addressed? If you suspect sleep apnea could be a possibility, definitely have this checked. Remember even thin people can have apnea. If you have a snoring tendency or there is a family snoring tendency, you should be even more suspicious.

Sleep Apnea Symptoms The disorder is usually caused by a narrowed airway that gets more obstructed when sleeping, causing short, repeated breathing pauses (see Figure 4.8). Major medical problems, including high blood pressure, heart attack, and stroke, are associated with sleep apnea. It also has a negative impact on diabetes and increases the risk of work-related and automobile accidents. In children, if untreated, it can lead to poorer school performance and attention problems. Although sleep apnea is most common when people are overweight, it can affect people of any weight.

Not all people with sleep apnea are sleepy during the day, nor do all people realize that their sleep is disrupted, because they have become accustomed to it. Moderate to loud snoring and a family history for sleep apnea should make one consider checking for this possibility even in the absence of symptoms.

Interestingly, many people with sleep apnea are aware of having insomnia, but they do not complain of breathing problems or snoring.

TERMS

narcolepsy A rare neurological disorder characterized by excessive daytime sleepiness, sleep paralysis, and sudden loss of muscle control.

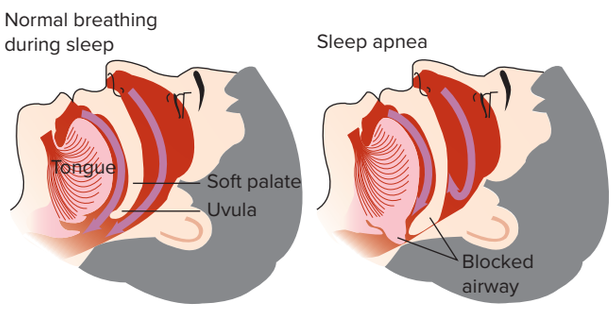


FIGURE 4.8 Sleep apnea. Sleep apnea occurs when soft tissues surrounding the airway relax, "collapsing" the airway and restricting airflow.

Sleep Apnea Treatment Sleep apnea is treatable, and treatment can have a major impact on quality of life and daytime function while also reducing associated risks. There are a number of treatments for sleep apnea, ranging from lifestyle adjustments to medical devices. Lifestyle changes include weight loss, sleeping on your side, quitting smoking, and using nasal sprays or allergy medicines to keep nasal passages open at night. Medical interventions include removal of the tonsils or adenoids, oral appliances, or continuous positive airway pressure (CPAP) nasal masks and machines. Dental devices, which are inserted mouthpieces, can be worn at night to adjust the position of the lower jaw. A CPAP machine has a mask that fits over the mouth and/or the nose and gently blows air into the throat, keeping it open. As sleep apnea has become increasingly recognized, it has become more and more common to see people bringing their CPAP machines onto airplanes or to hotels.

Narcolepsy

Narcolepsy is a rare disorder that affects about 1 in 2000 people and appears between the ages of 10 and 20. The condition comes from a gene mutation in the brain and cannot be passed down from parent to child. Its symptoms include excessive daytime sleepiness, sleep paralysis, and sudden loss of muscle control.

Narcolepsy Symptoms When narcoleptic people feel sleepy in the daytime, it can come as an overwhelming urge to sleep while driving, working, or eating—very inconvenient times. At nighttime, they do not sleep well. And in the transition to waking, the paralysis that we all experience during REM lingers for people with narcolepsy: Instead of the brain releasing them from paralysis at just the right time, they may have difficulty talking or moving. Gradually the paralysis wears off. The third symptom, called *cataplexy*, is a sudden loss of muscle control that might be noticeable in slurred speech, a jaw dropping, or legs buckling. The cataplexy can be triggered by strong emotions like laughing hard or getting startled. In these moments, a narcoleptic person may collapse into a body paralysis.

Narcolepsy Treatment Unfortunately, treatments for narcolepsy are few and ineffective. The disorder is rare enough that drug companies have not found it profitable to invest much research in drug therapies. But patients can take a drug called Provigil to help them stay awake during the day and antidepressants to help suppress REM sleep and thus the paralysis characteristic of the other two symptoms.

TIPS FOR TODAY AND THE FUTURE

RIGHT NOW YOU CAN:

- Identify sleep disrupters using the "Sleep-Disrupter Checklist" (pages 87–88).
- Determine your natural sleep rhythm (night owl or morning lark) and overall individual sleep need (short sleeper, long sleeper). Design your optimal sleep period.
- Evaluate your sleep environment and bedtime activities: How are the temperature, darkness, and noise in your bedroom? Is there a problem disengaging from distractors and electronics at night?

IN THE FUTURE YOU CAN:

- Be aware of sleep-disrupting substances such as caffeine, performance protein supplements, alcohol, and stimulants.
- Avoid going to bed too early or getting up too late (if you didn't have a good night's sleep). Keep to a specific time frame, and set clear sleep and wake times. Avoid lying down to rest or nap for more than 20 minutes.
- Exercise during the day, but not at night.

SUMMARY

• Sleep affects almost all systems of the body, including respiratory, cardiovascular, endocrine, gastrointestinal, urinary, and nervous systems.

• Sleep occurs in two main phases: rapid eye movement (REM) sleep and non–rapid eye movement (NREM) sleep, which constitutes three substages. A sleeper goes through several cycles of NREM and REM sleep each night. Each stage is characterized by different patterns of electrical brain activity as measured by the electroencephalogram (EEG) and accomplishes different functions.

• Two main natural forces drive us toward sleep—the homeostatic sleep drive and the circadian rhythm. Homeostatic sleep drive is driven by a neurochemical, adenosine, that accumulates in the brain as a by-product of energy the brain uses, and adenosine promotes sleep onset. The drive is strengthened by a reasonable wake–sleep schedule without naps and dozing and caffeine.

• Circadian rhythm is the sleep and wake pattern coordinated by the brain's master internal clock, the suprachiasmatic nucleus (SCN). The SCN sets and controls—synchronizes—the sleep–wake cycle of the brain and of every cell in every organ of the body. The rhythm can be disrupted by jet lag and irregular and late sleep practices, as well as by substances such as caffeine and alcohol. Our circadian rhythm is most strongly influenced by light exposure, as well as by activity, exercise, and eating—zeitgabers that can reset our wake–sleep clocks. Good light exposure in the morning and daytime and reduced exposure to light at night strengthen the rhythmic effects.

• Sleep rhythms and needs change with aging. Over a typical life span, the amount of time we spend sleeping each day declines and patterns during sleep change. After teen years, adults consistently need 7-9 hours of sleep per night. As we age, however, the amount of overall sleep and the amount of deep sleep we get diminish. In the teen years, a delayed sleep phase develops, and other circadian rhythms change. Differences in sleep arousal evolve throughout life.

• Sleep is important for mental health, mood, creativity and learning, and physical health. It has an impact on longevity and the emergence of major diseases. Poor-quality or insufficient sleep has been associated with a number of health problems and impairments—heart disease, high blood pressure, depression, earlier death, increased risk for dementia, weight gain, poorer glucose control, increased risk for accidents, reduced motivation and attention, and increased irritability or hyperactivity. Improving your sleep can combat our national public epidemic of sleep deprivation.

• Lack of sleep has a great impact on stress. In someone who is suffering from sleep deprivation (not getting enough sleep over time), mental and physical processes deteriorate steadily. A sleep-deprived person experiences headaches, feels irritable, cannot concentrate, and is prone to forgetfulness. Poor-quality sleep has long been associated with stress and depression.

• Drowsiness slows your reaction time and lessens your ability to pay attention and make good decisions. People who are most at risk for falling asleep while driving include young adults aged 18–29. Researchers estimate that drowsy driving is responsible for more than 70,000 crashes, 40,000 injuries, and as many as 7500 deaths per year. Accidents due to sleepiness are preventable.

• As many as 70 million Americans suffer from chronic sleep disorders—medical conditions that prevent them from sleeping well. Very common sleep disorders are chronic insomnia, trouble falling asleep or staying asleep; restless leg syndrome, and sleep apnea, repeated stops in breathing for short periods—frequently 20 to 40 seconds—while asleep. They can all be treated, some through lifestyle changes.

• Sleep disrupters are specific factors that interfere with the ability to fall or stay asleep that can usually be corrected if they are targeted specifically. These include caffeine, reflux, nasal congestion, cough, urination, anxiety or stress, pain, environmental factors such as room temperature and lighting, electronic devices, alcohol, tobacco, medications, among others.

• Sleep time has to be tailored to the individual, and then reasonable practices can be developed that definitely improve quality of sleep: supporting natural sleep rhythms and drives, creating a good sleep environment, and avoiding substances and events that disrupt sleep.

• You can take control of your sleep by monitoring your sleep habits (keeping a sleep diary to identify your schedule and the best hours for adequate sleep), tracking your eating and exercise behaviors, and

LAB EXERCISES
Sleep Case Scenarios

These cases by no means exhaust the many patterns of sleep issues people may face, and most people can encounter some of these various problems at different times. Being aware of how to troubleshoot sleep problems can help you take charge of your sleep-related health and know when to seek further help when a problem becomes more persistent.

Case 1. I have trouble falling asleep at night.

Some potential remedies: (1) Cut down and eliminate all sources of caffeine—even in the morning. (2) Avoid all daytime naps or at least limit these to 20 minutes before 2:00 p.m. (may set an alarm). (3) Avoid bright lights and electronic activities in the hour before bedtime, and remove clocks or devices that tell the time from the bedroom. It is best if cell phones are charged outside of the bedroom. (4) Increase bright light exposure in the morning. (5) Avoid exercising in the evening. (6) Set bedtime late enough to allow for sleep drive to accumulate (an appropriate bedtime might be 11:00 p.m. or later for some people). (7) Set wake time early enough so that there is enough time to develop sleep need over the day. (8) Ensure that you are not accidentally dozing before bedtime and using up the sleep drive that helps you fall asleep (you can try to sit in less comfortable chairs or be more active in the evenings if this is the case).

Case 2. I have several episodes of waking up during the night.

(1) Ensure that you are not drinking or eating in the three hours before bedtime. (2) Do you have any nasal allergies? Treatment of these may improve sleep continuity. (3) Have you been drinking any caffeine during the day? Caffeine can cause wake-ups during the night after the sleep drive has worn off, and eliminating caffeine can help. (4) Do you have a family history of apnea, or are you a snorer? Is there a possibility you might have apnea? (5) Are there factors in the environment waking you up? Noise? Is the temperature too hot? Are there pets in the bedroom? (6) Did you drink alcohol before going to bed?

Case 3. I have trouble waking up in the morning.

(1) Do you have different times that you wake up on different days—for example, do you wake up much later on the weekend and much earlier on certain days of the week? If so, you may be putting your body through a frequent jet-lag experience, and keeping your wake times closer to one another from day to day may be helpful to keep your circadian rhythm in sync. (2) Are you getting enough sleep? Do you need to wind down earlier? (3) Do your bedtimes tend to get later and later? You may need to anchor your circadian rhythm with more light in the morning. (4) Are there sleep disrupters at night that are disturbing your sleep (see Case 2)?

Case 4. I am too sleepy in the daytime.

(1) Are you getting enough sleep at night? This problem may be helped by increasing your sleep time. You may be a naturally long sleeper and need more sleep time. (2) Is nighttime sleep disrupted by snoring, possible apnea, reflux, nasal congestion, noise, or other factors so that you are not getting enough continuous sleep at night even though you are in bed? (3) Are you taking medications that can worsen sleepiness? (4) Do most of your problems with sleepiness occur in the morning, and might you have problems outlined in Case 3?

noting any medical conditions that might interfere, and then setting goals and identifying strategies for improving sleep behaviors.

- Chronic insomnia, repeated disrupted sleep that lasts for months, is very common and affects an estimated 10% of the population. Behavioral intervention and treatment is based on shortening the sleep period slightly and setting a very strict sleep window—denying sleep outside that time constraint—to slightly sleep-deprive the person. That in turn has the effect of "kickstarting" the natural physiological sleep rhythms.

- While a good effect of using a digital sleep tracker is the greater focus it places on sleep, no consumer technology can equal the ability of a sleep lab to detect sleep stages or diagnose specific sleep disorders.

- General benefits of adequate sleep:
  - Improves memory of recently learned information
  - Washes waste from the brain that can contribute to mild cognitive impairment
  - Addressing a sleep disorder may improve inattention symptoms and learning capacity
  - Helps optimize athletic performance
  - Positively affects appetite regulation factors ghrelin and leptin
  - Improves mood and stamina against depression

- The good news is that with more knowledge about sleep and the factors that affect it, people can improve their sleep and, in turn, their health. Along with exercise and good nutrition, good sleep is a critical pillar of good health.

FOR MORE INFORMATION

American Academy of Sleep Medicine. Advocates research and advocacy to improve sleep health.
https://aasm.org/

American Sleep Association. Advances the medical specialty of sleep medicine.
www.sleepassociation.org

Centers for Disease Control and Prevention. Seeks to raise awareness about the problems connected to insufficient sleep and related disorders.
www.cdc.gov/sleep/index.html

Choose Sleep. Aims to increase awareness about the risks of sleep disorders and the importance of sleep.

http://www.choosesleep.org

Harvard Medical School Division of Sleep Medicine. Engages in research on sleep, circadian rhythms, and sleep-disorder treatment.

https://sleep.med.harvard.edu/

National Institutes of Health. Supports research about key health topics, including sleep.

www.nih.gov

National Sleep Foundation. Provides information about sleep and how to overcome sleep problems such as insomnia and jet lag.

https://www.sleepfoundation.org/

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