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Eleventh Edition

HEALTH PSYCHOLOGY

Shelley E. Taylor • Annette L. Stanton

Mc Graw Hill

HEALTH PSYCHOLOGY

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University of California, Los Angeles

Mc Graw Hill

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For Everyone Living with a Chronic Disease Who So Generously Takes Part in Our Research

ABOUT THE AUTHOR

Courtesy of Shelley E. Taylor

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Courtesy of Annette Stanton

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PREFACE

When I (Dr. Taylor) wrote the first edition of *Health Psychology* over 30 years ago, the task was much simpler than it is now. Health psychology was a new field and was relatively small. In recent decades, the field has grown steadily, and great research advances have been made. Chief among these developments is the use and refinement of the biopsychosocial model: the study of health issues from the standpoint of biological, psychological, and social factors acting together. Increasingly, researchers have identified the biological pathways by which psychosocial factors such as stress may adversely affect health and potentially protective factors such as social support may buffer the impact of stress. With Dr. Stanton joining as an author, our goal in the 11th edition of this text is to convey this increasing sophistication of the field in a manner that makes it accessible, comprehensible, and exciting to undergraduates.

Like any science, health psychology is cumulative, building on past research advances to develop new ones. Accordingly, we have tried to present not only the fundamental contributions to the field but also the current research on these issues. Because health psychology is developing and changing so rapidly, it is essential that a text be up to date. Therefore, we have not only reviewed the recent research in health psychology but also obtained information about research projects that will not be available in the research literature for several years. In so doing, we are presenting a text that is both current and pointed toward the future.

A second goal is to portray health psychology appropriately as being intimately involved with the problems of our times. The aging of the population and the shift in numbers toward the later years have created unprecedented health needs to which health psychology must respond. Such efforts include the need for health promotion with this aging cohort and an understanding of the psychosocial issues that arise in response to aging and its associated chronic disorders. Because AIDS is a leading cause of death worldwide, the need for health measures such as condom use is readily apparent if we are to halt the spread of this disease. Obesity is now one of the world's leading health problems, nowhere more so than in the United States. Reversing this dire trend that threatens to shorten life expectancy worldwide is an important current goal of health psychology. Increasingly, health psychology is an international undertaking, with researchers from around the world providing insights into the problems that affect both developing and developed countries. The 11th edition includes current research that reflects the international focus of both health problems and the health research community.

Health habits lie at the origin of our most prevalent disorders, and this fact underscores more than ever the importance of modifying problematic health behaviors such as smoking and alcohol consumption. Increasingly, research documents the importance of a healthy diet, regular exercise, and weight control among other positive health habits for maintaining good health. The at-risk role has taken on more importance in prevention, as breakthroughs in genetic research have made it possible to identify genetic risks for diseases long before disease is evident. How people cope with being at risk and what interventions are appropriate for them represent important tasks for health psychology research to address.

Health psychology is both an applied field and a basic research field. Accordingly, in highlighting the accomplishments of the field, we present both the scientific progress and its important applications. Chief among these are efforts by clinical psychologists to intervene with people to treat biopsychosocial disorders, such as post traumatic stress disorder; to help people manage health habits that have become life threatening, such as eating disorders; and to develop clinical interventions that help people better manage their chronic illnesses.

Finding the right methods and venues for modifying health continues to be a critical issue. The chapters on health promotion put particular emphasis on the most promising methods for changing health behaviors. The chapters on chronic diseases highlight how knowledge of the psychosocial causes and consequences of these disorders may be used to intervene with people at risk—first, to reduce the likelihood that such disorders will develop, and second, to deal effectively with the psychosocial issues that arise following diagnosis.

The success of any text depends ultimately on its ability to communicate the content clearly to student readers and spark interest in the field. In this 11th edition, we strive to make the material interesting and relevant to the lives of student readers. Many chapters highlight news stories related to health. In addition, the presentation of material has been tied to the needs and interests of young adults. For example, the topic of stress management is tied directly to how students might manage the stresses associated with college life. The topic of problem drinking includes sections on college students' alcohol consumption and its modification. Health habits relevant to this age group—tanning, exercise, and condom use, among others—are highlighted for their relevance to the student population. By learning from anecdotes, case histories, and specific research examples that are relevant to their own lives, students learn how important this body of knowledge is to their lives as young adults.

Health psychology is a science, and consequently, it is important to communicate not only the research itself but also some understanding of how studies were designed and why they were designed that way. The explanations of particular research methods and the theories that have guided research appear throughout the book. Important studies are described in depth so that students have a sense of the methods researchers use to make decisions about how to gather the best data on a problem or how to intervene most effectively.

Throughout the book, we have made an effort to balance general coverage of psychological concepts with coverage of specific health issues. One method of doing so is by presenting groups of chapters, with the initial chapter offering general concepts and subsequent chapters applying those concepts to specific health issues. Thus, Chapter 3 discusses general strategies of health promotion, and Chapters 4 and 5 discuss those issues with specific reference to particular health habits such as exercise, smoking, accident prevention, and weight control. Chapters 11 and 12 discuss broad issues that arise in the context of managing chronic health disorders and terminal illness. In Chapters 13 and 14, these issues are addressed concretely, with reference to specific disorders such as heart disease, cancer, and AIDS.

Rather than adopt a particular theoretical emphasis throughout the book, we have attempted to maintain a flexible orientation. Because health psychology is taught within all areas of psychology (e.g., clinical, social, cognitive, physiological, learning, and developmental), material from each of these areas is included in the text so that it can be accommodated to the orientation of each instructor. Consequently, not all material in the book is relevant for all courses. Successive chapters

of the book build on each other but do not depend on each other. Chapter 2, for example, can be used as assigned reading, or it can act as a resource for students wishing to clarify their understanding of biological concepts or learn more about a particular biological system or illness. Thus, each instructor can accommodate the use of the text to his or her needs, giving some chapters more attention than others and omitting some chapters altogether, without undermining the integrity of the presentation.

NEW TO THIS EDITION

- More than 300 new citations
- Discussion of artificial intelligence and health care (Chapters 1, 9)
- Expanded coverage of web-based interventions (Chapters 1, 3, 11)
- Coverage of the significance of telomeres (Chapters 2, 6)
- Coverage of the gut–brain connection (Chapter 2)
- Discussion of telemedicine (Chapters 2, 8, 15)
- Expanded coverage of dementia (Chapters 2, 11)
- Discussion of socio cultural values and health (Chapters 3, 14)
- Expanded coverage of aging and health (Chapters 3, 4, 11, 14)
- Coverage of just-in-time interventions (Chapters 3, 15)
- Enhanced coverage of marijuana use (Chapter 5)
- New research on positive parenting, stress, and health (Chapter 6)
- Expanded converge on the health effects of prejudice and discrimination (Chapters 6, 13, 14, 15)
- Coverage of the benefits of a sense of purpose and meaning in life (Chapter 7)
- Coverage of research on attempts to cope through actively approaching or avoiding stressful experiences (Chapter 7)
- Enhanced coverage of couples' attempts to cope with shared stressors (Chapter 7)
- Expanded coverage of mindfulness and mindfulness meditation (Chapters 7, 10)
- Enhanced coverage of the health consequences of social support and loneliness (Chapter 7)
- Discussion of the opioid crisis (Chapter 10)
- Expanded coverage of suicide (Chapter 12)
- Coverage of palliative care and end-of-life options (Chapter 12)
- Expanded discussion of bereavement (Chapter 12)
- Enhanced coverage of the prevention and treatment of HIV/AIDS (Chapter 14)
- Expanded coverage of contributors to cancer onset and progression (Chapter 14)
- The changing face of health psychology (Chapter 15)

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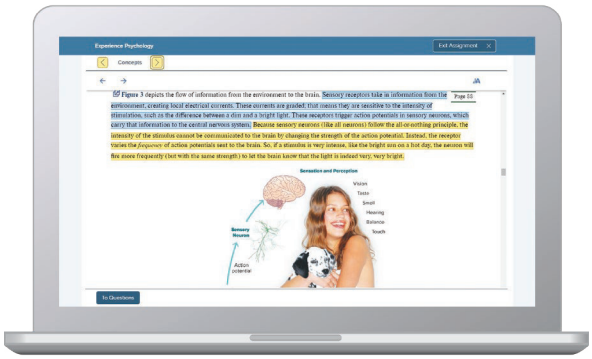

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PART 1

Introduction to Health Psychology

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CHAPTER 1

What Is Health Psychology?

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Every day, we see headlines about health. We are told that smoking is bad for us, that we need to exercise more, and that we've grown obese. We learn about new treatments for diseases about which we are only dimly aware, or we hear that a particular herbal remedy may make us feel better about ourselves. We are told that meditation or optimistic beliefs can keep us healthy or help us get well more quickly. How do we make sense of all these claims? Health psychology addresses important questions like these.

DEFINITION OF HEALTH PSYCHOLOGY

Health psychology is an exciting and relatively new field devoted to understanding psychological influences on how people stay healthy, why they become ill, and how they respond when they do get ill. Health psychologists both study such issues and develop interventions to help people stay well or recover from illness. For example, a health psychology researcher might explore why people continue to smoke even though they know that smoking increases their risk of cancer and heart disease. Understanding this poor health habit leads to interventions to help people stop smoking.

Fundamental to research and practice in health psychology is the definition of health. Decades ago, a forward-looking World Health Organization (1948) defined **health** as "a complete state of physical, mental, and social well-being and not merely the absence of disease or infirmity." This definition is at the core of health psychologists' conception of health. Rather than defining health as the absence of illness, health is recognized to be an achievement involving balance among physical, mental, and social well-being. Many use the term **wellness** to refer to this optimum state of health.

Health psychologists focus on *health promotion and maintenance,* which includes issues such as how to get children to develop good health habits, how to promote regular exercise, and how to design a media campaign to get people to improve their diets.

Health psychologists study the psychological aspects of the *prevention and treatment of illness.* A health psychologist might teach people in a high-stress occupation how to manage stress effectively to avoid health risks. A health psychologist might work with people who are already ill to help them follow their treatment regimen.

Health psychologists also focus on *the etiology and correlates of health, illness, and dysfunction.* **Etiology** refers to the origins or causes of illness. Health psychologists especially address the behavioral and social factors that contribute to health, illness, and dysfunction, such as alcohol consumption, drug use, exercise, the wearing of seat belts, and ways of coping with stress.

Finally, health psychologists analyze and attempt to improve *the health care system and the formulation of health policy.* They study the impact of health institutions and health professionals on people's behavior to develop recommendations for improving health care.

In summary, health psychology examines the psychological and social factors that lead to the enhancement of health, the prevention and treatment of illness, and the evaluation and modification of health policies that influence health care.

Why Did Health Psychology Develop?

To many people, health is simply a matter of staying well or getting over illnesses quickly. Psychological and social factors might seem to have little to contribute. But consider some of the following puzzles that cannot be understood without the input of health psychology:

- When people are exposed to a cold virus, some get colds whereas others do not.
- Men who are married live longer than men who are not married.
- Throughout the world, life expectancy is increasing. But in countries going through dramatic social upheaval, life expectancy can plummet.
- Women live longer than men in all countries except those in which they are denied access to health care. But women are more disabled, have more illnesses, and use health services more.

- Infectious diseases such as tuberculosis, pneumonia, and influenza used to be the major causes of illness and death in the United States. Now chronic disorders such as heart disease, cancer, and diabetes are the main causes of disability and death.
- Attending a church or synagogue, praying, or otherwise tending to spiritual needs is good for your health.

By the time you have finished this book, you will know why these findings are true.

THE MIND–BODY RELATIONSHIP: A BRIEF HISTORY

During prehistoric times, most cultures regarded the mind and body as intertwined. Disease was thought to arise when evil spirits entered the body, and treatment consisted primarily of attempts to exorcise these spirits. Some skulls from the Stone Age have small, symmetrical holes that are believed to have been made intentionally with sharp tools to allow the evil spirit to leave the body while the shaman performed the treatment ritual.

The ancient Greeks were among the earliest civilizations to identify the role of bodily factors in health and illness. Rather than ascribing illness to evil spirits, they developed a humoral theory of illness. According to this viewpoint, disease resulted when the four humors or circulating fluids of the body—blood, black bile, yellow bile, and phlegm—were out of balance. The goal of treatment was to restore balance among the humors. The Greeks also believed that the mind was important. They described personality types associated with each of the four humors, with blood being associated with a passionate temperament, black bile with sadness, yellow bile with an angry disposition, and phlegm with a laid-back approach to life. Although these theories are now known not to be true, the emphasis on mind and body in health and illness was a breakthrough for that time.

By the Middle Ages, however, the pendulum had swung to supernatural explanations for illness. Disease was regarded as God's punishment for evildoing, and cure often consisted of driving out the evil forces by torturing the body. Later, this form of "therapy" was replaced by penance through prayer and good works. During this time, the Church was the guardian of medical knowledge, and as a result, medical practice assumed religious overtones. The functions of the physician were typically absorbed by priests, and so healing and the practice of religion became virtually indistinguishable.

Sophisticated, though not always successful, techniques for the treatment of illness were developed during the Renaissance. This woodcut from the 1570s depicts a surgeon drilling a hole in a patient's skull, with the patient's family and pets looking on.

Source: The National Library of Medicine.

Beginning in the Renaissance and continuing into the present day, great strides were made in understanding the technical bases of medicine. These advances include the invention of the microscope in the 1600s and the development of the science of autopsy, which allowed medical practitioners to see the organs that were implicated in different diseases. As the science of cellular pathology progressed, the humoral theory of illness was put to rest. Medical practice drew increasingly on laboratory findings and looked to bodily factors rather than to the mind as bases for health and illness. In an effort to break with the superstitions of the past, practitioners resisted acknowledging any role for the mind in disease processes. Instead, they focused primarily on organic and cellular pathology as a basis for their diagnoses and treatment recommendations.

The resulting **biomedical model,** which has governed the thinking of most health practitioners for the past 300 years, maintains that all illness can be explained on the basis of aberrant somatic bodily processes, such as biochemical imbalances or neurophysiological abnormalities. The biomedical model assumes that psychological and social processes are largely irrelevant to the disease process. The problems with the biomedical model are summarized in Table 1.1.

TABLE 1.1 | The Biomedical Model: Why Is It Ill-suited to Understanding Illness?

- Reduces illness to low-level processes such as disordered cells and chemical imbalances
- Fails to recognize social and psychological processes as powerful influences over bodily states—assumes a mind–body dualism
- Emphasizes illness over health rather than focusing on behaviors that promote health
- Cannot address many puzzles that face practitioners: why, for example, if six people are exposed to a flu virus, do only three develop the flu?

THE RISE OF THE BIOPSYCHOSOCIAL MODEL

The biomedical viewpoint began to change with the rise of modern psychology, particularly with Sigmund Freud's (1856–1939) early work on **conversion hysteria.** According to Freud, specific unconscious conflicts can produce physical disturbances that symbolize repressed psychological conflicts. Although this viewpoint is no longer central to health psychology, it gave rise to the field of psychosomatic medicine.

Psychosomatic Medicine

The idea that specific illnesses are produced by people's internal conflicts was perpetuated in the work of Flanders Dunbar in the 1930s (Dunbar, 1943) and Franz Alexander in the 1940s (Alexander, 1950). For example, Alexander developed a profile of the ulcer-prone personality as someone with excessive needs for dependency and love.

Dunbar and Alexander maintained that conflicts produce anxiety, which becomes unconscious and takes a physiological toll on the body via the autonomic nervous system. The continuous physiological changes eventually produce an organic disturbance. In the case of the ulcer patient, for example, repressed emotions resulting from frustrated dependency and love-seeking needs were thought to increase the secretion of acid in the stomach, eventually eroding the stomach lining and producing ulcers (Alexander, 1950).

Dunbar's and Alexander's work helped shape the emerging field of **psychosomatic medicine** by offering profiles of particular disorders believed to be psychosomatic in origin, that is, caused by emotional conflicts. These disorders include ulcers, hyperthyroidism, rheumatoid arthritis, essential hypertension, neurodermatitis (a skin disorder), colitis, and bronchial asthma.

We now know that all illnesses raise psychological issues. Moreover, researchers now believe that a particular conflict or personality type is not sufficient to produce illness. Rather, the onset of disease is usually due to several factors working together, which may include a biological pathogen (such as a viral or bacterial infection) coupled with social and psychological factors, such as high stress, low social support, and low socioeconomic status.

The idea that the mind and the body together determine health and illness logically implies a model for studying these issues. This model is called the **biopsychosocial model.** Its fundamental assumption is that health and illness are consequences of the interplay of biological, psychological, and social factors.

Advantages of the Biopsychosocial Model

How does the biopsychosocial model of health and illness overcome the disadvantages of the biomedical model? The biopsychosocial model maintains that biological, psychological, and social factors are all important determinants of health and illness. Both macrolevel processes (such as the existence of social support or

the presence of depression) and microlevel processes (such as cellular disorders or chemical imbalances) continually interact to influence health and illness and their course.

The biopsychosocial model emphasizes both health and illness. From this viewpoint, health becomes something that one achieves through attention to biological, psychological, and social needs, rather than something that is taken for granted.

Clinical Implications of the Biopsychosocial Model

The biopsychosocial model is useful for people treating patients as well. First, the process of diagnosis can benefit from understanding the interacting role of biological, psychological, and social factors in assessing a person's health or illness. Treatment can focus on all three sets of factors.

The biopsychosocial model makes explicit the significance of the relationship between patient and practitioner. An effective patient–practitioner relationship can improve a patient's use of services, the efficacy of treatment, and the rapidity with which illness is resolved.

The Biopsychosocial Model: The Case History of Nightmare Deaths

To see how completely the mind and body are intertwined in health, consider a case study that intrigued medical researchers for nearly 15 years. It involved the bewildering "nightmare deaths" among Southeast Asians.

Following the Vietnam War, in the 1970s, refugees from Southeast Asia, especially Laos, Vietnam, and Cambodia, immigrated to the United States. Around 1977, the Centers for Disease Control and Prevention (CDC) in Atlanta became aware of a strange phenomenon: sudden, unexpected nocturnal deaths among male refugees from these groups. Death often occurred in the first few hours of sleep. Relatives reported that the victim began to gurgle and move about in bed restlessly. Efforts to awaken him were unsuccessful, and shortly thereafter he died. Even more mysteriously, autopsies revealed no specific cause of death.

However, most of the victims appeared to have a rare, genetically based malfunction in the heart's pacemaker. The fact that only men of particular ethnic backgrounds were affected was consistent with the potential role of a genetic factor. Also, the fact that the deaths seemed to cluster within particular families was consistent with the genetic theory. But how and why would such a defect be triggered during sleep?

As the number of cases increased, it became evident that psychological and cultural, as well as biological, factors were involved. Some family members reported that the victim had experienced a dream foretelling the death. Among the Hmong of Laos, a refugee group that was especially plagued by these nightmare deaths, dreams are taken seriously as portents of the future. Anxiety due to these dreams, then, may have played a role in the deaths (Adler, 1991).

Another vital set of clues came from a few men who were resuscitated by family members. Several of them said that they had been having a severe night terror. One man, for example, said that his room had suddenly grown darker, and a figure like a large black dog had come to his bed and sat on his chest. He had been unable to push the dog off and had become quickly and dangerously short of breath (Tobin & Friedman, 1983). This was also an important clue because night terrors are known to produce abrupt and dramatic physiological changes.

Interviews with the survivors revealed that many of the men had been watching violent TV shows shortly before retiring, and the content of the shows appeared to have made its way into some of the frightening dreams. In other cases, the fatal event occurred immediately after a family argument. Many of the men were said by their families to have been exhausted from combining demanding full-time jobs with a second job or with night school classes to learn English. The pressures to support their families had been taking their toll.

All these clues suggest that the pressures of adjusting to life in the United States played a role in the deaths. The victims may have been overwhelmed by cultural differences, language barriers, and difficulties finding satisfactory jobs. The combination of this chronic strain, a genetic susceptibility, and an immediate trigger provided by a family argument, violent television, or a frightening dream culminated in nightmare death (Lemoine & Mougne, 1983). Clearly, the biopsychosocial model unraveled this puzzle.

THE NEED FOR HEALTH PSYCHOLOGY

What factors led to the development of health psychology? Since the inception of the field of psychology in the early 20th century, psychologists have made important contributions to health, exploring how and

why some people get ill and others do not, how people adjust to their health conditions, and what factors lead people to practice health behaviors. In response to these trends, the American Psychological Association (APA) created a task force in 1973 to focus on psychology's potential role in health research. Participants included counseling, clinical, and rehabilitation psychologists, many of whom were already employed in health settings. Independently, social psychologists, developmental psychologists, and community/environmental psychologists were developing conceptual approaches for exploring health issues (Friedman & Silver, 2007). These groups joined forces, and in 1978, the Division of Health Psychology was formed within the APA. It is safe to say that health psychology is one of the most important developments within the field of psychology in the past 50 years. What other factors have fueled the growing field of health psychology?

Changing Patterns of Illness

An important factor influencing the rise of health psychology has been the change in illness patterns in the United States and other technologically advanced societies in recent decades. As Table 1.2 shows, until the 20th century, the major causes of illness and death in the United States were **acute disorders.** Acute disorders are short-term illnesses, often a result of a viral or bacterial invader and usually amenable to cure. The prevalence of acute infectious disorders, such as tuberculosis, influenza, measles, and poliomyelitis, has declined because of treatment innovations and changes in public health standards, such as improvements in waste control and sewage.

Now, **chronic illnesses**—especially heart disease, cancer, and respiratory diseases—are the main contributors to disability and death, particularly in industrialized countries. Chronic illnesses are slowly developing diseases with which people live for many years and that typically cannot be cured but rather are managed by patient and health care providers. Table 1.3 lists the main diseases worldwide at the present time. Note how the causes are projected to change over the next decade or so worldwide.

Why have chronic illnesses helped spawn the field of health psychology? First, these are diseases in which psychological and social factors are implicated as causes. For example, personal health habits, such as diet and smoking, contribute to the development of heart disease and cancer, and sexual activity is critical to the likelihood of developing AIDS (acquired immune deficiency syndrome).

Second, because people may live with chronic diseases for many years, psychological issues arise in their management. Health psychologists help chronically ill people adjust psychologically and socially to their changing health state and treatment regimens, many of which involve self-care. Chronic illnesses affect family functioning, including relationships with a partner or children, and health psychologists help ease the problems in family functioning that may result.

Chronic illnesses may require medication use and self-monitoring of symptoms, as well as changes in

TABLE 1.2 | What Are the Leading Causes of Death in the United States? A Comparison of 1900 and 2017, per 100,000 Population

1900		2017	
Influenza and pneumonia	202.2	Heart disease	165.0
Tuberculosis, all forms	194.4	Cancer	152.5
Gastroenteritis	142.7	Unintentional injuries	49.4
Diseases of the heart	137.4	Chronic lower respiratory diseases	40.9
Vascular lesions of the CNS	106.9	Stroke	37.6
Chronic nephritis	81.0	Alzheimer's disease	31.0
All accidents	72.3	Diabetes	21.5
Malignant neoplasms (cancer)	64.0	Influenza and pneumonia	14.3
Certain diseases of early infancy	62.6	Intentional self-harm (suicide)	14.0
Diphtheria	40.3	Nephritis, nephrotic syndrome, and nephrosis	13.0

Note that some accidents and overdoses may be attempts at suicide, so it can be hard to distinguish between those two categories.
Source: Xu, Jiaquan, Sherry L. Murphy, Kenneth D. Kochanek, Brigham Bastian, and Elizabeth Arias. "Deaths: Final Data for 2016." *National Vital Statistics Reports* 67, no. 5 (July 2018): 1–76.

TABLE 1.3 | What Are the Worldwide Causes of Death?

2016		2030	
Rank	Disease or Injury	Projected Rank	Disease or Injury
1	Ischemic heart disease	1	Ischemic heart disease
2	Stroke	2	Stroke
3	Chronic obstructive pulmonary disease	3	Chronic obstructive pulmonary disease
4	Lower respiratory infections	4	Alzheimer's disease and other dementias
5	Alzheimer's disease and other dementias	5	Lower respiratory infections
6	Trachea, bronchus, lung cancers	6	Diabetes mellitus
7	Diabetes mellitus	7	Trachea, bronchus, lung cancers
8	Road injury	8	Kidney diseases
9	Diarrheal diseases	9	Cirrhosis of the liver
10	Tuberculosis	10	Road injury

Source: World Health Organization. "The Top 10 Causes of Death." Accessed June 10, 2019. https://www.who.int/news-room/fact-sheets/detail/the-top-10-causes-of-death.

behavior, such as altering diet and getting exercise. Health psychologists develop interventions to help people learn these regimens and promote adherence to them.

Advances in Technology and Research

New medical technologies and scientific advances create issues that can be addressed by health psychologists. Just in the past few years, genes have been uncovered that contribute to many diseases including breast cancer. How do we help a college student whose mother has just been diagnosed with breast cancer come to terms with her risk? If she tests positive for a breast cancer gene, how will this change her life? Health psychologists help answer such questions.

Certain treatments that prolong life may severely compromise quality of life. Increasingly, patients are asked their preferences regarding life-sustaining measures, and they may require counseling in these matters. These are just a few examples of how health psychologists respond to scientific developments.

Expanded Health Care Services

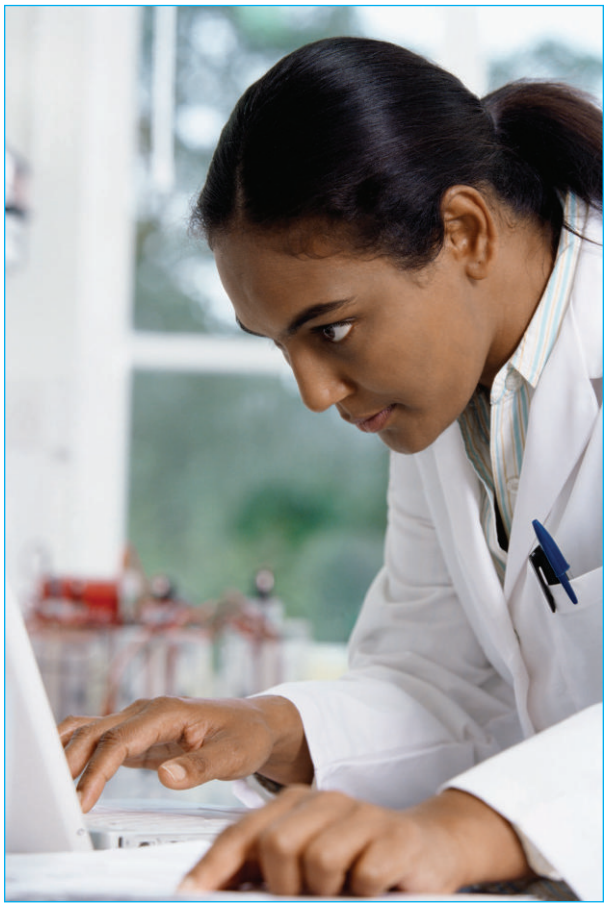
Other factors contributing to the rise of health psychology involve the expansion of health care services. Health care is the largest service industry in the United States, and it is still growing rapidly. Americans spend more than $3.5 trillion annually on health care (National Health Expenditures, 2017). In recent years, the health care industry has come under increasing scrutiny, as substantial increases in health care costs have not brought improvement in basic indicators of health.

Moreover, huge disparities exist in the United States such that some individuals enjoy the very best health care available in the world while others receive little health care except in emergencies. Prior to the Affordable Care Act (known as Obamacare), 49.9 million Americans had no health insurance at all (U.S. Census Bureau, 2011). Efforts to reform the health care system to provide all Americans with a basic health care package, similar to what already exists in most European countries, have resulted.

Health psychology represents an important perspective on these issues for several reasons:

- Because containing health care costs is so important, health psychology's main emphasis on prevention—namely, modifying people's risky health behaviors before they become ill—can reduce the dollars devoted to the management of illness.
- Health psychologists know what makes people satisfied or dissatisfied with their health care (see Chapters 8 and 9) and can help in the design of a user-friendly health care system.
- The health care industry employs millions of people. Nearly every person in the country has direct contact with the health care system as a recipient of services. Consequently, its impact is enormous.

For all these reasons, then, health care delivery has a substantial social and psychological impact on people, an impact that is addressed by health psychologists.



In the 19th and 20th centuries, great strides were made in the technical basis of medicine. As a result, physicians looked more and more to the medical laboratory and less to the mind as a way of understanding the onset and progression of illness.
image 100/age fotostock

Increased Medical Acceptance

There is an increasing acceptance of health psychologists within the medical community. Health psychologists have developed a variety of short-term behavioral interventions to address health-related problems, including managing pain, modifying bad health habits such as smoking, and controlling the side effects of treatments. Techniques that may take a few hours to teach can produce years of benefit. Such interventions, particularly those that target risk factors such as diet or smoking, have contributed to the decline in the incidence of some diseases, especially coronary heart disease.

To take another example, psychologists learned many years ago that informing patients fully about the procedures and sensations involved in unpleasant medical procedures such as surgery improves their adjustment (Janis, 1958; Johnson, 1984). As a consequence of these studies, many hospitals and other treatment centers now routinely prepare patients for such procedures.

Ultimately, if a health-related discipline is to flourish, it must demonstrate a strong track record, not only as a research field but as a basis for interventions as well. Health psychology fulfills both the tasks.

HEALTH PSYCHOLOGY RESEARCH

Health psychologists make important research contributions to understand health and illness (Riley, 2017). The health psychologist can be a valuable team member by providing the theoretical, methodological, and statistical expertise that is the hallmark of good training in psychology.

The Role of Theory in Research

Although much research in health psychology is guided by practical problems, such as how to ease the transition from hospital to home care, about one-third of health psychology investigations are guided by theory (Painter, Borba, Hynes, Mays, & Glanz, 2008). A **theory** is a set of analytic statements that explain a set of phenomena, such as why people practice poor health behaviors. The best theories are simple and useful. We will highlight a number of such theories throughout this book.

The advantages of theory for guiding research and treatment are several. Theories provide guidelines for how to do research and interventions (Masters, 2018). For example, the general principles of cognitive–behavioral therapy can tell one investigator what components should go into an intervention with breast cancer patients to help them cope with the aftermath of surgery, and these same principles can help a different investigator develop a weight loss intervention for obese people.

Theories generate specific predictions, so they can be tested and modified as the evidence comes in. For example, testing theories of health behavior change revealed that people need to believe that they can change their behavior, and so the importance of self-efficacy has been incorporated into theories of health behaviors.

Theories help tie together loose ends. Everyone knows that smokers relapse, people go off their diets, and alcoholics have trouble remaining abstinent. A theory of relapse unites these scattered observations

into general principles of relapse prevention that can be incorporated into diverse interventions. A wise psychologist once said, "There is nothing so practical as a good theory" (Lewin, 1946), and we will see this wisdom repeatedly borne out.

Experiments

Much research in health psychology is experimental. In an **experiment,** a researcher creates two or more conditions that differ from each other in exact and predetermined ways. People are then randomly assigned to these different conditions, and their reactions are measured. Experiments to evaluate the effectiveness of treatments or interventions over time are also called **randomized clinical trials,** in which a target treatment is compared against the existing standard of care or a placebo control, that is, an organically inert treatment (Freedland, 2017).

Medical interventions increasingly are based on these methodological principles. **Evidence-based medicine** means that medical and psychological interventions go through rigorous testing and evaluation of their benefits, usually through randomized clinical trials, before they become the standard of care. These criteria for effectiveness are also frequently now applied to psychological interventions.

What kinds of experiments do health psychologists undertake? To determine if social support groups improve adjustment to cancer, cancer patients might be randomly assigned to participate in a support group or to a comparison condition, such as an educational intervention. The patients could be evaluated at a subsequent time to pinpoint how the two groups differed in their adjustment.

Experiments have been the mainstay of science, because they typically provide more definitive answers to problems than other research methods. When we manipulate a variable and see its effects, we can establish a cause–effect relationship definitively. For this reason, experiments and randomized clinical trials are the gold standards of health psychology research. However, sometimes it is impractical to study issues experimentally. People cannot, for example, be randomly assigned to diseases. In this case, other methods, such as correlational methods, may be used.

Correlational Studies

Much research in health psychology is **correlational research,** in which the health psychologist measures whether changes in one variable correspond with changes in another variable. A correlational study, for example, might reveal that people who are more hostile have a higher risk for cardiovascular disease.

The disadvantage of correlational studies is that it is difficult to determine the direction of causality unambiguously. For example, perhaps cardiovascular risk factors lead people to become more hostile. On the other hand, correlational studies often have advantages over experiments because they are more adaptable, enabling us to study issues when variables cannot be manipulated experimentally.

Prospective and Retrospective Designs

Some of the problems with correlational studies can be remedied by using a prospective design. **Prospective research** looks forward in time to see how a group of people change, or how a relationship between two variables changes over time. For example, if we were to find that hostility develops relatively early in life, but heart disease develops later, we would be more confident that hostility is a risk factor for heart disease and recognize that the reverse direction of causality—namely, that heart disease causes hostility—is less likely.

Health psychologists conduct many prospective studies in order to understand the risk factors that relate to health conditions. We might, for example, intervene in the diet of one community and not in another and over time look at the difference in rates of heart disease. This would be an experimental prospective study. Alternatively, we might measure the diets that people create for themselves and look at changes in rates of heart disease, based on how good or poor the diet is. This would be an example of a correlational prospective study.

A particular type of prospective study is **longitudinal research,** in which the same people are observed at multiple points in time. For example, to understand what factors are associated with early breast cancer in women at risk, we might follow a group of young women whose mothers developed breast cancer, identify which daughters developed breast cancer, and identify factors reliably associated with that development, such as diet, stress, or alcohol consumption.

Investigators also use **retrospective designs,** which look backward in time in an attempt to reconstruct the conditions that led to a current situation. Retrospective methods, for example, were critical in identifying the risk factors that led to AIDS. Initially, researchers

saw an abrupt increase in a rare cancer called Kaposi's sarcoma and observed that the men who developed this cancer often eventually died of general failure of the immune system. By taking extensive histories of the men who developed this disease, researchers were able to determine that the practice of anal-receptive sex without a condom is related to the development of the disorder. Because of retrospective studies, researchers knew some of the risk factors for AIDS even before they had identified the retrovirus.

The Role of Epidemiology in Health Psychology

Changing patterns of illness have been charted and followed by the field of epidemiology, a discipline closely related to health psychology in its goals and interests (Freeland, 2017). **Epidemiology** is the study of the frequency, distribution, and causes of infectious and noninfectious diseases in a population. For example, epidemiologists study not only who has what kind of cancer but also why some cancers are more prevalent than others in particular geographic areas or among particular groups of people.

Epidemiological studies frequently use two important terms: "morbidity" and "mortality." **Morbidity** refers to the number of cases of a disease that exist at some given point in time. Morbidity may be expressed as the number of new cases (incidence) or as the total number of existing cases (prevalence). Morbidity statistics, then, tell us how many people have what kinds of disorders at any given time. **Mortality** refers to numbers of deaths due to particular causes.

Morbidity and mortality statistics are essential to health psychologists. Charting the major causes of disease can lead to steps to reduce their occurrence. For example, knowing that automobile accidents are a major cause of death among children, adolescents, and young adults has led to safety measures, such as child-safety restraint systems, mandatory seat belt laws, and raising the legal drinking age.

But morbidity is important as well. What is the use of affecting causes of death if people remain ill but simply do not die? Health psychology addresses health-related quality of life. Indeed, some researchers maintain that quality of life and symptom reduction should be more important targets for our interventions than mortality and other biological indicators (Kaplan, 1990). Consequently, health psychologists work to improve quality of life so that people with chronic disorders can live their lives as free from pain, disability, and lifestyle compromise as possible.

Methodological Tools

This section highlights some of the methodological tools that have proven valuable in health psychology research.

Tools of Neuroscience The field of neuroscience has developed powerful new tools such as functional magnetic resonance imaging (fMRI) that permit glimpses into the brain. This area of research has also produced knowledge about the autonomic, neuroendocrine, and immune systems that have made a variety of breakthrough studies possible. For example, health psychologists can now connect psychosocial conditions, such as social support and positive beliefs, to underlying biology in ways that make believers out of skeptics. The knowledge and methods of neuroscience also shed light on such questions as, how do placebos work? Why are many people felled by functional disorders that seem to have no underlying biological causes? Why is chronic pain so intractable to treatment? What are effective ways to change health behaviors (Hall, Erickson, & Gianaros, 2017)? How does the brain respond to efforts to change health behaviors (Cooper, Tompson, O'Donnell, Vettel, Basset, & Falk, 2018)? We address these issues in later chapters. These and other applications of neuroscience will help address clinical puzzles that have mystified practitioners for decades (Gianaros & Hackman, 2013).

Web-based Mobile and Wireless Technologies Web-based technologies are widely used in health psychology interventions.

Many of these involve efforts to change poor health behaviors, such as insufficient exercise. Others involve providing social support to people in need of more or more helpful social contact. Web-based programs for managing distress in response to illness or treatment now exist for many disorders (Habibovic et al., 2017). Interventions make use of cell phones, pagers, palm pilots, tablets, and other mobile technologies to deliver interventions and assess health-related events in the natural environment. Interventions have included studies of smoking cessation, weight loss, diabetes management, eating disorders, healthy diet, and physical activity (Heron & Smyth, 2010). Telemedicine that provides virtual medical visits is good for treating modest health issues, such as cold, flu, stomachache, and urinary tract infections (Lankford, 2019).

People in these studies typically participate through an apparatus, such as a cell phone, that can provide on-the-spot administration of a treatment or intervention, as well as the collection of data. For example, text messages sent just before meals can remind people about their intentions to consume a healthy diet. Short text messaging has also been used to enhance smoking cessation programs and ensure maintenance of quitting (Berkman, Dickenson, Falk, & Lieberman, 2011). Activity measures and sensors can accurately assess how much exercise a person is getting. Mobile technology can also help people already diagnosed with disorders. People on medications may receive reminders from mobile devices to take their medications. Numerous other applications are possible.

Measuring biological indicators of health has usually required an invasive procedure such as a blood draw. Now, however, mobile health technologies can assess some biological processes. Ambulatory blood pressure monitoring devices help people with high blood pressure identify conditions when their blood pressure goes up. People with diabetes can monitor their blood glucose levels multiple times a day with less invasive technology than was true just a few years ago.

At present, evidence for the success of mobile health-based interventions and assessments is mixed (Kaplan & Stone, 2013), suggesting the need for more research. But these procedures have greatly improved health psychologists' abilities to study health-related phenomena in real time.

Meta-analysis

For some topics in health psychology, enough studies have been done to conduct a meta-analysis. **Meta-analysis** combines results from different studies to identify how strong the evidence is for particular research findings. For example, a meta-analysis might be conducted on 100 studies of dietary interventions to identify which characteristics of these interventions lead to more successful dietary change. Such an analysis might reveal, for example, that only those interventions that enhance self-efficacy, that is, the belief that one will be able to modify one's diet, are successful. Meta-analysis is a particularly powerful methodological tool, because it uses a broad array of diverse evidence to reach conclusions.

Qualitative Research

In addition to the methods just described, there is an important role for qualitative research in health psychology. Listening to an individual person talk about his or her health needs and experiences is, of course, beneficial for planning an intervention for that person, such as help in losing weight. But more broadly, guided interviews and narratives can provide insights into health processes that summary statistics may not provide. For example, interviews with cancer patients about their chemotherapy experiences may be more helpful in redesigning how chemotherapy is administered than are numerical ratings of how satisfied patients are. Qualitative research can also supplement insights from other research methods. For example, surveys of college students can identify rates of problem drinking, but interviews may be helpful for identifying how to build responsible drinking skills (deVisser et al., 2015). Quantitative and qualitative methods can work hand in hand to develop the research evidence for effective interventions.

WHAT IS HEALTH PSYCHOLOGY TRAINING FOR?

Students who are trained in health psychology on the undergraduate level go on to many different occupations. Some students go into medicine, becoming physicians and nurses. Because of their experience in health psychology, some of these health care practitioners conduct research as well. Other health psychology students go into the allied health professional fields, such as social work, occupational therapy, dietetics, physical therapy, or public health. Social workers in medical settings, for example, may assess where patients go after discharge, decisions that are informed by knowledge of their psychosocial needs. Dietetics is important in the dietary management of chronic illnesses, such as cancer, heart disease, and diabetes. Physical therapists help patients regain the use of limbs and functions that may have been compromised by illness and its treatment.

Students who receive either a PhD in health psychology or a PsyD most commonly go into academic research as faculty members or into private practice, where they provide individual and group counseling. Other PhDs in health psychology practice in hospitals and other health care settings. Many are involved in the management of health care, including business and government positions. Others work in medical schools, hospitals and other treatment settings, and industrial or occupational health settings to promote healthy behavior, prevent accidents, and help control health care costs. •

SUMMARY

1. Health psychology examines psychological influences on how people stay healthy, why they become ill, and how they respond when they do get ill. The field focuses on health promotion and maintenance; prevention and treatment of illness; the etiology and correlates of health, illness, and disability; and improvement of the health care system and the formulation of health policy.
2. The interaction of the mind and the body has concerned philosophers and scientists for centuries. Different models of the relationship have predominated at different times in history.
3. The biomedical model, which has dominated medicine, is a reductionistic, single-factor model of illness that treats the mind and the body as separate entities and emphasizes illness concerns over health.
4. The biomedical model is currently being replaced by the biopsychosocial model, which regards any health disorder as the result of the interplay of biological, psychological, and social factors. The biopsychosocial model recognizes the importance of interacting macrolevel and microlevel processes in producing health and illness. Under this model, health is regarded as an active achievement.
5. The biopsychosocial model guides health psychologists and practitioners in their research efforts to uncover factors that predict states of health and illness and in their clinical interventions with patients.
6. The rise of health psychology can be tied to several factors, including the increase in chronic or lifestyle-related illnesses, the expanding role of health care in the economy, the realization that psychological and social factors contribute to health and illness, the demonstrated importance of psychological interventions to improving people's health, and the rigorous methodological contributions of health psychology researchers.
7. Health psychologists perform a variety of tasks. They develop theories and conduct research on the interaction of biological, psychological, and social factors in producing health and illness. They help treat patients with a variety of disorders and conduct counseling for the psychosocial problems that illness may create. They develop worksite interventions to improve employees' health habits and work in medical settings and other organizations to improve health and health care delivery.

KEY TERMS

acute disorders
biomedical model
biopsychosocial model
chronic illnesses
conversion hysteria
correlational research
epidemiology
etiology
evidence-based medicine
experiment
health
health psychology
longitudinal research
meta-analysis
morbidity
mortality
prospective research
psychosomatic medicine
randomized clinical trials
retrospective designs
theory
wellness

CHAPTER 2

The Systems of the Body

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CHAPTER OUTLINE

The Nervous System
- *Overview*
- *The Brain*
- *The Role of Neurotransmitters*
- *Disorders of the Nervous System*

The Endocrine System
- *Overview*
- *The Adrenal Glands*
- *Disorders Involving the Endocrine System*

The Cardiovascular System
- *Overview*
- *The Heart*
- *Disorders of the Cardiovascular System*
- *Blood Pressure*
- *The Blood*

The Respiratory System
- *Overview*
- *The Structure and Functions of the Respiratory System*
- *Disorders Associated with the Respiratory System*
- *Dealing with Respiratory Disorders*

The Digestive System and the Metabolism of Food
- *Overview*
- *The Functioning of the Digestive System*
- *Disorders of the Digestive System*
- *The Gut-Brain Connection*

The Renal System
- *Overview*
- *Disorders of the Renal System*

The Reproductive System
- *Overview*
- *The Ovaries and Testes*
- *Fertilization and Gestation*
- *Disorders of the Reproductive System*

Genetics and Health
- *Overview*
- *Genetics and Susceptibility to Disorders*

The Immune System
- *Overview*
- *Infection*
- *The Course of Infection*
- *Immunity*
- *Disorders Related to the Immune System*

An understanding of health requires a working knowledge of human physiology, namely the study of the body's functioning. Having basic knowledge of physiology clarifies how good health habits make illness less likely, how stress affects the body, how chronic stress can lead to hypertension or coronary artery disease, and how cell growth is radically altered by cancer.

THE NERVOUS SYSTEM

Overview

The **nervous system** is a complex network of interconnected nerve fibers. As Figure 2.1 shows, the nervous system is made up of the central nervous system, which consists of the brain and the spinal cord, and the peripheral nervous system, which consists of the rest of the nerves in the body, including those that connect to the brain and the spinal cord. Sensory nerve fibers provide input to the brain and spinal cord by carrying signals from sensory receptors; motor nerve fibers provide output from the brain or spinal cord to muscles and other organs, resulting in voluntary and involuntary movement.

The peripheral nervous system is made up of the somatic nervous system and the autonomic nervous system. The somatic, or voluntary, nervous system connects nerve fibers to voluntary muscles and provides the brain with feedback about voluntary movement, such as a tennis swing. The autonomic, or involuntary, nervous system connects the central nervous system to all internal organs over which people do not customarily have control.

Regulation of the autonomic nervous system occurs via the sympathetic nervous system and the parasympathetic nervous system. The **sympathetic nervous system** prepares the body to respond to emergencies, to strong emotions such as anger or fear, and to strenuous activity. As such, it plays an important role in reaction to stress.

The **parasympathetic nervous system** controls the activities of organs under normal circumstances and acts antagonistically to the sympathetic nervous system. When an emergency has passed, the parasympathetic nervous system helps to restore the body to a normal state.

The Brain

The brain is the command center of the body. It receives sensory impulses from the peripheral nerve endings and sends motor impulses to the extremities and to internal organs to carry out movement. The parts of the brain are shown in Figure 2.2.

The Hindbrain and the Midbrain The hindbrain has three main parts: the medulla, the pons, and the cerebellum. The **medulla** is responsible for the regulation of heart rate, blood pressure, and respiration. Sensory information about the levels of carbon dioxide and oxygen in the body also comes to the medulla, which, if necessary, sends motor impulses to respiratory muscles to alter the rate of breathing. The **pons** serves as a link between the hindbrain and the midbrain and also helps control respiration.

The **cerebellum** coordinates voluntary muscle movement, the maintenance of balance and equilibrium, and

FIGURE 2.1 | The Components of the Nervous System

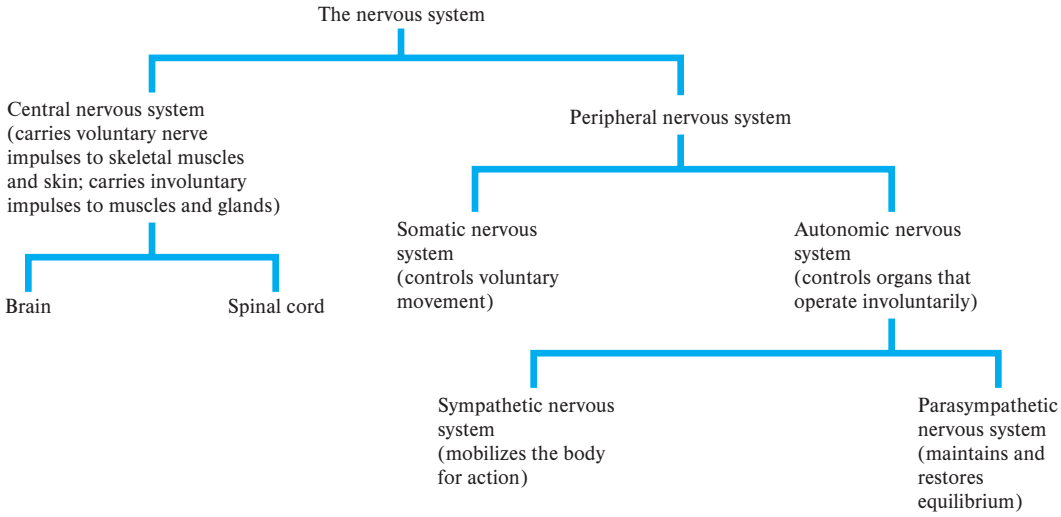
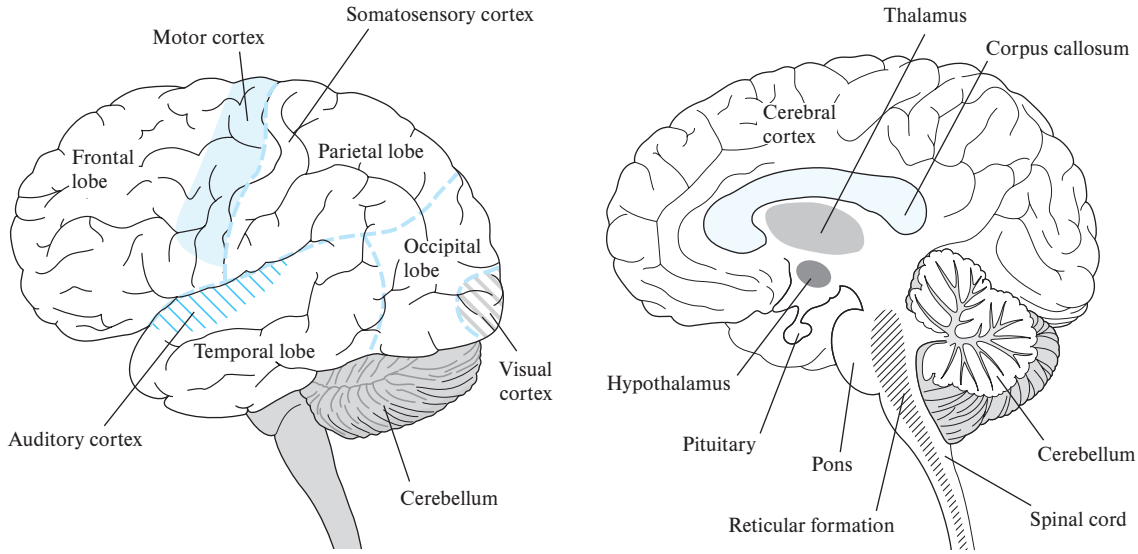


FIGURE 2.2 | The Brain (*Source:* Lankford, T. Randall. *Integrated science for health students*. Virginia: Reston, 1979, p. 232.)



(a) Surface diagram

(b) Cross-sectional diagram

the maintenance of muscle tone and posture. Damage to this area can produce loss of muscle tone, tremors, and disturbances in posture or gait.

The midbrain is the major pathway for sensory and motor impulses moving between the forebrain and the hindbrain. It is also responsible for the coordination of visual and auditory reflexes.

The Forebrain

The forebrain includes the thalamus and the hypothalamus. The **thalamus** is involved in the recognition of sensory stimuli and the relay of sensory impulses to the cerebral cortex.

The **hypothalamus** helps regulate cardiac functioning, blood pressure, respiration, water balance, and appetites, including hunger and sexual desire. It is an important transition center between the thoughts generated in the cerebral cortex of the brain and their impact on internal organs. For example, embarrassment can lead to blushing via the hypothalamus through the vasomotor center in the medulla to the blood vessels. Together with the pituitary gland, the hypothalamus helps regulate the endocrine system, which releases hormones that affect functioning in target organs throughout the body.

The forebrain also includes the **cerebral cortex,** the largest portion of the brain, involved in higher-order intelligence, memory, and personality. Sensory impulses that come from the peripheral areas of the body are received and interpreted in the cerebral cortex.

The cerebral cortex consists of four lobes: frontal, parietal, temporal, and occipital. Each lobe has its own memory storage area or areas of association. Through these complex networks of associations, the brain is able to relate current sensations to past ones, giving the cerebral cortex its formidable interpretive capabilities.

In addition to its role in associative memory, each lobe is generally associated with particular functions. The frontal lobe contains the motor cortex, which coordinates voluntary movement. The parietal lobe contains the somatosensory cortex, in which sensations of touch, pain, temperature, and pressure are registered and interpreted. The temporal lobe contains the cortical areas responsible for auditory and olfactory (smell) impulses, and the occipital lobe contains the visual cortex, which receives visual impulses.

The Limbic System

The limbic system plays an important role in stress and emotional responses. The amygdala and the hippocampus are involved in the detection of threat and in emotionally charged memories, respectively. The cingulate gyrus, the septum, and areas in the hypothalamus are related to emotional functioning as well.

Many health disorders implicate the brain. One important disorder that was overlooked until recently is chronic traumatic encephalopathy, whose causes and consequences are described in Box 2.1.

Costs of War to the Brain BOX 2.1

A 27-year-old former Marine who had done two tours of Iraq returned home, attempting to resume his family life and college classes. Although he had once had good grades, he found he could not remember small details or focus his attention any longer. He became irritable, snapping at his family, and eventually, his wife initiated divorce proceedings. He developed an alcohol problem, and a car crash caused him to lose his driver's license. When his parents hadn't heard from him, they phoned the police, who found him, a suicide victim of hanging.

Chronic traumatic encephalopathy (CTE) is a degenerative brain disorder that strikes people who have had repeated or serious head injuries. Former boxers and football players, for example, have high rates of CTE. In CTE, an abnormal form of a protein accumulates and eventually destroys cells in the brain, including the frontal and temporal lobes, which are critical for decision making, impulse control, and judgment.

Autopsies suggest that CTE may also be present at high levels among returning veterans, and that blasts from bombs or grenades may have produced these serious effects, including irreversible losses in memory and thinking abilities. More than 27,000 cases of traumatic war injuries were reported by the U.S. military in 2009 alone, and CTE is a likely contributor (Congressional Research Service, 2010). CTE is suspected in some cases that have been diagnosed as post traumatic stress disorder (see Chapter 6). Whether the military will find ways to reduce exposure to its causes or ways to retard the processes CTE sets into effect remains to be seen. Health psychologists can play an important role in addressing the cognitive and social costs of this degenerative disorder.

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Source: Kristof, Nicholas. "Veterans and Brain Disease." *The New York Times,* April 25, 2012. https://www.nytimes.com/2012/04/26/opinion/kristof-veterans-and-brain-disease.html.

The Role of Neurotransmitters

The nervous system functions by means of chemicals, called **neurotransmitters,** that regulate nervous system functioning. Stimulation of the sympathetic nervous system prompts the secretion of two neurotransmitters, epinephrine and norepinephrine, together termed the **catecholamines.** These substances are carried through the bloodstream throughout the body, promoting sympathetic activation.

The release of catecholamines prompts important bodily changes. Heart rate increases, the heart's capillaries dilate, and blood vessels constrict, increasing blood pressure. Blood is diverted into muscle tissue. Respiration rate goes up, and the amount of air flowing into the lungs is increased. Digestion and urination are generally decreased. The pupils of the eyes dilate, and sweat glands are stimulated to produce more sweat. These changes are critically important in responses to stressful circumstances. Chronic or recurrent arousal of the sympathetic nervous system can accelerate the development of several chronic disorders, such as coronary artery disease and hypertension, discussed in greater detail in Chapter 13.

Parasympathetic functioning is a counterregulatory system that helps restore homeostasis following sympathetic arousal. The heart rate decreases, the heart's capillaries constrict, blood vessels dilate, respiration rate decreases, and the metabolic system resumes its activities.

Disorders of the Nervous System

Approximately 25 million Americans have some disorder of the nervous system. The most common forms of neurological dysfunction are epilepsy and Parkinson's disease. Cerebral palsy, multiple sclerosis, and Huntington's disease also affect substantial numbers of people.

Epilepsy A disease of the central nervous system affecting 1 in 26 people in the United States (Epilepsy Foundation, 2018), epilepsy is often idiopathic, which

means that no specific cause for the symptoms can be identified. Symptomatic epilepsy may be traced to harm during birth, severe injury to the head, infectious disease such as meningitis or encephalitis, or metabolic or nutritional disorders. Risk for epilepsy may also be inherited.

Epilepsy is marked by seizures, which range from barely noticeable to violent convulsions accompanied by irregular breathing and loss of consciousness. Epilepsy cannot be cured, but it can often be controlled through medication and behavioral interventions designed to manage stress (see Chapters 7 and 11).

Parkinson's Disease People with Parkinson's disease have progressive degeneration of the basal ganglia, a group of nuclei in the brain that control smooth motor coordination. The result of this deterioration is tremors, rigidity, and slowness of movement. As many as 1 million Americans have Parkinson's disease, which primarily strikes people age 50 and older (Parkinson's Disease Foundation, 2018); men are more likely than women to develop the disease. Although the cause of Parkinson's is not fully known, depletion of the neurotransmitter dopamine may be involved. Parkinson's disease may be treated with medication, but large doses, which can cause undesirable side effects, are often required for control of the symptoms.

Cerebral Palsy Currently, more than 764,000 people in the United States have or experience symptoms of cerebral palsy (CerebralPalsy.org, 2019). Cerebral palsy is a chronic, nonprogressive disorder marked by lack of muscle control. It stems from brain damage caused by an interruption in the brain's oxygen supply, usually during childbirth. In older children, a severe accident or physical abuse can produce the condition. Apart from being unable to control motor functions, those who have the disorder may (but need not) also have seizures, spasms, mental retardation, difficulties with sensation and perception, and problems with sight, hearing, and/or speech.

Multiple Sclerosis Approximately 2.3 million people worldwide have multiple sclerosis (National Multiple Sclerosis Society, 2016). In the United States, there are nearly 1 million people who have multiple sclerosis (Nelson, Wallin, Marrie, Culpepper, & Langer-Gould, 2019). This degenerative disease can cause paralysis and, occasionally, blindness, deafness, and mental deterioration. Early symptoms include numbness, double vision, dragging of the feet, loss of bladder or bowel control, speech difficulties, and extreme fatigue. Symptoms may appear and disappear over a period of years; after that, deterioration is continuous.

The effects of multiple sclerosis result from the disintegration of myelin, a fatty membrane that surrounds nerve fibers and facilitates the conduction of nerve impulses. Multiple sclerosis is an autoimmune disorder, so called because the immune system fails to recognize its own tissue and attacks the myelin sheath surrounding nerve fibers.

Huntington's Disease A hereditary disorder of the central nervous system, Huntington's disease is characterized by chronic physical and mental deterioration. Symptoms include involuntary muscle spasms, loss of motor abilities, personality changes, and other signs of mental disintegration.

The disease affects about 30,000 people directly, and 200,000 more are at risk in the United States (Huntington's Disease Society of America, 2019). The gene for Huntington's has been isolated, and a test is now available that indicates not only if one is a carrier of the gene but also at what age (roughly) one will succumb to the disease. As will be seen later in this chapter, genetic counseling with this group of at-risk people is important.

Polio Poliomyelitis is a highly infectious viral disease that affects mostly young children. It attacks the spinal nerves and destroys the cell bodies of motor neurons so that motor impulses cannot be carried from the spinal cord outward to the peripheral nerves or muscles. Depending on the degree of damage that is done, the person may be left with difficulties in walking and moving properly, ranging from shrunken and ineffective limbs to full paralysis. Polio cases have decreased substantially worldwide, although polio is still a major health issue in Pakistan and Afghanistan.

Paraplegia and Quadriplegia Paraplegia is paralysis of the lower extremities of the body; it results from an injury to the lower portion of the spinal cord. Quadriplegia is paralysis of all four extremities and the trunk of the body; it occurs when the upper portion of the spinal cord is severed. People who have these conditions usually lose bladder and bowel control and the muscles below the cut area may lose their tone, becoming weak and flaccid.

Dementia Dementia (meaning "deprived of mind") is a serious loss of cognitive ability beyond what might be expected from normal aging. A history of brain injuries

or a genetically based propensity may be involved in long-term decline. A chronically stressful life, as may result from socioeconomic position, can lead to atrophy in the hippocampus, which can compromise cognitive functioning, often severely (Elbejjani et al., 2017) Although dementia is most common among older adults, it may occur at any stage of adulthood. Memory, attention, language, and problem solving are affected early in the disorder and often lead to diagnosis.

The most common form of dementia is Alzheimer's, accounting for 60 to 70 percent of the cases. In most people, symptoms appear in their mid-60s, and the disease progresses irreversibly, due to plaques and tangles in the progressively shrinking brain. In addition to the early signs of cognitive decline, especially difficulty with short-term memory, social functioning, and use of language, are disrupted as the disease progresses. What leads people to develop Alzheimer's? Lack of physical exercise and intellectual activity are lifestyle factors implicated in its development, and there are also genes that predispose to the disease (Rodriguez et al., 2018). Other contributing factors will be unearthed by the substantial research devoted to this major health issue. About 47 million people worldwide have Alzheimer's (Alzheimer's Association, 2019).

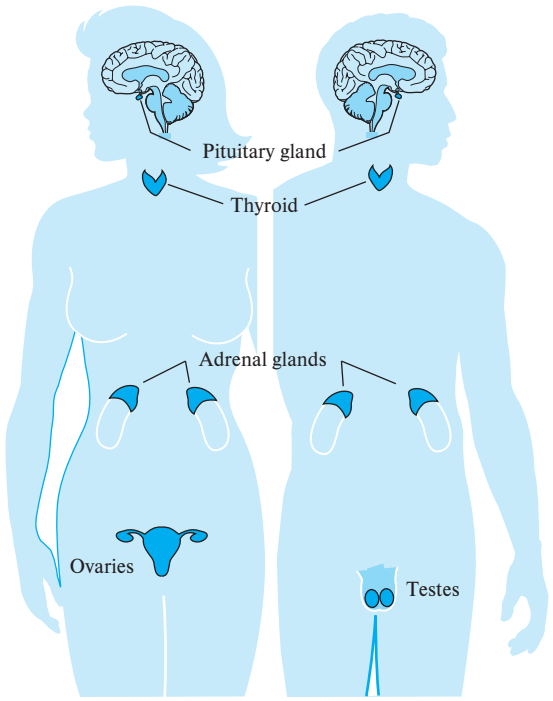
THE ENDOCRINE SYSTEM

Overview

The **endocrine system,** diagrammed in Figure 2.3, complements the nervous system in controlling bodily activities. The endocrine system is made up of a number of ductless glands that secrete hormones into the blood, stimulating changes in target organs. The endocrine and nervous systems depend on each other, stimulating and inhibiting each other's activities. The nervous system is chiefly responsible for fast-acting, short-duration responses to changes in the body, whereas the endocrine system mainly governs slow-acting responses of long duration.

The endocrine system is regulated by the hypothalamus and the **pituitary gland**. Located at the base of the brain, the pituitary has two lobes. The posterior pituitary lobe produces oxytocin, which controls contractions during labor and lactation and is also involved in social affiliation, and vasopressin, or antidiuretic hormone (ADH), which controls the water-absorbing ability of the kidneys, among other functions. The anterior pituitary lobe of the pituitary gland secretes hormones responsible for growth: somatotropic hormone (STH), which regulates bone, muscle, and other organ development; gonadotropic hormones, which control the growth, development, and secretions of the gonads (testes and ovaries); thyrotropic hormone (TSH), which controls the growth, development, and secretion of the thyroid gland; and adrenocorticotropic hormone (ACTH), which controls the growth and secretions of the cortical region of the adrenal glands.

FIGURE 2.3 | The Endocrine System



The Adrenal Glands

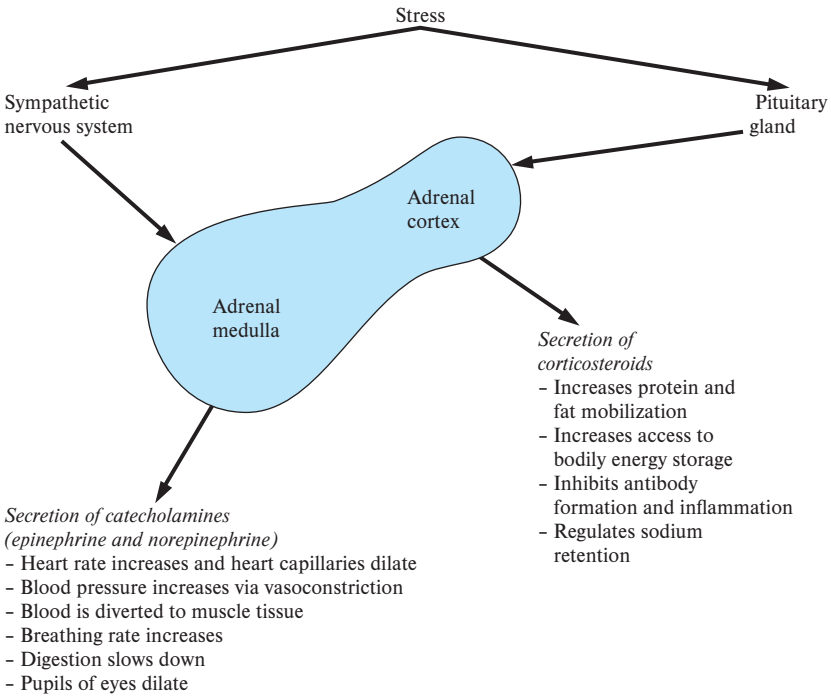
The **adrenal glands** are small glands located on top of each of the kidneys. Each adrenal gland consists of an adrenal medulla and an adrenal cortex. The hormones of the adrenal medulla are epinephrine and norepinephrine, which were described earlier.

As Figure 2.4 implies, the adrenal glands are critically involved in physiological and neuroendocrine reactions to stress. Catecholamines, secreted in conjunction with sympathetic arousal, and corticosteroids are implicated in biological responses to stress. We will consider these stress responses more fully in Chapter 6.

Disorders Involving the Endocrine System

Diabetes Diabetes is a chronic endocrine disorder in which the body is not able to manufacture or

FIGURE 2.4 | Adrenal Gland Activity in Response to Stress



properly use insulin. It is the fourth most common chronic illness in this country and one of the leading causes of death. Diabetes consists of two primary forms. Type I diabetes is a severe disorder that typically arises in late childhood or early adolescence. At least partly genetic in origin, Type I diabetes is an autoimmune disorder, possibly precipitated by an earlier viral infection. The immune system falsely identifies cells in the islets of Langerhans in the pancreas as invaders and destroys those cells, compromising or eliminating their ability to produce insulin.

Type II diabetes, which typically occurs after age 40, is the more common form. In Type II diabetes, insulin may be produced by the body, but there may not be enough of it, or the body may not be sensitive to it. It is heavily a disease of lifestyle, and risk factors include obesity and stress, among other factors.

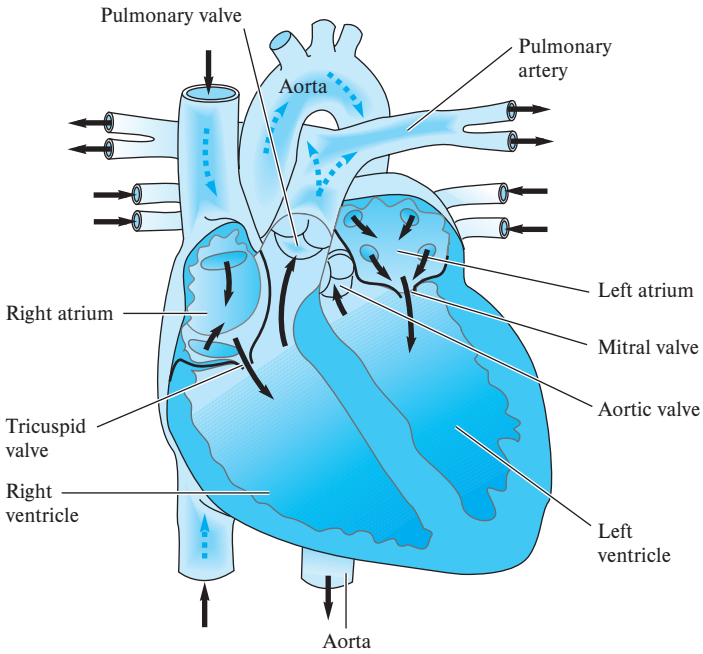
Diabetic patients have high rates of coronary heart disease, and diabetes is the leading cause of blindness among adults. It accounts for almost 44 percent of all the patients who require renal dialysis for kidney failure (National Institute of Diabetes and Digestive and Kidney Disorders, 2007). Diabetes can also produce nervous system damage, leading to pain and loss of sensation. In severe cases, amputation of the extremities, such as toes and feet, may be required. As a consequence of these complications, people with diabetes have a considerably shortened life expectancy. In later chapters, we will consider Type I (Chapter 14) and Type II (Chapter 13) diabetes, and the issues associated with their management.

THE CARDIOVASCULAR SYSTEM

Overview

The **cardiovascular system** comprises the heart, blood vessels, and blood and acts as the transport system of the body. Blood carries oxygen from the lungs to the tissues and carbon dioxide from the tissues to the lungs. Blood also carries nutrients from the digestive tract to the individual cells so that the cells may extract nutrients for growth and energy. The blood carries waste products from the cells to the kidneys, from which the waste is excreted in the urine. It also carries hormones from the endocrine glands to other organs of the body and transports heat to the surface of the skin to control body temperature.

FIGURE 2.5 | The Heart



The Heart

The heart functions as a pump, and its pumping action causes the blood to circulate throughout the body. The left side of the heart, consisting of the left atrium and left ventricle, takes in oxygenated blood from the lungs and pumps it out into the aorta (the major artery leaving the heart), from which the blood passes into the smaller vessels (the arteries, arterioles, and capillaries) to reach cell tissues. The blood exchanges its oxygen and nutrients for the waste materials of the cells and is then returned to the right side of the heart (right atrium and right ventricle), which pumps it back to the lungs via the pulmonary artery. Once oxygenated, the blood returns to the left side of the heart through the pulmonary veins. The anatomy of the heart is pictured in Figure 2.5.

The heart performs these functions through regular rhythmic phases of contraction and relaxation known as the cardiac cycle. There are two phases in the cardiac cycle: systole and diastole. During systole, blood is pumped out of the heart, and blood pressure in the blood vessels increases. As the muscle relaxes during diastole, blood pressure drops, and blood is taken into the heart.

The flow of blood into and out of the heart is controlled by valves at the inlet and outlet of each ventricle. These heart valves ensure that blood flows in one direction only. The sounds that one hears when listening to the heart are the sounds of these valves closing. These heart sounds make it possible to time the cardiac cycle to determine how rapidly or slowly blood is being pumped into and out of the heart.

A number of factors influence the rate at which the heart contracts and relaxes. During exercise, emotional excitement, or stress, for example, the heart speeds up, and the cardiac cycle is completed in a shorter time. A chronically or excessively rapid heart rate can decrease the heart's strength, which may reduce the volume of blood that is pumped. Heart rate variability is a measure of the variability in the time between each heartbeat. It is a measure of cardiac regulation, and is generally viewed as related to cardiovascular fitness and possibly also to psychological well-being (Sloane et al., 2017)

Disorders of the Cardiovascular System

The cardiovascular system is subject to a number of disorders. Some of these are due to congenital defects—that is, defects present at birth—and others, to infection. By far, however, the major threats to the cardiovascular system are due to lifestyle factors, including stress, poor diet, lack of exercise, and smoking.

Atherosclerosis

The major cause of heart disease is atherosclerosis, a problem that becomes worse with age. **Atherosclerosis** is caused by deposits of cholesterol and other substances on the arterial walls, which form plaques that narrow the arteries. These plaques reduce the flow of blood through the arteries and interfere with the passage of nutrients from the capillaries into the cells—a process that can lead to tissue damage. Damaged arterial walls are also potential sites for the formation of blood clots, which can obstruct a vessel and cut off the flow of blood.

Atherosclerosis is associated with several primary clinical manifestations:

- **Angina pectoris,** or chest pain, which occurs when the heart has insufficient supply of oxygen or inadequate removal of carbon dioxide and other waste products.
- **Myocardial infarction (MI),** or heart attack, which results when a clot has developed in a coronary vessel and blocks the flow of blood to the heart.
- **Ischemia,** a condition characterized by lack of blood flow and oxygen to the heart muscle. As many as 3 million to 4 million Americans have silent ischemic episodes without knowing it, and they may consequently have a heart attack with no prior warning.

Other major disorders of the cardiovascular system include the following.

- Congestive heart failure (CHF), which occurs when the heart's delivery of oxygen-rich blood is inadequate to meet the body's needs.
- Arrhythmia, irregular beatings of the heart, which, at its most severe, can lead to loss of consciousness and sudden death.

Blood Pressure

Blood pressure is the force that blood exerts against the blood vessel walls. During systole, the force on the blood vessel walls is greatest; during diastole, it falls to its lowest point. The measurement of blood pressure includes these two indicators.

Blood pressure is influenced by several factors. The first is cardiac output—pressure against the arterial walls is greater as the volume of blood flow increases. A second factor is peripheral resistance, or the resistance to blood flow in the small arteries of the body (arterioles), which is affected by the number of red blood cells and the amount of plasma the blood contains. In addition, blood pressure is influenced by the structure of the arterial walls: If the walls have been damaged, if they are clogged by deposits of waste, or if they have lost their elasticity, blood pressure will be higher. Chronically high blood pressure, called hypertension, is the consequence of too high a cardiac output or too high a peripheral resistance. We will consider hypertension further in Chapter 13.

The Blood

An adult's body contains approximately 5 liters of blood, which consists of plasma and cells. Plasma, the fluid portion of blood, accounts for approximately 55 percent of the blood volume. The remaining 45 percent of blood volume is made up of cells. The blood cells are suspended in the plasma, which contains plasma proteins and plasma electrolytes (salts) plus the substances that are being transported by the blood (oxygen and nutrients or carbon dioxide and waste materials). The blood also helps to regulate skin temperature.

Blood cells are manufactured in the bone marrow in the hollow cavities of bones. Bone marrow contains five types of blood-forming cells: myeloblasts and monoblasts, both of which produce types of white blood cells; lymphoblasts, which produce lymphocytes; erythroblasts, which produce red blood cells; and megakaryocytes, which produce platelets. Each of these types of blood cells has an important function.

White blood cells play an important role in healing by absorbing and removing foreign substances from the body. They contain granules that secrete digestive enzymes, which engulf and act on bacteria and other foreign particles, turning them into a form conducive to excretion. An elevated white cell count suggests the presence of infection.

Lymphocytes produce antibodies—agents that destroy foreign substances. Together, these groups of cells play an important role in fighting infection and disease. We will consider them more fully in our discussion of the immune system in Chapter 14.

Red blood cells are important mainly because they contain hemoglobin, which is needed to carry oxygen and carbon dioxide throughout the body. Anemia, which involves below-normal numbers of red blood cells, can interfere with this transport function.

Platelets serve several important functions. They clump together to block small holes that develop in

blood vessels, and they also play an important role in blood clotting.

Clotting Disorders Clots (or thromboses) can sometimes develop in the blood vessels. This is most likely to occur if arterial or venous walls have been damaged or roughened because of the buildup of cholesterol. Platelets then adhere to the roughened area, leading to the formation of a clot. A clot can have especially serious consequences if it occurs in the blood vessels leading to the heart (coronary thrombosis) or brain (cerebral thrombosis), because it will block the vital flow of blood to these organs. When a clot occurs in a vein, it may become detached and form an embolus, which can become lodged in the blood vessels to the lungs, causing pulmonary obstruction. Death is a common consequence of these conditions.

THE RESPIRATORY SYSTEM

Overview

Respiration, or breathing, has three main functions: to take in oxygen, to excrete carbon dioxide, and to regulate the composition of the blood.

The body needs oxygen to metabolize food. During the process of metabolism, oxygen combines with carbon atoms in food, producing carbon dioxide (CO_2). The **respiratory system** brings in oxygen through inspiration; it eliminates carbon dioxide through expiration.

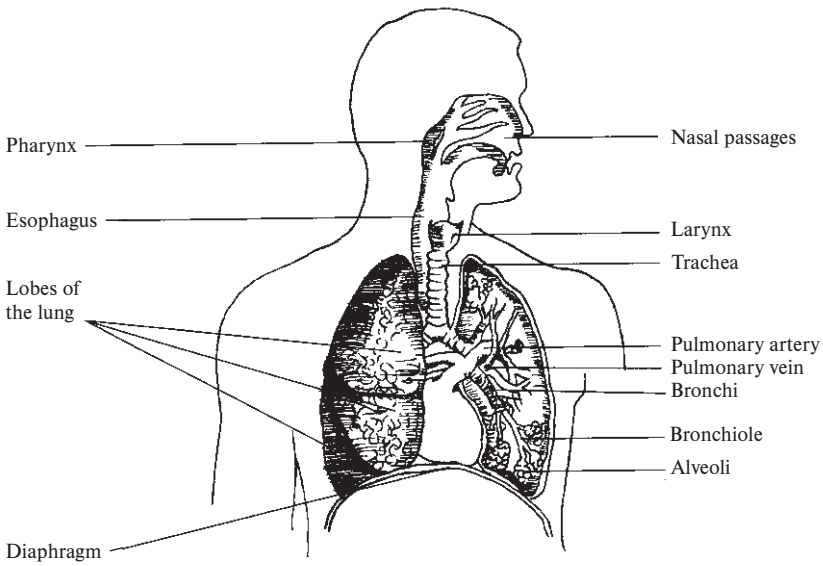
The Structure and Functions of the Respiratory System

Air is inhaled through the nose and mouth and then passes through the pharynx and larynx to the trachea. The trachea, a muscular tube extending downward from the larynx, divides at its lower end into two branches called the primary bronchi. Each bronchus enters a lung, where it then subdivides into secondary bronchi, still-smaller bronchioles, and, finally, microscopic alveolar ducts, which contain many tiny clustered sacs called alveoli. The alveoli and the capillaries are responsible for the exchange of oxygen and carbon dioxide. A diagram of the respiratory system appears in Figure 2.6.

The inspiration of air is an active process, brought about by the contraction of muscles. Inspiration causes the lungs to expand inside the thorax (the chest wall). Expiration, in contrast, is a passive function, brought about by the relaxation of the lungs, which reduces the volume of the lungs within the thorax. The lungs fill most of the space within the thoracic cavity and are very elastic, depending on the thoracic walls for support. If air gets into the space between the thoracic wall and the lungs, one or both lungs will collapse.

Respiratory movements are controlled by a respiratory center in the medulla. The functions of this center depend partly on the chemical composition of the blood. For example, if the blood's carbon dioxide

FIGURE 2.6 | The Respiratory System (*Source:* Lankford, T. Randall. *Integrated science for health students*. Virginia: Reston, 1979, p. 467.)



level rises too high, the respiratory center will be stimulated and respiration will be increased. If the carbon dioxide level falls too low, the respiratory center will slow down until the carbon dioxide level is back to normal.

The respiratory system is also responsible for coughing. Dust and other foreign materials are inhaled with every breath. Some of these substances are trapped in the mucus of the nose and the air passages and are then conducted back toward the throat, where they are swallowed. When a large amount of mucus collects in the large airways, it is removed by coughing (a forced expiratory effort).

Disorders Associated with the Respiratory System

Asthma Asthma is a severe allergic reaction typically to a foreign substance, including dust, dog or cat dander, pollens, or fungi. An asthma attack can also be touched off by emotional stress or exercise. These attacks may be so serious that they produce bronchial spasms and hyperventilation.

During an asthma attack, the muscles surrounding air tubes constrict, inflammation and swelling of the lining of the air tubes occur, and increased mucus is produced, clogging the air tubes. The mucus secretion, in turn, may then obstruct the bronchioles, reducing the supply of oxygen and increasing the amount of carbon dioxide.

Statistics show a dramatic increase in the prevalence of allergic disorders, including asthma, in the past 20 to 30 years. Currently, approximately 235 million people worldwide have asthma, 26 million of them in the United States (Centers for Disease Control and Prevention, May 2018; World Health Organization, August 2017). The numbers are increasing, especially in industrialized countries and in urban areas as opposed to rural areas. Asthma rates are especially high in low-income areas, and psychosocial stressors may play a role in aggravating an underlying vulnerability (Vangeepuram, Galvez, Teitelbaum, Brenner, & Wolff, 2012). However, the reasons for the dramatic increase in asthma cases are not yet fully known. Children who have a lot of infectious disorders during childhood are less likely to develop allergies, suggesting that exposure to infectious agents plays a protective role. Thus, paradoxically, the improved hygiene of industrialized countries may actually be contributing to the high rates of allergic disorders currently seen.

Viral Infections The respiratory system is vulnerable to infections, especially the common cold, a viral infection of the upper and sometimes the lower respiratory tract. The infection that results causes discomfort, congestion, and excessive secretion of mucus. The incubation period for a cold—that is, the time between exposure to the virus and onset of symptoms—is 12 to 72 hours, and the typical duration is a few days. Secondary bacterial infections may complicate the illness. These occur because the primary viral infection causes inflammation of the mucous membranes, reducing their ability to prevent secondary infection.

Bronchitis is an inflammation of the mucosal membrane inside the bronchi of the lungs. Large amounts of mucus are produced in bronchitis, leading to persistent coughing.

A serious viral infection of the respiratory system is influenza, which can occur in an epidemic form. Flu viruses attack the lining of the respiratory tract, killing healthy cells. Fever and inflammation of the respiratory tract may result. A common complication is a secondary bacterial infection, such as pneumonia.

Bacterial Infections The respiratory system is also vulnerable to bacterial disorders, including strep throat, whooping cough, and diphtheria. Usually, these disorders do not cause permanent damage to the upper respiratory tract. The main danger is the possibility of secondary infection, which results from lowered resistance. However, these bacterial infections can cause permanent damage to other tissues, including heart tissue.

Chronic Obstructive Pulmonary Disease Chronic obstructive pulmonary disease (COPD), including chronic bronchitis and emphysema, is the fourth-leading cause of death in the United States. Some 16 million Americans have COPD (National Heart, Lung, & Blood Institute, 2017). Although COPD is not curable, it is preventable. Its chief cause is smoking, which accounts for over 80 percent of all cases of COPD (COPD International, 2015).

Pneumonia There are two main types of pneumonia. Lobar pneumonia is a primary infection of the entire lobe of a lung. The alveoli become inflamed, and the normal oxygen–carbon dioxide exchange between the blood and alveoli can be disrupted. Spread of infection to other organs is also likely.

Bronchial pneumonia, which is confined to the bronchi, is typically a secondary infection that may occur as a complication of other disorders, such as a severe cold or flu. It is not as serious as lobar pneumonia.

Tuberculosis and Pleurisy Tuberculosis (TB) is an infectious disease caused by bacteria that invade lung tissue. When the invading bacilli are surrounded by macrophages (a type of white blood cells), they form a clump called a tubercle. Eventually, through a process called caseation, the center of the tubercle turns into a cheesy mass, which can produce cavities in the lung. Such cavities, in turn, can give rise to permanent scar tissue, causing chronic difficulties in oxygen and carbon dioxide exchange between the blood and the alveoli. Once the leading cause of death in the United States, it has been in decline for several decades. However, worldwide, it remains common and deadly, affecting one-fourth of the world's population (Centers for Disease Control and Prevention, 2018).

Pleurisy is an inflammation of the pleura, the membrane that surrounds the organs in the thoracic cavity. The inflammation, which produces a sticky fluid, is usually a consequence of pneumonia or tuberculosis and can be extremely painful.

Lung Cancer Lung cancer is a disease of uncontrolled cell growth in tissues of the lung. The affected cells begin to divide in a rapid and unrestricted manner, producing a tumor. Malignant cells grow faster than healthy cells. This growth may lead to metastasis, which is the invasion of adjacent tissue and infiltration beyond the lungs. The most common symptoms are shortness of breath, coughing (including coughing up blood), and weight loss. Smoking is one of the primary causes. There were an estimated 228,150 new lung cancer cases in the United States in 2018 (American Cancer Society, 2019)

Dealing with Respiratory Disorders

A number of respiratory disorders can be addressed by health psychologists. For example, smoking is implicated in both pulmonary emphysema and lung cancer. Dangerous substances in the workplace and air pollution are also factors that contribute to the incidence of respiratory problems. Both of these causes of disease can be modified.

As we will see in Chapters 3 to 5, health psychologists have conducted research on many of these problems and discussed the clinical issues they raise. Some respiratory disorders are chronic conditions. Consequently, issues of long-term physical, vocational, social, and psychological rehabilitation become important. We cover these issues in Chapters 11, 13, and 14.

THE DIGESTIVE SYSTEM AND THE METABOLISM OF FOOD

Overview

Food, essential for survival, is converted through the process of metabolism into heat and energy, and it supplies nutrients for growth and the repair of tissues. But before food can be used by cells, it must be changed into a form suitable for absorption into the blood. This conversion process is called digestion.

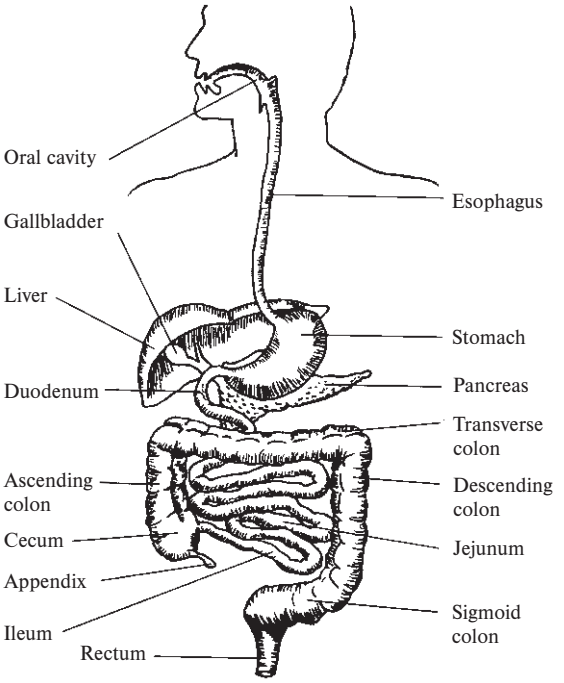
The Functioning of the Digestive System

Food is first lubricated by saliva in the mouth, where it forms a soft, rounded lump called a bolus. It passes through the esophagus by means of peristalsis, a unidirectional muscular movement toward the stomach. The stomach produces various gastric secretions, including pepsin and hydrochloric acid, to further the digestive process. The sight or even the thought of food starts the flow of gastric juices.

As food progresses from the stomach to the duodenum (the intersection of the stomach and lower intestine), the pancreas becomes involved in the digestive process. Pancreatic juices, which are secreted into the duodenum, contain enzymes that break down proteins, carbohydrates, and fats. A critical function of the pancreas is the production of the hormone insulin, which facilitates the entry of glucose into the bodily tissues. The liver also plays an important role in metabolism by producing bile, which enters the duodenum and helps break down fats. Bile is stored in the gallbladder and is secreted into the duodenum as needed.

Most metabolic products are water soluble and can be easily transported in the blood, but some substances, such as lipids, are not soluble in water and so must be transported in the blood plasma. Lipids include fats, cholesterol, and lecithin. An excess of lipids in the blood is called hyperlipidemia, a condition common in diabetes, some kidney diseases, hyperthyroidism, and alcoholism. It is also a causal factor in the development of heart disease (see Chapters 5 and 13).

FIGURE 2.7 | The Digestive System
(*Source:* Lankford, T. Randall. *Integrated science for health students*. Virginia: Reston, 1979, p. 523.)



The absorption of food takes place primarily in the small intestine, which produces enzymes that complete the breakdown of proteins to amino acids. The motility of the small intestine is under the control of the sympathetic and parasympathetic nervous systems, such that parasympathetic activity speeds up metabolism, whereas sympathetic nervous system activity reduces it.

Food then passes into the large intestine, which acts largely as a storage organ for the accumulation of food residue and helps in the reabsorption of water. The entry of feces into the rectum leads to the expulsion of solid waste. The organs involved in the metabolism of food are pictured in Figure 2.7.

Disorders of the Digestive System

The digestive system is susceptible to a number of disorders.

Gastroesophageal reflux disease

Gastroesophageal reflux disease (GERD), also known as acid reflux disease, results from an abnormal reflux in the esophagus. This is commonly due to changes in the barrier between the esophagus and the stomach. As much as 60 percent of the U.S. adult population experiences acid reflux at least occasionally (U.S. Healthline, 2012). A systematic review of GERD found that the prevalence in North America was between 18 and 28 percent (El-Serag, Sweet, Winchester, & Dent, 2013).

Gastroenteritis, Diarrhea, and Dysentery

Gastroenteritis is an inflammation of the lining of the stomach and small intestine. It may be caused by excessive amounts of food or drink, contaminated food or water, or food poisoning. Symptoms appear approximately 2 to 4 hours after the ingestion of food and include vomiting, diarrhea, abdominal cramps, and nausea.

Diarrhea, characterized by watery and frequent bowel movements, occurs when the lining of the small and large intestines cannot properly absorb water or digested food. Chronic diarrhea may result in serious disturbances of fluid and electrolyte (sodium, potassium, magnesium, calcium) balance.

Dysentery is similar to diarrhea except that mucus, pus, and blood are also excreted. It may be caused by a protozoan that attacks the large intestine (amoebic dysentery) or by a bacterial organism. These conditions are only rarely life threatening in industrialized countries; in developing countries, they are among the most common causes of death.

Peptic Ulcer

A peptic ulcer is an open sore in the lining of the stomach or the duodenum. It results from the hypersecretion of hydrochloric acid and occurs when pepsin, a protein-digesting enzyme secreted in the stomach, digests a portion of the stomach wall or duodenum. A bacterium called *Helicobacter pylori* is believed to contribute to the development of many ulcers. Once thought to be primarily psychological in origin, ulcers are now believed to be aggravated by stress, but not caused by it.

Appendicitis

Appendicitis is a common condition that occurs when wastes and bacteria accumulate in the appendix. If the small opening of the appendix becomes obstructed, bacteria can easily proliferate. Soon this condition gives rise to pain, increased peristalsis, and nausea. If the appendix ruptures and the bacteria are released into the abdominal cavity or peritoneum, they can cause further infection (peritonitis) or even death.

Hepatitis

Hepatitis means "inflammation of the liver," and the disease produces swelling, tenderness,

and sometimes permanent damage. When the liver is inflamed, bilirubin, a product of the breakdown of hemoglobin, cannot easily pass into the bile ducts. Consequently, it remains in the blood, causing a yellowing of the skin known as jaundice. Other common symptoms are fatigue, fever, muscle or joint pain, nausea, vomiting, loss of appetite, abdominal pain, and diarrhea.

There are several types of hepatitis, which differ in severity and mode of transmission. Hepatitis A, caused by viruses, is typically transmitted through food and water. It is often spread by poorly cooked seafood or through unsanitary preparation or storage of food. Hepatitis B is more serious. Up to 2.2 million Americans are chronically infected with hepatitis B and thousands will die each year (Hepatitis B Foundation, 2018). Also known as serum hepatitis, it is caused by a virus and is transmitted by the transfusion of infected blood, by improperly sterilized needles, through sexual contact, and through mother-to-infant contact. It is a particular risk among intravenous drug users. Its symptoms are similar to those of hepatitis A but are far more serious.

Hepatitis C, also spread via blood and needles, is most commonly caused by blood transfusions; 130 million to 150 million people worldwide have the disorder, which accounts for half a million deaths annually. Hepatitis D is found mainly in intravenous drug users who are also carriers of hepatitis B, necessary for the hepatitis D virus to spread. Finally, hepatitis E resembles hepatitis A but is caused by a different virus.

The Gut–Brain Connection

Recent research has focused on how the brain and the gut communicate with each other. The microbial composition of the gut is complex and individualized, making definitive conclusions difficult. However, dysbiosis, the technical term for the microbial imbalance of the gut, has been linked not only to temporary and mild symptoms such as stomach upset but also to potentially more serious conditions such as inflammatory bowel disease, obesity, metabolic syndrome (a frequent precursor to heart disease), and Type II diabetes (Mayer & Hsiao, 2017) as well as to psychiatric disorders and poor mood (Sundin, Ohman, & Simven, 2017). Experiments show that altering the microbial environment through use of probiotics or other dietary interventions may beneficially affect the course of some of these disorders (Dinan & Cryan, 2017) and improve mood and energy. Certain patterns of microbial composition may represent vulnerabilities for adverse responses to stress, such as post traumatic stress disorder and exposure to extreme stress, such as racism, can alter the gut microbiota adversely (Carson et al., 2018).

The gut sends signals to the brain, which vary with microbial composition, that are then interpreted in the brain leading not only to physical symptoms but to changes in behavior and psychological states. In many important ways, then, the gut and the brain interact to affect physical and psychological health. Moreover, there is some evidence that the benefits of dietary interventions to treat adverse gut–brain interactions may affect not only the target person but subsequent generations (Callaghan, 2017).

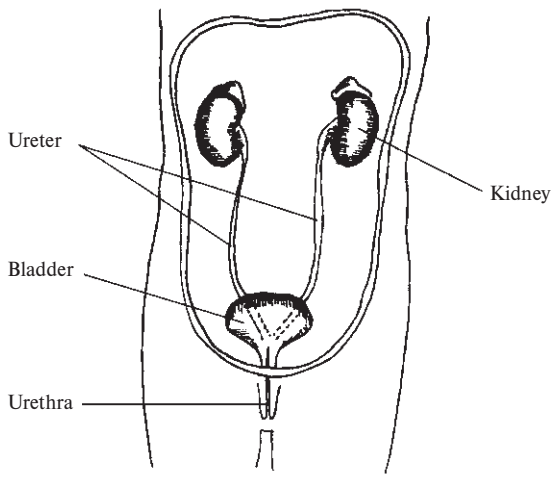
THE RENAL SYSTEM

Overview

The **renal system** consists of the kidneys, ureters, urinary bladder, and urethra. The kidneys are chiefly responsible for the regulation of bodily fluids; their principal function is to produce urine. The ureters contain smooth muscle tissue, which contracts, causing peristaltic waves to move urine to the bladder, a muscular bag that acts as a reservoir for urine. The urethra then conducts urine from the bladder out of the body. The anatomy of the renal system is pictured in Figure 2.8.

Urine contains surplus water, surplus electrolytes, waste products from the metabolism of food, and

FIGURE 2.8 | The Renal System
(*Source:* Lankford, T. Randall. *Integrated science for health students*. Virginia: Reston, 1979, p. 585.)



surplus acids or alkalis. By carrying these products out of the body, urine maintains water balance, electrolyte balance, and blood pH. Of the electrolytes, sodium and potassium are especially important because they are involved in muscular contractions and the conduction of nerve impulses, among other vital functions.

One of the chief functions of the kidneys is to control the water balance in the body. For example, on a hot day, when a person has been active and has perspired profusely, relatively little urine will be produced so that the body may retain more water. On the other hand, on a cold day, when a person is relatively inactive or has consumed a good deal of liquid, urine output will be higher so as to prevent overhydration.

Urine can offer important diagnostic clues to many disorders. For example, an excess of glucose may indicate diabetes, and an excess of red blood cells may indicate a kidney disorder. This is one of the reasons that a medical checkup often includes a urinalysis.

To summarize, the urinary system regulates bodily fluids by removing surplus water, surplus electrolytes, and the waste products generated by the metabolism of food.

Disorders of the Renal System

The renal system is vulnerable to a number of disorders. Among the most common are urinary tract infections, to which women are especially vulnerable and which can result in considerable pain, especially on urination. If untreated, they can lead to more serious infection.

Nephrons are the basic structural and functional units of the kidneys. In many types of kidney disease, such as that associated with hypertension, large numbers of nephrons are destroyed or damaged so severely that the remaining nephrons cannot perform their normal functions.

Glomerular nephritis involves the inflammation of the glomeruli in the nephrons of the kidneys that filter blood. Nephritis can be caused by infections, exposure to toxins, and autoimmune diseases, especially lupus. Nephritis is a serious condition linked to a large number of deaths worldwide.

Another common cause of acute renal shutdown is tubular necrosis, which involves destruction of the epithelial cells in the tubules of the kidneys. Poisons that destroy the tubular epithelial cells and severe circulatory shock are the most common causes of tubular necrosis.

Kidney failure is a severe disorder because the inability to produce an adequate amount of urine will cause the waste products of metabolism, as well as surplus inorganic salts and water, to be retained in the body. An artificial kidney, a kidney transplant, or **kidney dialysis** may be required in order to rid the body of its wastes. Although these technologies can cleanse the blood to remove the excess salts, water, and metabolites, they are highly stressful medical procedures. Kidney transplants carry many health risks, and kidney dialysis can be extremely uncomfortable for patients. Consequently, health psychologists have been involved in addressing these problems.

THE REPRODUCTIVE SYSTEM

Overview

The development of the reproductive system is controlled by the pituitary gland. The anterior pituitary lobe produces the gonadotropic hormones, which control the development of the ovaries in females and the testes in males. A diagrammatic representation of the human reproductive system appears in Figure 2.9.

The Ovaries and Testes

The female has two ovaries located in the pelvis. Each month, one of the ovaries releases an ovum (egg), which is discharged at ovulation into the fallopian tubes. If the ovum is not fertilized (by sperm), it remains in the uterine cavity for about 14 days and is then flushed out of the system with the uterine endometrium and its blood vessels (during menstruation).

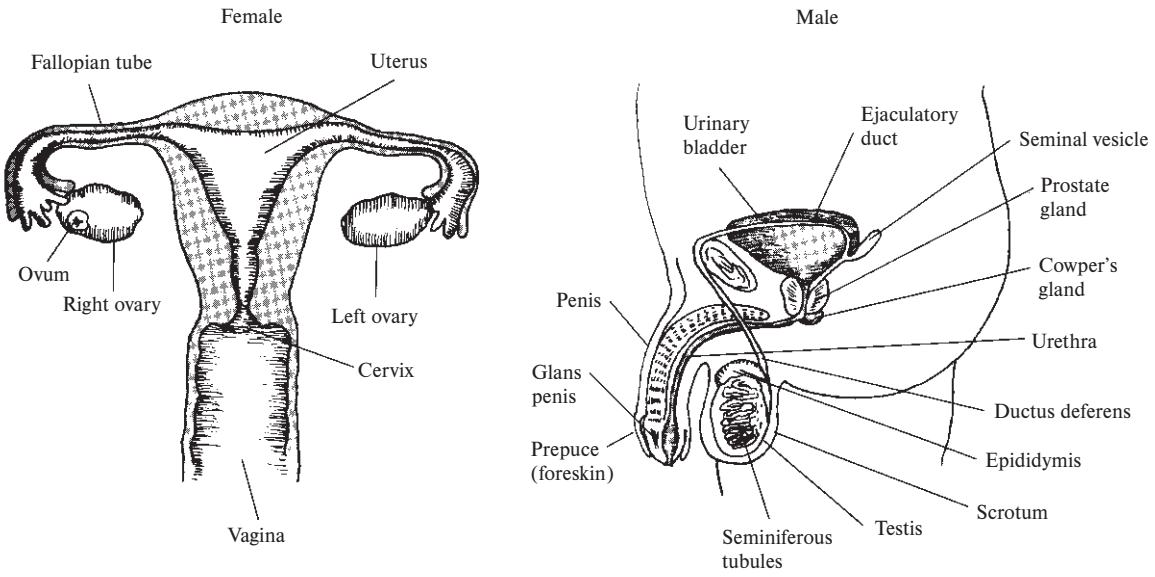
The ovaries also produce the hormones estrogen and progesterone. Estrogen leads to the development of secondary sex characteristics in females, including breasts and the distribution of both body fat and body hair. Progesterone, which is produced during the second half of the menstrual cycle to prepare the body for pregnancy, declines if pregnancy does not occur.

In males, testosterone is produced by the interstitial cells of the testes under the control of the anterior pituitary lobe. It brings about the production of sperm and the development of secondary sex characteristics, including growth of the beard, deepening of the voice, distribution of body hair, and both skeletal and muscular growth.

Fertilization and Gestation

When sexual intercourse takes place and ejaculation occurs, sperm are released into the vagina. These sperm, which have a high degree of motility, proceed upward

FIGURE 2.9 | The Reproductive System (*Sources:* Green, John Herbert. *Basic clinical physiology*. New York: Oxford University Press, 1978; Lankford, T. Randall. *Integrated science for health students*. Virginia: Reston, 1979, p. 688.)



through the uterus into the fallopian tubes, where one sperm may fertilize an ovum. The fertilized ovum then travels down the fallopian tube into the uterine cavity, where it embeds itself in the uterine wall and develops over the next 9 months into a human being.

Disorders of the Reproductive System

The reproductive system is vulnerable to a number of diseases and disorders. Among the most common and problematic are sexually transmitted diseases (STDs), which occur through sexual intercourse or other forms of sexually intimate activity. STDs include herpes, gonorrhea, syphilis, genital warts, chlamydia, and, most seriously, AIDS.

For women, a risk from several STDs is chronic pelvic inflammatory disease (PID), which may produce severe abdominal pain and infections that may compromise fertility. Other gynecologic disorders to which women are vulnerable include vaginitis, endometriosis (in which pieces of the endometrial lining of the uterus move into the fallopian tubes or abdominal cavity, grow, and spread to other sites), cysts, and fibroids (nonmalignant growths in the uterus that may nonetheless interfere with reproduction). Women are vulnerable to disorders of the menstrual cycle, including amenorrhea, which is the absence of menses, and oligomenorrhea, which is infrequent menstruation.

The reproductive system is also vulnerable to cancer, including testicular cancer in men and gynecologic cancers in women. Every 6 minutes, a woman in the United States is diagnosed with a gynecologic cancer, including cancer of the cervix, uterus, and ovaries (American Cancer Society, 2012a). Endometrial cancer is the most common female pelvic malignancy, and ovarian cancer is the most lethal.

Approximately 12 to 13 percent of U.S. couples may have infertility, defined as the inability to conceive a pregnancy after 1 year of regular sexual intercourse without contraception (U.S. Department of Health & Human Services, 2019). Although physicians once believed that infertility has emotional origins, researchers now believe that distress may complicate but does not cause infertility. Fortunately, over the past few decades, the technology for treating infertility has improved. A variety of drug treatments have been developed, as have more invasive technologies. In vitro fertilization (IVF) is the most widely used method of assistive reproductive technology. The live birth success rate for IVF is 41 to 43 percent per cycle. However, women over age 42 have a 4 percent success rate. (Medline Plus, 2018).

Menopause is not a disorder of the reproductive system; rather, it occurs when a woman's reproductive life ends. A variety of noxious symptoms can occur during the transition into menopause, including sleep

disorders, hot flashes, joint pain, forgetfulness, dizziness, and enhanced stress reactivity (Endrighi, Hamer, & Steptoe, 2016). As a result, some women choose to take hormone therapy (HT), which typically includes estrogen or a combination of estrogen and progesterone. HT was once thought not only to reduce the symptoms of menopause but also to protect against the development of coronary artery disease, osteoporosis, breast cancer, and Alzheimer's disease. It is now believed that, rather than protecting against these disorders, HT may actually increase some of these risks. As a result of this new evidence, many women and their physicians are rethinking the use of HT, especially over the long term.

GENETICS AND HEALTH

Overview

The fetus starts life as a single cell, which contains the inherited information from both parents that will determine its characteristics. The genetic code regulates such factors as eye and hair color, as well as behavioral factors. Genetic material for inheritance lies in the nucleus of the cell in the form of 46 chromosomes, 23 from the mother and 23 from the father. Two of these 46 are sex chromosomes, which are an X from the mother and either an X or a Y from the father. If the father provides an X chromosome, a female child will result; if he provides a Y chromosome, a male child will result.

Genetics and Susceptibility to Disorders

Genetic studies have provided valuable information about the inheritance of susceptibility to disease. For example, scientists have bred strains of rats, mice, and other laboratory animals that are sensitive or insensitive to the development of particular diseases and then used these strains to study illness onset and the course of illness. For example, a strain of rats that is susceptible to cancer may shed light on the development of this disease and what other factors contribute to its occurrence. The initial susceptibility of the rats ensures that many of them will develop malignancies when implanted with carcinogenic (cancer-causing) materials.

In humans, several types of research help demonstrate whether a characteristic is genetically based. Studies of families, for example, can reveal whether members of the same family are more likely to develop a disorder, such as heart disease, than are unrelated individuals in a similar environment. If a factor has genetic determinants, family members will show it more frequently than will unrelated individuals.

Twin research is another method for examining the genetic basis of a characteristic. If a characteristic is genetically transmitted, identical twins share it more commonly than do fraternal twins or other brothers and sisters. This is because identical twins share the same genetic makeup, whereas other brothers and sisters have only partially overlapping genetic makeup.

Examining the characteristics of twins reared together as opposed to twins reared apart is also informative regarding genetics. Attributes that emerge in twins reared apart are suspected to have genetic bases, especially if the rate of occurrence between twins reared together and those reared apart is the same.

Finally, studies of adopted children also help identify which characteristics have genetic origins and which are primarily the product of the environment. Adopted children will not manifest genetically transmitted characteristics from their adoptive parents, but they may manifest environmentally transmitted characteristics.

Consider, for example, obesity, which is a risk factor for a number of disorders, including coronary artery disease and diabetes. If twins reared apart show highly similar body weights, then we would suspect that body weight has a genetic component. If, on the other hand, weight within a family is highly related, and adopted children show the same weight as their parents and any natural offspring, then we would look to the family diet as a potential cause of obesity. For many attributes, including obesity, both environmental and genetic factors are involved.

Research like this has increasingly uncovered the genetic contribution to many health disorders and behavioral factors that may pose risks to health. Such diseases as asthma, Alzheimer's disease, cystic fibrosis, muscular dystrophy, Tay–Sachs disease, and Huntington's disease have a genetic basis. There is also a genetic basis for coronary heart disease and for some forms of cancer, including some breast and colon cancers. This genetic basis does not preclude the important role of the environment, however.

Genetics will continue to be of interest as the contribution of genes to health continues to be uncovered. For example, genetic contributions to obesity and alcoholism have emerged in recent years. Moreover, the contributions of genetics studies to health psychology are broadening. Even some personality characteristics, such as optimism, which is believed to have protective

health effects, have genetic underpinnings (Saphire-Bernstein, Way, Kim, Sherman, & Taylor, 2011).

Genetics and Health Psychology Health psychologists have important roles to play with respect to genetic contributions to health disorders. One question concerns whether people need to be alerted to genetic risks. Many people think that genetic risks are immutable and that any efforts they might undertake to affect their health would be fruitless if genes are implicated (Dar-Nimrod & Heine, 2011). Such erroneous beliefs may deter health behavior change and information seeking about one's risk (Marteau & Weinman, 2006). Genetic risk information may also evoke defensive processes whereby people downplay their risk (Shiloh, Drori, Orr-Urtreger, & Friedman, 2009). Genetic risks may also interact with stress or trauma to increase risks for certain disorders (Zhao, Bremner, Goldberg, Quyyumi, & Vaccarino, 2013). Accordingly, making people aware of genetic risk factors should be accompanied by educational information to offset these potential problems.

Another role for health psychologists involves genetic counseling. Prenatal diagnostic tests permit the detection of some genetically based disorders, including Tay–Sachs disease, cystic fibrosis, muscular dystrophy, Huntington's disease, and breast cancer. Helping people decide whether to be screened and how to cope with genetic vulnerabilities if they test positive represents an important role for health psychologists (Mays et al., 2014). For example, belief in a genetic cause can lead people to take medical actions that may be medically unwarranted (Petrie et al., 2015).

In addition, people who have a family history of genetic disorders, those who have already given birth to a child with a genetic disorder, or those who have recurrent reproductive problems, such as multiple miscarriages, often seek such counseling. In some cases, technological advances have made it possible to treat some of these problems before birth through drugs or surgery. However, if the condition cannot be corrected, the parents often must make the difficult decision of whether to terminate the pregnancy.

Children, adolescents, and young adults sometimes learn of a genetic risk to their health, as research uncovers such causes. Breast cancer, for example, runs in families, and among young women whose mothers, aunts, or sisters have developed breast cancer, vulnerability is higher. Families that share genetic risks may need special attention through family counseling. Some of the genes that contribute to the development of breast cancer have been identified, and tests are now available to determine whether a genetic susceptibility is present. Although this type of cancer accounts for only 5 percent of breast cancer, women who carry these genetic susceptibilities are more likely to develop the disease at an earlier age; thus, these women are at high risk and need careful monitoring and assistance in making treatment-related decisions. With genetic testing becoming available online to people who submit samples to a genetic testing website, knowledge of genetic risks may increase. However, it is essential to have any genetic risk that is identified independently validated because erroneous results can occur (Kolata, 2018).

Carriers of genetic risks may experience distress (Hamilton, Lobel, & Moyer, 2009). Should people be told about their genetic risks if nothing can be done to treat them? Growing evidence suggests that people at risk for treatable disorders benefit from genetic testing and do not suffer long-term psychological distress (Frieser, Scott, & Vrieze, 2018). Moreover, many people seek to learn their genetic risk factors (Reid et al., 2018). People who are chronically anxious, though, may require special attention and counseling (Rimes, Salkovskis, Jones, & Lucassen, 2006).

In some cases, genetic risks can be offset by behavioral interventions to address the risk factor. For example, one study (Aspinwall, Leaf, Dola, Kohlmann, & Leachman, 2008) found that being informed that one had tested positive for a gene implicated in melanoma (a serious skin cancer) and receiving counseling led to better skin self-examination practices at a 1-month follow-up. Thus health psychologists have an important role to play in research and counseling related to genetic risks, especially if they can help people modify their risk status and manage their distress (Aspinwall, Taber, Leaf, Kohlmann, & Leachman, 2013).

THE IMMUNE SYSTEM

Overview

Disease is caused by a variety of factors. In this section, we address the transmission of disease by infection, that is, the invasion of microbes and their growth in the body. The microbes that cause infection are transmitted to people in several ways:

- Direct transmission involves bodily contact, such as handshaking, kissing, and sexual intercourse. For example, genital herpes is typically contracted by direct transmission.

BOX 2.2 Portraits of Two Carriers

Carriers are people who transmit a disease to others without actually contracting that disease themselves. They are especially dangerous because they are not ill and so they can infect dozens, hundreds, or even thousands of people while going about the business of everyday life.

"TYPHOID MARY"

Perhaps the most famous carrier in history was "Typhoid Mary," a young Swiss immigrant to the United States who infected thousands of people during her lifetime. During her ocean crossing, Mary was taught how to cook, and eventually, some 100 individuals aboard the ship died of typhoid, including the cook who trained her. Once Mary arrived in New York, she obtained a series of jobs as a cook, continually passing on the disease to those for whom she worked without contracting it herself.

Typhoid is precipitated by a salmonella bacterium, which can be transmitted through water, food, and physical contact. Mary carried a virulent form of the infection in her body but was herself immune to the disease. It is believed that she was unaware she was a carrier for many years. Toward the end of her life, however, she began to realize that she was responsible for the many deaths around her.

Mary's status as a carrier also became known to medical authorities, and she spent the latter part of her life in and out of institutions in a vain attempt to isolate her from others. In 1930, Mary died not of typhoid but of a brain hemorrhage (Federspiel, 1983).

"HELEN"

The CBS News program *60 Minutes* profiled an equally terrifying carrier: a prostitute, "Helen," who is a carrier of HIV, the virus that causes AIDS (acquired immune deficiency syndrome). Helen has never had AIDS, but her baby was born with the disease. As a prostitute and heroin addict, Helen is not only at risk for developing the illness herself but also poses a threat to her clients and anyone with whom she shares a needle.

Helen represents a dilemma for medical and criminal authorities. She is a known carrier of AIDS, yet there is no legal basis for preventing her from coming into contact with others. Although she can be arrested for prostitution or drug dealing, such incarcerations are usually short-term and have a negligible impact on her ability to spread the disease to others. For potentially fatal diseases such as AIDS, the carrier represents a nightmare, and medical and legal authorities have been almost powerless to intervene (Moses, 1984).

- Indirect transmission (or environmental transmission) occurs when microbes are passed to an individual via airborne particles, dust, water, soil, or food. Influenza is an example of an environmentally transmitted disease.
- Biological transmission occurs when a transmitting agent, such as a mosquito, picks up microbes, changes them into a form conducive to growth in the human body, and passes them on to the human. Yellow fever, for example, is transmitted by this method.
- Mechanical transmission is the passage of a microbe to an individual by means of a carrier that is not directly involved in the disease process. Dirty hands, bad water, rats, mice, and flies can be implicated in mechanical transmission. Box 2.2 tells about two people who were carriers of deadly diseases and transmitted them to others.

Infection

Once a microbe has reached the body, it penetrates into bodily tissue via any of several routes, including the skin, the throat and respiratory tract, the digestive tract, or the genitourinary system. Whether the invading microbes gain a foothold in the body and produce infection depends on three factors: the number of organisms, the virulence of the organisms, and the body's defensive capacities. The virulence of an organism is determined by its aggressiveness (i.e., its ability to resist the body's defenses) and by its toxigenicity (i.e., its ability to produce poisons, which invade other parts of the body).

The Course of Infection

Assuming that the invading organism does gain a foothold, the natural history of infection follows a specific course. First, there is an incubation period between the time the infection is contracted and the time the symptoms appear.

Next, there is a period of nonspecific symptoms, such as headaches and general discomfort, which precedes the onset of the disorder. During this time, the microbes are actively colonizing and producing toxins. The next stage is the acute phase, when the illness and its symptoms are at their height. Unless the infection proves fatal, a period of decline follows the acute phase. During this period, the organisms are expelled from the mouth and nose in saliva and respiratory secretions, as well as through the digestive tract and the genitourinary system in feces and urine.

Infections may be localized, focal, or systemic. Localized infections remain at their original site and do not spread throughout the body. Although a local infection is confined to a particular area, it sends toxins to other parts of the body, causing other disruptions. Systemic infections affect a number of areas or body systems.

The primary infection initiated by the microbe may also lead to secondary infections. These occur because the body's resistance is lowered from fighting the primary infection, leaving it susceptible to other invaders. In many cases, secondary infections, such as pneumonia, pose a greater risk than the primary one.

Immunity

Immunity is the body's resistance to invading organisms. It may develop either naturally or artificially. Some natural immunity is passed from the mother to the child at birth and through breast-feeding, although this type of immunity is only temporary. Natural immunity is also acquired through disease. For example, if you have measles once, you are unlikely to develop it a second time; you will have built up an immunity to it.

Artificial immunity is acquired through vaccinations and inoculations. For example, most children and adolescents receive shots for a variety of diseases—among them, diphtheria, whooping cough, smallpox, poliomyelitis, and hepatitis—so that they will not contract these diseases, should they be exposed.

Natural and Specific Immunity

How does immunity work? The body has a number of responses to invading organisms, some nonspecific and others specific. **Nonspecific immune mechanisms** are a general set of responses to any kind of infection or disorder; **specific immune mechanisms,** which are always acquired after birth, fight particular microorganisms and their toxins.

Natural immunity is involved in defense against pathogens. The cells involved in natural immunity provide defense not against a particular pathogen, but rather against many pathogens. The largest group of cells involved in natural immunity is granulocytes, which include neutrophils and macrophages; both are phagocytic cells that engulf target pathogens. Neutrophils and macrophages congregate at the site of an injury or infection and release toxic substances. Macrophages release cytokines that lead to inflammation and fever, among other side effects, and promote wound healing. Natural killer cells are also involved in natural immunity; they recognize "nonself" material (such as viral infections or cancer cells) and lyse (break up and disintegrate) those cells by releasing toxic substances. Natural killer cells are believed to be important in signaling potential malignancies and in limiting early phases of viral infections.

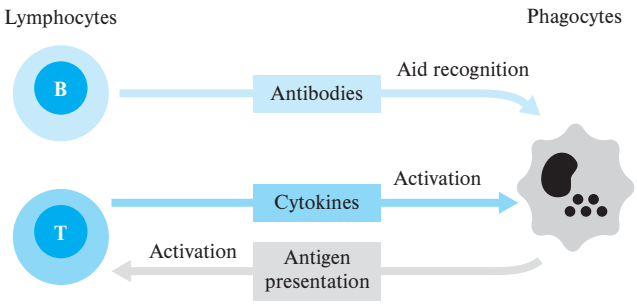
Natural immunity occurs through four main ways: anatomical barriers, phagocytosis, antimicrobial substances, and inflammatory responses. Anatomical barriers prevent the passage of microbes from one section of the body to another. For example, the skin functions as an effective anatomical barrier to many infections, and the mucous membranes lining the nose and mouth also provide protection.

Phagocytosis is the process by which certain white blood cells (called phagocytes) ingest microbes. Phagocytes are usually overproduced when there is a bodily infection, so that large numbers can be sent to the site of infection to ingest the foreign particles.

Antimicrobial substances are chemicals produced by the body that kill invading microorganisms. Interferon, hydrochloric acid, and enzymes such as lysozyme are some antimicrobial substances that help destroy invading microorganisms.

The inflammatory response is a local reaction to infection. At the site of infection, the blood capillaries first enlarge, and a chemical called histamine is released into the area. This chemical causes an increase in capillary permeability, allowing white blood cells and fluids to leave the capillaries and enter the tissues; consequently, the area becomes reddened and fluids accumulate. The white blood cells attack the microbes, resulting in the formation of pus. Temperature increases at the site of inflammation because of the increased flow of blood. Usually, a clot then forms around the inflamed area, isolating the microbes and keeping them from spreading to other parts of the body. Familiar examples of the inflammatory response

FIGURE 2.10 | Interaction Between Lymphocytes and Phagocytes B lymphocytes release antibodies, which bind to pathogens and their products, aiding recognition by phagocytes. Cytokines released by T cells activate phagocytes to destroy the material they have taken up. In turn, mononuclear phagocytes can present antigen to T cells, thereby activating them. (*Source:* Roitt, Ivan Maurice, Jonathan Brostoff, and David K. Male. *Immunology*. London: Mosby International, 1998.)



are the reddening, swelling, discharge, and clotting that result when you accidentally cut your skin and the sneezing, runny nose and teary eyes that result from an allergic response to pollen.

Specific immunity is acquired after birth by contracting a disease or through artificial means, such as vaccinations. It operates through the antigen-antibody reaction. Antigens are foreign substances whose presence stimulates the production of antibodies in the cell tissues. Antibodies are proteins produced in response to stimulation by antigens, which combine chemically with the antigens to overcome their toxic effects.

Specific immunity is slower and, as its name implies, more specific than natural immunity. The lymphocytes involved in specific immunity have receptor sites on their cell surfaces that fit with one, and only one, antigen, and thus, they respond to only one kind of invader. When they are activated, these antigen-specific cells divide and create a population of cells called the proliferative response.

Essentially, natural and specific immunity work together, such that natural immunity contains an infection or wound rapidly and early on following the invasion of a pathogen, whereas specific immunity involves a delay of up to several days before a full defense can be mounted. Figure 2.10 illustrates the interaction between lymphocytes and phagocytes.

Humoral and Cell-Mediated Immunity

There are two basic immunologic reactions—humoral and cell mediated. **Humoral immunity** is mediated by B lymphocytes. The functions of B lymphocytes include protecting against bacteria, neutralizing toxins produced by bacteria, and preventing viral reinfection. B cells confer immunity by the production and secretion of antibodies.

Cell-mediated immunity, involving T lymphocytes from the thymus gland, is a slower-acting response. Rather than releasing antibodies into the blood, as humoral immunity does, cell-mediated immunity operates at the cellular level. When stimulated by the appropriate antigen, T cells secrete chemicals that kill invading organisms and infected cells. Components of the immune system are shown in Figure 2.11.

The Lymphatic System's Role in Immunity

The **lymphatic system,** which is a drainage system of the body, is involved in important ways in immune functioning. There is lymphatic tissue throughout the body, consisting of lymphatic capillaries, vessels, and nodes. Lymphatic capillaries drain water, proteins, microbes, and other foreign materials from spaces between the cells into lymph vessels. This material is then conducted in the lymph vessels to the lymph nodes, which filter out microbes and foreign materials for ingestion by lymphocytes. The lymphatic vessels then drain any remaining substances into the blood.

Additional discussion of immunity can be found in Chapter 14, where we consider the rapidly developing field of psychoneuroimmunology and the role of immunity in the development of AIDS.

Disorders Related to the Immune System

The immune system is subject to a number of disorders and diseases. One very important one is AIDS, which