UNIT II
Behavior

Foundational Concept: Biological, psychological, and sociocultural factors influence behavior and behavior change.

CHAPTER 4

Individual Influences on Behavior

Read This Chapter to Learn About

- ➤ The Nervous System
- ➤ The Endocrine System
- ➤ Behavioral Genetics
- ➤ Personality
- ➤ Psychological Disorders
- ➤ Motivation
- ➤ Sleep
- ➤ Attitudes

THE NERVOUS SYSTEM

Neurons are the basic building blocks of the nervous system. Each **neuron** is a cell that can receive information, transform it, and transmit that information. The neuron receives information from other neurons as it is transmitted across the **synapse** (the junction between two neurons). The **dendrites** receive the information and forward it to the soma. The **soma** (cell body) is the location of the cell nucleus and the general functioning of the cell. The signal then travels down the **axon** away from the soma to the **terminal buttons** that release neurotransmitters into the synapse to transmit the signal to the dendrites on the next cell. See Figure 4-1.

Neurons only fire in an “all-or-nothing” pattern. When a neuron is in its resting state, positively charged sodium and potassium ions are actively pumped out, while negatively charged chloride ions are kept inside. This creates an electrochemical

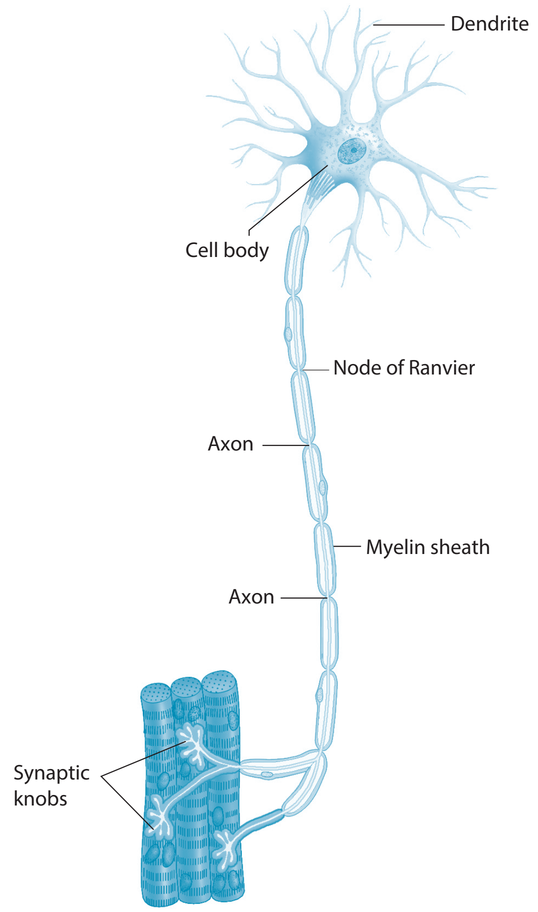

FIGURE 4-1 Neuron structure. A typical neuron consists of dendrites, a cell body, and an axon. *Source*: From Sylvia S. Mader, *Biology*, 8th ed., McGraw-Hill, 2004, reproduced with permission of The McGraw-Hill Companies.

gradient that stores potential energy. A neuron that is in its stable, charged state and is not firing or recovering has a **resting potential** of approximately −70 millivolts (mv). In this state, the neuron has the ability to fire if stimulated. During firing, the "windows," or **ion channels**, of the neuron briefly open, allowing the positively charged ions to flow inside. This process is called **depolarization**, indicating a reduced electrical differential between the inside and outside of the neuron. Then the windows close, and the neuron begins to actively transport the K+ and Na+ ions back out of the cell in order to regain its −70 millivolts charge. The **action potential** reflects a very brief alteration in the neuron's electrical charge as the signal moves down the axon. After firing, the neuron undergoes an **absolute refractory period**, during which it cannot fire, followed by a **relative refractory period**, when only a very large stimulus will trigger a firing.

If the axon is covered with a **myelin sheath** (an insulating material that surrounds axons), the signal will travel more quickly than if the axon is unmyelinated. The myelin sheath is an outgrowth of **glial cells**. In the peripheral nervous system, a subtype of glial cell is called a **Schwann cell**; in the central nervous system, oligodendrocytes myelinate the neurons. Though much smaller than neurons, **oligodendrocyte glial cells** make up about 50 percent of the brain's volume and provide various support activities for the neurons (e.g., nourishment, removal of waste, insulation).

Neurotransmitters are the primary means by which cells communicate with each other across the synapse (see Figure 4-2). **Neurotransmitters** are chemical messengers that transmit signals from one cell to another.

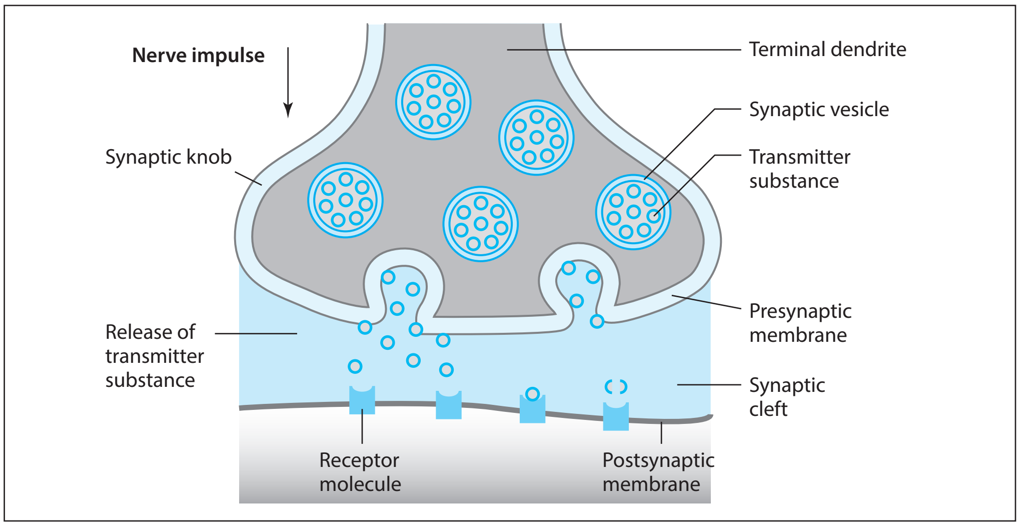

FIGURE 4-2 Communication across a synapse.

Neurotransmitters are packaged in **vesicles** by the neuron. When the cell fires, the vesicles merge with the **presynaptic membrane** and release the neurotransmitter into the **synaptic cleft**. When a neurotransmitter is dumped into the synapse by the presynaptic cell, it fits into the receptors on the postsynaptic cell. It should be noted that neurotransmitters from a presynaptic neuron and exogenous chemicals (drugs) may perform one of four different actions on the postsynaptic neuron:

- Cause a neuron to fire by attaching to a postsynaptic receptor and triggering depolarization (**agonist** creating an **action potential**).
- Encourage a neuron to fire by attaching to a receptor but with only partial efficacy to activate it, allowing some positively charged ions into the neuron and making the neuron less negatively charged (e.g., −60 mv). This, in conjunction with the same "fire" message from other neurons within a short period of time, will build up until a critical **threshold** is reached (around −55 mv) and the postsynaptic neuron fires (**partial agonist** creating **excitatory postsynaptic potential**).
- Inhibit a neuron from firing by attaching to and blocking the receptor molecules on the postsynaptic membrane, which means agonists cannot attach to the receptor (**antagonist** blocking any effects on internal neuron polarization).

- Encourage a neuron not to fire by attaching to a postsynaptic receptor that makes the neuron more negatively polarized (e.g., −80 mv) (**inverse agonist** creating **inhibitory postsynaptic potential**).

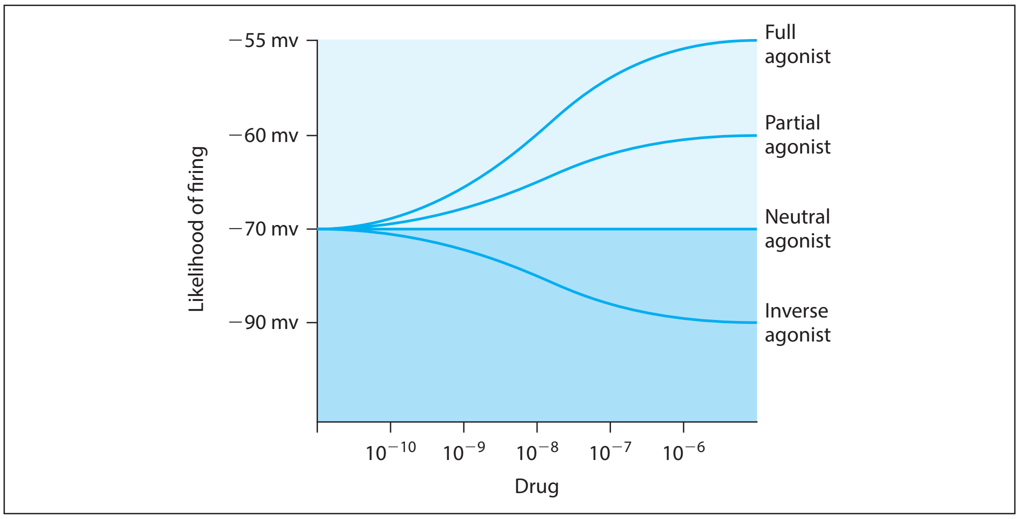

FIGURE 4-3 Likelihood of firing by a neuron.

The neuron may receive multiple inputs simultaneously, both inhibitory and excitatory, and it is the summation of these inputs that ultimately determines if the neuron reaches the firing threshold to produce an action potential. Figure 4-3 diagrams the likelihood of firing by a neuron.

The influence of the neurotransmitter ends when the neurotransmitter (1) is removed from the synaptic cleft as an intact neurotransmitter and returned to the presynaptic cell in a process called **reuptake** (most common), (2) is broken down by enzymes in the synaptic cleft and the pieces returned to the presynaptic cell, or (3) floats away into the fluids surrounding the neuron (minimal).

To be a neurotransmitter, (1) a chemical must be produced inside the neuron, (2) all of the precursor enzymes must be located in the neuron, (3) there must be enough of the chemical in the presynaptic neuron to produce an effect on the postsynaptic neuron if released, (4) the presynaptic neuron must be able to release the chemical and the postsynaptic neuron must have receptors for it to bind to, and (5) a biological mechanism such as reuptake or removal from the synaptic cleft must be possible to stop the effect on the neuron. There are also some molecules that act like neurotransmitters but do not obey all of these rules, including some neuropeptides or gases. While there are currently more than 50 identified neurotransmitters (or molecules such as neuropeptides that act like neurotransmitters), there are six major neurotransmitters and one major neuropeptide in the human body. They are listed in Table 4-1.

TABLE 4-1 Major Neurotransmitters.

Six Major Neurotransmitters and One Major Neuropeptide		
Name	**Symbol**	**Activities**
Acetylcholine	ACh	Most often in the periphery: motor neurons for skeletal muscles Learning, memory, problem solving, attention REM stage sleep onset
Dopamine*	DA	Controls voluntary movement (lack of DA is associated with Parkinson's disease) Involved in goal-directed behavior and motivation Reward and pleasant feelings Addiction: cocaine, amphetamines, and other drugs of abuse elevate DA Schizophrenia: elevated DA Depression: some antidepressants increase DA
Norepinephrine*	NE	Associated with mood and arousal (fight-or-flight response) Depression: some antidepressants elevate NE Addiction: some drugs of abuse elevate NE
Serotonin*	5HT	Most often found in the brain (#1) and in the gut (#2) Involved in biological regulation (sleep, eating, sex, pain perception) Involved in cognition (memory, learning) Involved in mood (aggression, depression, anxiety) Most medications for depression and obsessive-compulsion increase 5HT
Histamine*	H	Affects arousal and attention Affects immune response Influences food and water intake May affect blood flow in the brain
Gamma-aminobutyric acid	GABA	Primary inhibitory neurotransmitter in the body Many antianxiety, antiseizure, and sleep medications affect this system Many drugs of abuse (e.g., alcohol) affect this system
Endorphins		Neuropeptide Similar to opiate drugs in structure and its effects on the body Released by exercise, pain, positive social contact Creates pain relief, pleasurable emotions Many drugs of abuse hijack this pathway (e.g., heroin)

* Belong to a class of neurotransmitters called "monoamines" due to the shape of a single amino group connected to an aromatic ring

Within the nervous system, there are two major divisions: the peripheral and the central nervous systems. The **peripheral nervous system (PNS)** refers to the nerves that lie outside of the brain and spinal cord. Within the PNS, there are two subdivisions: the somatic and the autonomic systems. The **somatic nervous system** is made up of the nerves that control voluntary muscle movements (efferent nerves) and receive sensations from the body (afferent nerves). The **autonomic nervous system** is often referred to as the “involuntary” system, although recent research has shown that humans do have some control over these processes. Within the autonomic system there is the **sympathetic system** (which responds to stress to mobilize the body’s resources) and the **parasympathetic system** (which returns the body to its normal state of balanced functioning, or **homeostasis**, after the stressor has passed). See the diagram in Figure 4-4.

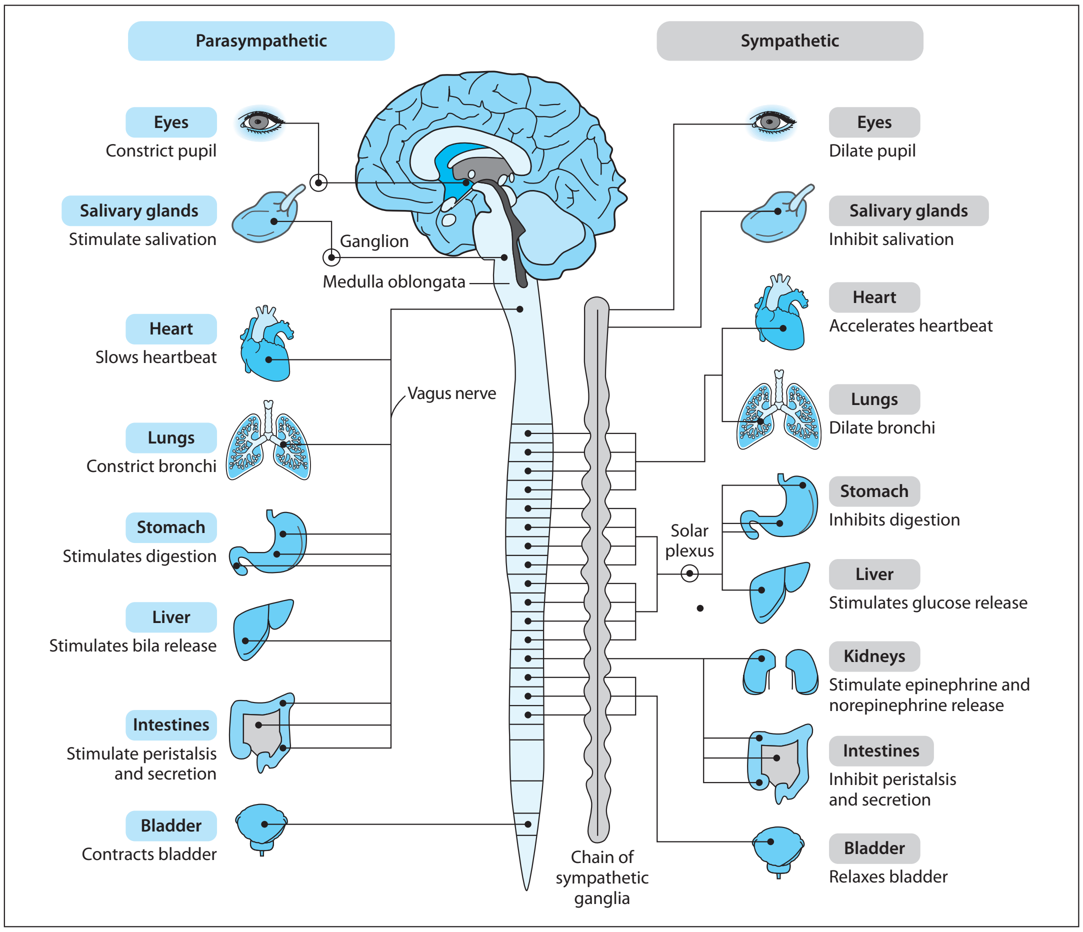

FIGURE 4-4 The parasympathetic and sympathetic nervous systems regulate organ function.

The **central nervous system** refers to the nerves that constitute the brain and spinal cord. The spinal cord carries both **afferent** (to the brain) sensory signals and **efferent** (from the brain) motor signals. The brain itself is divided into three major components based on their likely evolutionary development (see Figure 4-5).

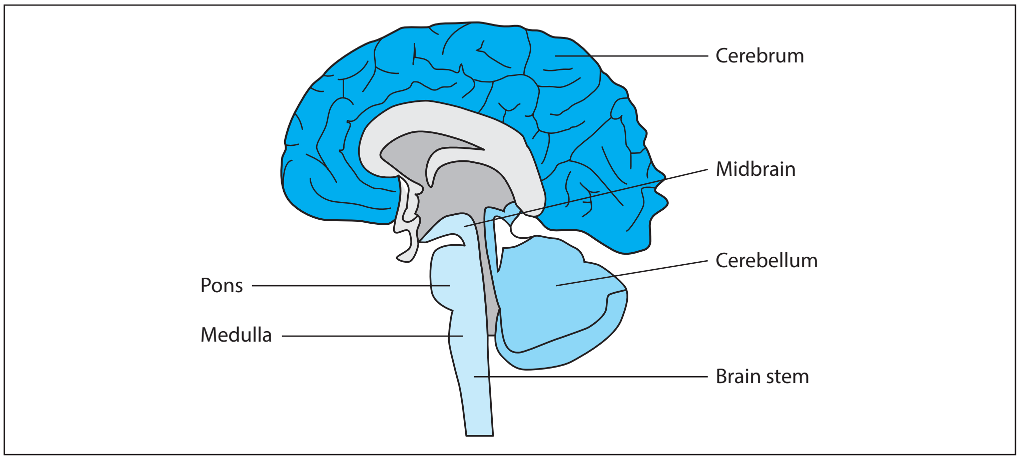

FIGURE 4-5 Sections of the brain.

- The **hindbrain** (or **brain stem**) is composed of the cerebellum, medulla, and the pons. The **medulla** controls many unconscious processes vital for life, including blood circulation, breathing, muscle tone, and reflexes. The **pons** includes areas involved in sleep and arousal. The **cerebellum** coordinates balance, movement, and the sense of equilibrium.
- The **diencephalon** or **midbrain** sits between the brain stem and cerebrum in adult humans. It primarily comprises the **thalamus**, which acts as the primary relay station between the incoming sensory signals (except smell) and the brain, as well as the outgoing motor signals to the body. This is also the location of the **hypothalamus**, which is responsible for basic biological needs such as hunger, thirst, and temperature control for the body.
- The largest portion of the brain is called the **cerebrum** (or **forebrain**); this part sits under the skull and is responsible for sensing, thinking, consciousness, emotion, memory, and voluntary movements. The **limbic system**, the system closely associated with emotions, lies in the subcortical region of the cerebrum as do some structures such as the **hippocampus**, which is associated with memory. The **cerebral cortex** is the outer layer of the cerebrum with its many folds; it houses complex thought and consciousness. The right and left hemispheres are connected by the **corpus callosum**, a bundle of axon fibers that facilitates communication between the two sides of the brain (see Figure 4-6).

The brain has four lobes (see Figure 4-7):

- The **occipital lobe** processes visual information.
- The **parietal lobe** receives the afferent signals from the body and processes physical sensations via the **somatosensory cortex**.
- The **temporal lobe** contains the **primary auditory cortex**, which processes auditory signals. **Wernicke's area**, the part of the brain responsible for language and speech comprehension, is located in the left temporal lobe.

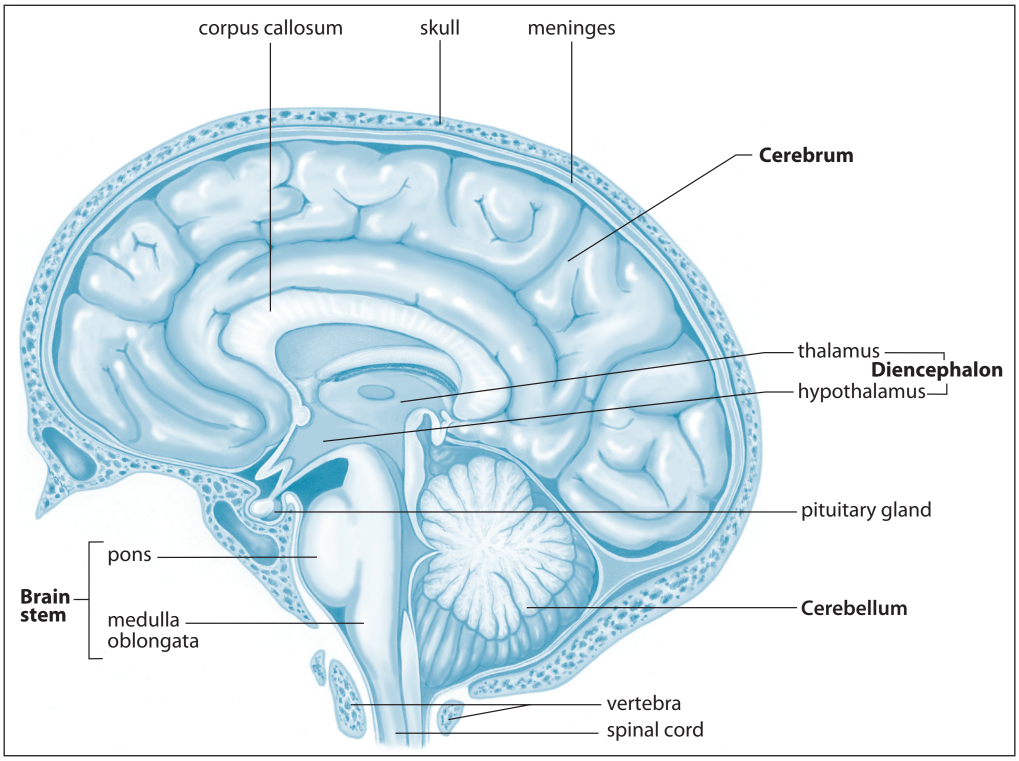

FIGURE 4-6 Brain structure. The cerebrum of the brain is divided into right and left hemispheres connected by the corpus callosum. *Source*: From Sylvia S. Mader, *Biology*, 8th ed., McGraw-Hill, 2004, reproduced with permission of The McGraw-Hill Companies.

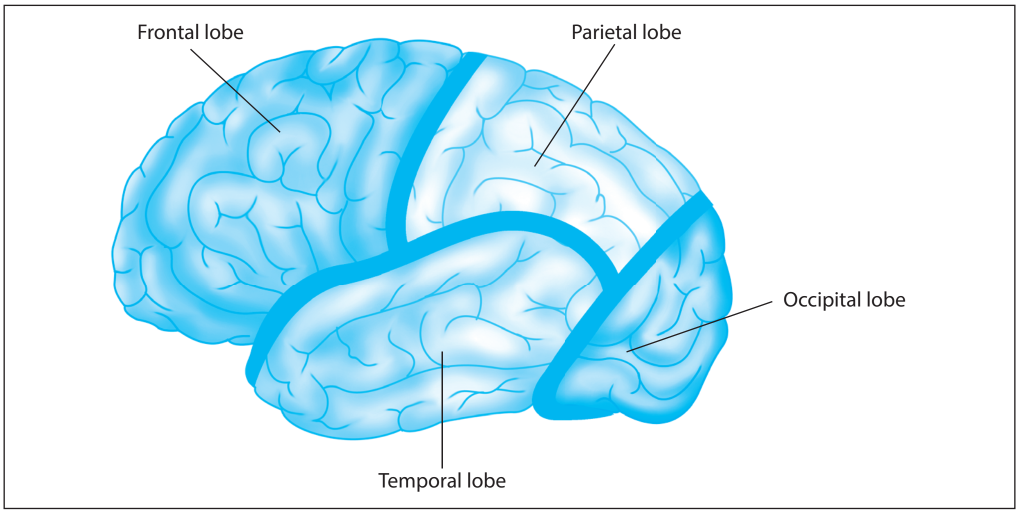

FIGURE 4-7 The cerebral lobes.

- The **frontal lobe** is responsible for "everything else." It contains the **primary motor cortex**, which lies adjacent to the parietal lobe's sensory cortex. The frontal lobe also houses the prefrontal cortex at the anterior portion of the brain. The **prefrontal cortex** is associated with a wide variety of higher-order cognitive functions, including judgment, problem solving, working memory, and attention. In general, it acts as the control system of the brain that determines how to synthesize complex information into organized and coherent thoughts.

THE ENDOCRINE SYSTEM

The **endocrine system** is a collection of glands that release hormones into circulation, sending signals to a wide variety of tissues, including organs, muscles, neurons, and even other glands, some of which are relatively far away from the glands (see Figure 4-8). The **hormones** are chemical communicators that travel through the bloodstream and transfuse into target cells. They are usually released in small pulsating bursts, sometimes based on circadian rhythms for regular maintenance of body systems, or in brief bursts that last only a few minutes for unusual situations. The **pituitary gland** is often called the **master gland**. It is located in the hypothalamus and often releases hormones that control how other glands release hormones. The endocrine system can have a strong influence on behavior. During times of stress, the fight-or-flight reaction is mediated by the pituitary gland, causing the adrenal glands to release adrenaline/epinephrine, which then prepares the body for an emergency. The gonadotropin hormones from the **pituitary gland** affect the **gonads** or sexual glands (testes and ovaries) during adolescent development, creating secondary sexual characteristics and heightened sexual interest. The **thymus gland** plays a critical role in the immune system. The **thyroid** controls energy use, protein production, and bodily sensitivity to other hormones. The **parathyroid** controls calcium use in the body. The **pineal gland** was once thought by the 17th-century French philosopher René Descartes to be the sole link between the mind and body. Today, however, it is recognized as having the critical role of releasing melatonin and assisting with the circadian rhythms of the body.

Some organs also have secondary endocrine functions and release hormones that affect distal tissues in the body. The pancreas releases insulin. The kidney releases hormones affecting blood pressure and urine concentration, which should not be confused with the adrenal glands that sit on top of the kidneys and release glucocorticoids among other hormones. The liver produces hormones that affect multiple areas of digestion and iron use in the body. The heart produces hormones to affect blood pressure and blood volume. Even adipose (fat) tissue releases hormones that affect energy storage and usage; recently it was also discovered that it releases low levels of the hormone estrogen as well.

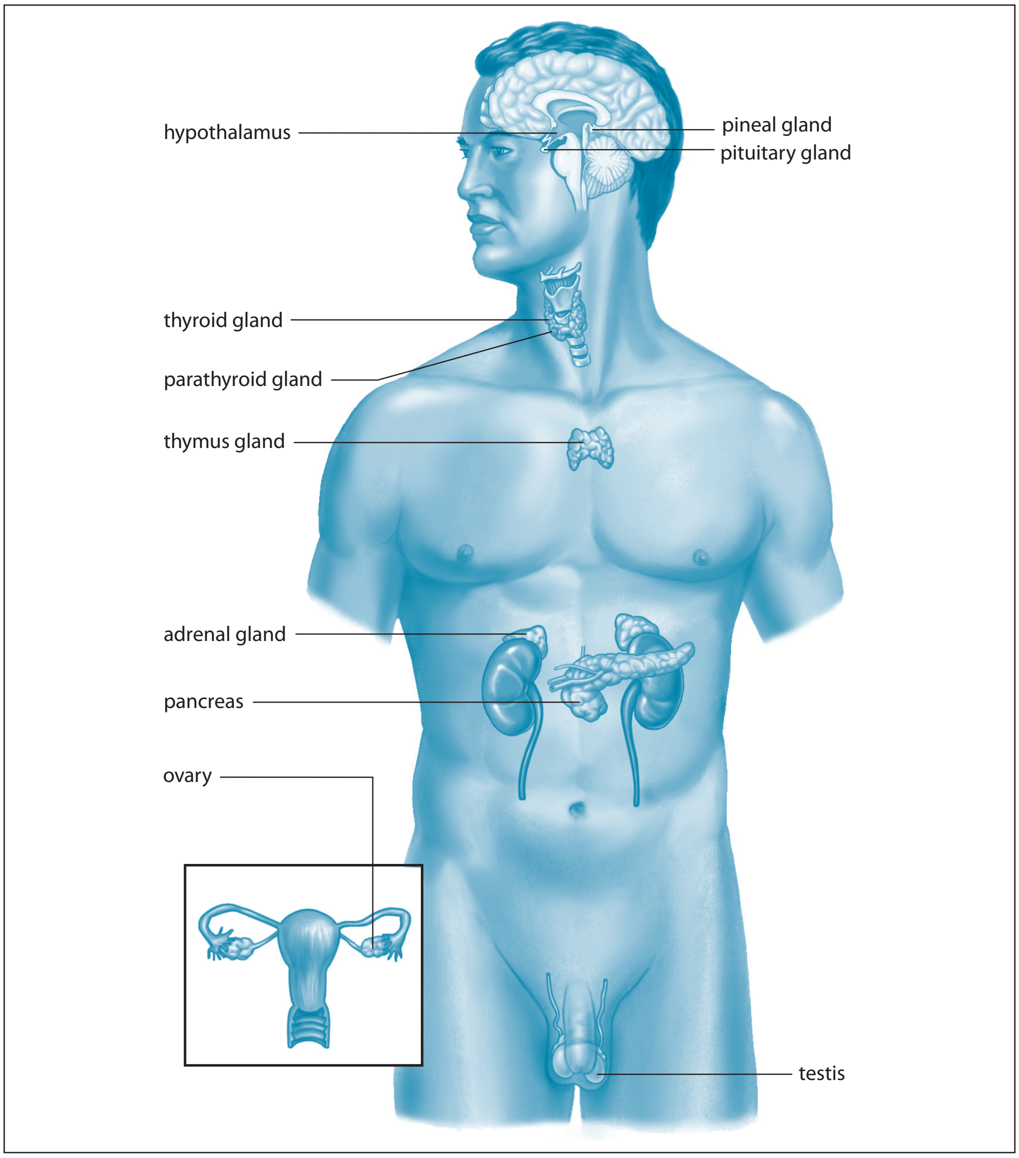

FIGURE 4-8 The endocrine system. Anatomic locations of major endocrine structures of the body. *Source*: From Sylvia S. Mader, *Biology*, 8th ed., McGraw-Hill, 2004, reproduced with permission of The McGraw-Hill Companies.

BEHAVIORAL GENETICS

Your genes interact with the environment to create temperament, behaviors, and cognitive ability, thus forming your physiological and psychological makeup. Hereditary material is made up of **chromosomes**. Humans have 46 chromosomes (23 pairs). Each parent contributes one chromosome to each pair, which means that a child has 50 percent genetic relatedness to each parent. **Identical twins** share 100 percent of their genetic material as a single zygote split into two separate individuals. **Fraternal twins** come from two separately fertilized eggs and share genetic similarity as do any two siblings (50 percent). Each chromosome contains thousands of genes. **Genes** are biochemical components of DNA that are key in transmitting hereditary material. Your **genotype** is your genetic makeup. Your **phenotype** is the observable expression of those genetics.

It should be noted that behavioral genetics has a difficult history. Sir Francis Galton, one of the first behavioral geneticists in the 1800s, believed that all of an individual's mental and physical health could be described by his or her genetic makeup. He proposed behavioral genetics in order to "explain" why the British upper class was supposedly more intelligent and enlightened than other ethnicities. Galton pioneered the field of eugenics that 20th-century fascist states later put to cruel misuse.

Abandoning the early history of the field, modern behavioral genetics is focused on how genetics affect behavior, cognition, and physiology and vice versa. There continues to be active discussion of "nature versus nurture" regarding how much of a person's character is caused by genetics and how much is caused by upbringing and environment. The most fundamental answer is that it appears to be the combination of genetics and environment that determines how an individual develops psychologically, behaviorally, and physically. It is likely that these characteristics are not controlled by a single gene, but are rather **polygenic traits**, determined by multiple genes. This means that adopted identical twin studies are the best way to answer nature–nurture questions. Identical twins (same genetic code) who have been adopted into different families (changing the environment of upbringing) are studied to identify correlations between temperament, cognitive ability, physical strength, and other individual factors. From these studies it has been determined that identical twins appear to have a 0.8 correlation for intelligence and a 0.5 correlation for personality traits. Interestingly, however, whether they are biological or adopted, children have only around a 0.2 correlation for intelligence with the parent(s) who raised them. Thus it appears to be a combination of genes and environment that governs the development of personality, physical skills, and behavior. Environment includes experiences, upbringing, and other external influences. The **diathesis-stress model** explains the relative impact of genes on mental health and behavior. This model proposes that an individual is set up with certain genetic characteristics that influence mental health (e.g., a susceptibility for depression). However, if external stressors (e.g., loss of a job, divorce) exceed the individual's protective factors (e.g., good self-esteem, social support), the genetic susceptibility may become a reality.

Of course, within any population there is a natural genetic variability. Some **regulatory genes** (genes that control the expression of other genes) may produce specific behaviors across cultures. These regulatory genes are more widely researched in nonhuman animals because techniques such as gene knockouts and cross-breeding make it much easier to control the genetic makeup and genetic expression of animals. However, regulatory genes are a likely factor in human behaviors such as basic facial expressions.

PERSONALITY

Personality can be defined and measured in a number of different ways. But across all definitions, it is generally seen as a robust set of reactions that make up how an individual interacts with the world. There are continuing disagreements between the major theories regarding how much a personality can be changed, and how much is due to nature versus nurture.

The **psychoanalytic theory of personality** was famously first espoused by Sigmund Freud. Under this model, the personality comprises three factors. The **id** is the most basic element of personality (e.g., What do I want?). It is the primary information processor and is strictly ruled by the pleasure principle. The id is largely unconscious and cannot be changed. The **ego** is the secondary level of processing. It is based in the reality principle (e.g., What can I get away with? or What do I need to do?). The individual is marginally conscious of this level of processing, but the ego cannot really be changed. The third and highest level of processing is the **superego** (e.g., What should I do?). It is somewhat conscious and the most susceptible to change via psychotherapy. The superego often mediates the relationship between the id and the ego.

Humanistic personality theory arose in reaction to Freud's psychoanalytic personality models. The American psychologist Carl Rogers is known as the founder of this field. He based his personality model on five primary statements:

1. Humans can be viewed only as gestaltic beings, and cannot be broken into independent parts.
2. Humans exist within their human community and within the larger cosmos.
3. Humans are self-aware and conscious, which makes them unique among animals.
4. Humans can choose their behavioral reactions to situations, and because of that awareness, they are also responsible for their behavioral choices.
5. Humans are continually pursuing future self-actualization by expanding their creativity and finding meaning in events.

Under this theory, mental health issues occur when individuals either do not take responsibility for their actions (4) or they are hampered from developing and growing as a human (5). In Rogers' view, psychotherapy can be very useful in changing negative personality characteristics to positive ones.

One problem with these two personality trait theories is that they rarely had research to support the assumptions they were based on (although there have been attempts to perform such research in the modern era). In contrast to the preceding theories, the **five-factor model** developed by Robert McCrae and Paul Costa was based on empirical research from the earliest development of the model. According to this model, personality includes multiple durable traits that explain behavioral reactions, and these reactions are maintained even across a wide variety of situations. Furthermore, personality characteristics group into five basic dimensions: extraversion, neuroticism, openness to new experience, agreeableness, and conscientiousness. A person's personality is defined based on his or her scores on each of the five factors. This model is widely used in industrial-organizational psychology, human resources, and career counseling.

The **social-cognitive theory**, developed by Albert Bandura, grew out of behaviorism. It was originally called social-learning theory, but the name was changed as the researchers came to understand how social influence affected cognition in general, not just learning. Bandura's model identifies how personality is shaped by social reaction to the individual. In this model, three aspects interact with each other to develop personality: **behavior, environment,** and **cognitive factors**. Bandura also emphasizes the importance of people's ability to understand how current actions affect the future and to plan accordingly. The individual's feelings of **self-efficacy**, or beliefs that his or her actions will achieve some planned future outcome, have gained increasing attention. A person who believes that his or her actions can affect the future, and who can apply future planning to the interacting three factors, can not only express a personality but also change that personality. Under this theory, a person who chooses to make personality changes can do well in psychotherapy.

While genetics likely interact with environmental characteristics to develop personality (as discussed in the previous section), it is unclear to what extent various aspects of biology impact personality. The German-born psychologist Hans Eysenck was a strong believer that personality is determined by a person's genes. His model proposes that there are only three personality factors: extraversion (sociable, outgoing), neuroticism (nervous, anxious), and psychoticism (egocentric, antisocial). Eysenck's model has mixed support. His three personality factors are not widely supported, but his view of the influence of genetics on personality is supported. Some adopted twin studies suggest that 40 to 58 percent of personality traits are genetically heritable.

PSYCHOLOGICAL DISORDERS

The definition of psychological disorders is somewhat culturally bound. There are some disorders that seem to occur only in specific cultural contexts (e.g., Hwa-Byung in Korean culture, or anorexia nervosa in affluent Western cultures), while others seem to cut across cultures (e.g., depression). When psychological disorders do arise, there are two major approaches to treatment.

The **biomedical approach** identifies genetic and chemical reasons for the disease state and attempts to counter these dysfunctions solely with medications. This approach has been the traditional approach in medicine, but it is losing ground as people develop a better understanding of the multiple factors that affect human health.

As medicine and psychology have grown increasingly sophisticated, there is a recognition that the old Cartesian dualistic belief that the body and the brain do not interact is completely faulty and may in fact do patients more harm than good. Today the increasingly supported approach to mental and physical health is the **biopsychosocial approach**. This approach is based on the idea that one needs to understand a person's biological, psychological, and social circumstances in order to identify the appropriate treatment for that person. It also includes the understanding that the appropriate treatment may not involve any biochemicals. For example, there is significant research that shows that cognitive-behavioral therapy is more effective in the treatment of depression than antidepressant medication. These studies also show that both psychotherapy and antidepressants create the same changes in the brain as measured by fMRI. However, after stopping both treatments, the positive brain changes caused by psychotherapy persist for at least one year, whereas the similar changes caused by medication stop within two weeks. With serious and persistent mental illness such as schizophrenia, the best treatment approach is a combination of medication and psychotherapy, which is far more effective than medication alone to increase treatment adherence and improve rehabilitation.

Proponents of medications and psychotherapy, though taking differing approaches to treating mental health, have pragmatically agreed on classifying major psychological disorders. The ***DSM*** **(*Diagnostic and Statistical Manual of Mental Disorders*)** published by the American Psychiatric Association was the primary means for diagnosing mental health disorders up through version 4 (*DSM-IV*). However, the publication of version 5 (*DSM-5*) created controversy due to what some felt was overwhelming influence on the diagnostic criteria by pharmaceutical companies, and it has since lost its following among mental health providers. Instead, many mental health providers are moving to the ***International Classification of Diseases*** **(version 10; *ICD-10*)** manual published by the World Health Organization. This publication is viewed as less influenced by pharmaceutical companies and more reflective of culturally-bound mental health diagnoses.

The estimated prevalence rate of mental health conditions varies by country. Further, prevalence rate should not be confused with diagnosed rate as there are many individuals in the United States who do not receive a diagnosis or treatment for their mental health condition due to stigma, economics, or availability of treatment providers. Estimated annual prevalence rates for the U.S. population are found in Table 4-2. Note that more than one-quarter of U.S. adults qualify for some type of mental health (emotional, behavioral, cognitive, and/or substance abuse) diagnosis.

TABLE 4-2 Psychological Disorders Among U.S. Adults.

	% of U.S. Adults
Qualify for any mental health diagnosis	26.2%
Nonsubstance-related mental health diagnosis	18.6%
Major depressive disorder	6.9%
Bipolar disorder	2.6%
Schizophrenia	1.1%
Anxiety disorder (PTSD, panic, general anxiety)	18.1%
Personality disorder	9.1%
Drug or alcohol abuse/dependence	8.7%

Data from National Institutes of Health

Types of Psychological Disorders

Anxiety disorders are associated with inappropriate escalations of the hypothalamus-pituitary-adrenal (HPA) axis that trigger the flight-or-flight response. There are increased feelings of being threatened and fearful emotions that the individual cannot control. There are multiple subtypes of anxiety disorders. Disorders that fall under this category include post-traumatic stress disorder (PTSD), panic disorder, phobias, obsessive-compulsive disorder, and generalized anxiety disorder. Neurochemically, this pathway is often associated with dysfunctions in the **GABA system** (the primary inhibitory system in the brain) or the **serotonin system** (the “feel good” pathway).

Somatoform disorders describe disorders that link physiological and psychological mental health. Somatoform disorders are often mistaken for disorders that some people intentionally create in order to gain something. For example, some people fake medical symptoms in order to support a lawsuit (**malingering**). Other people hurt themselves in order to create real medical symptoms, such as by injecting themselves with harmful bacteria in order to gain sympathy (**factitious disorder**; what used to be known as Munchausen’s syndrome). True somatoform disorders are *not* intentional. The individual actually experiences the symptom (sometimes in the context of a diagnosable medical condition) which can be exacerbated or alleviated by the individual’s psychological condition. **Conversion disorder** is an example of this; the individual experiences a severe trauma and then loses function in a body part. It should also be noted that *all* pain conditions (even those in diagnosed disease states) include a somatoform component because a person’s emotional state, depression, anxiety, social support, and other psychosocial factors have been shown to strongly affect that person’s pain experience.

The term **mood disorders** includes any mental health diagnosis that is affected by depression (e.g., major depression disorder, dysthymia, bipolar depression, seasonal affective disorder). Symptoms of these disorders can be classified into two categories, emotional-cognitive and vegetative symptoms. **Emotional-cognitive symptoms** include feelings of sadness, irritability, anger, low self-esteem, slowed processing speed, and low motivation. **Vegetative symptoms** include changes in sleep, sex drive, appetite, and increased fatigue. When assessing depression in patients who are medically ill, it is important to focus on the emotional-cognitive symptoms because the vegetative symptoms of depression may be caused or exacerbated by the medical illness. The etiology of mood disorders may be related to structural changes in the brain, genetic prevalence, and cognitive patterns. The idea that has received the most attention for pharmacological treatment is the monoamine hypothesis. This is related to the concept that mood disorders are related to too small or too large amounts of monoamines. **Monoamines** are a class of neurotransmitters that include serotonin, dopamine, and norepinephrine. These three neurotransmitters are the basis for most pharmacological treatments of depression.

Schizophrenia disorders involve a complex series of symptoms that are divided into positive and negative symptoms. Positive symptoms are those that are "additive"—and seen with greater prevalence among those with schizophrenia; these include hallucinations, delusions, emotional disturbance, and disorganized speech. Negative symptoms are those that show diminished functioning compared to healthy individuals; these include cognitive symptoms such as diminished problem solving and diminished adaptive behavior, social symptoms such as social withdrawal and diminished humor appreciation, and emotional symptoms such as flat emotions and apathy. Pharmacological treatment is generally better at addressing positive symptoms than negative symptoms. Schizophrenia usually occurs in early adulthood (before 25 years old). Full onset is colloquially known as a **schizophrenic break**, though often **prodromal symptoms** occur before the full onset of schizophrenia. Remission of symptoms can occur. An individual has a better chance of remission if onset is fast and later in life with few negative symptoms, and if the individual had good social and occupational engagement prior to onset. There does appear to be a genetic component. Those who have a first-degree relative with schizophrenia have a 9-percent chance of developing the disorder, with up to an 80-percent chance among identical twins if one twin is diagnosed with schizophrenia. By contrast, the general population risk level is 1 percent. Neurochemically, schizophrenia has been traditionally associated with the **dopamine hypothesis**, which suggests that overactivity is related to a specific receptor subtype of dopamine (D_2), especially in the mesolimbic dopamine pathway, and too little dopamine in the mesocortical pathways. Glutamate (a major excitatory neurotransmitter in the brain) has also been implicated in recent research, as has serotonin and GABA (a major inhibitory neurotransmitter). There has also been some research implicating malfunctioning sodium channels.

Drug addiction, substance abuse, and other addictive behaviors affect approximately 9 percent of the U.S. population. Frequently, addiction is to substances, but more recently, researchers have begun looking into addictive behaviors (e.g., gambling, internet addiction). Both substance addiction and addictive behaviors hijack the dopamine pathways and increase transmission of dopamine. Dopamine pathways are associated with the brain's reward system. Increasing dopaminergic activity makes the individual feel good and desire to keep repeating the behavior or substance use.

There are also a number of progressive nervous system disorders that show a gradual loss of functioning. **Alzheimer's disease** is a progressive dementia that affects a patient's memory and cognition. Most diagnoses of Alzheimer's occur after the age of 65; however, some early-onset cases can occur in the late forties. Early-onset cases appear to have a more genetic component compared to late-onset cases, and some specific genetic risk factors have been identified. Short-term memory is initially affected, and as the disease progresses, the individual will eventually have difficulty with encoding and recalling long-term memories as well. Other symptoms that arise as the disease progresses include mood swings, confusion, irritability, and aggression, and in the advanced stage, communication difficulties. The body appears to "forget" how to function over time. Therefore, while Alzheimer's is rarely a direct cause of death, its presence contributes to a number of other physical maladies (e.g., infected bedsores, pneumonia) that can be a direct cause of death. Multiple etiologies for Alzheimer's have been proposed and are being actively pursued in research. At present, two possibilities appear to have the most support. The first is that inefficient enzymes fail to adequately break down beta-amyloid, which develops into fibrillar plaques that inhibit learning and enhance neuronal decay. The second hypothesis posits that abnormal tau-amyloid proteins develop into neurofibrillary tangles within the cells that disrupt intracellular communication and cause cell death.

Parkinson's disease is officially identified as a movement disorder. It is characterized by tremors when a patient is not actively moving. Onset usually occurs in the fifties; however, early onset is also possible (e.g., actor Michael J. Fox's publicized battle with early-onset Parkinson's). Over time, the tremors progress to difficulty with motor movement, motor "freezing," and a shuffling walk. Cognitive changes are likely to occur as the disease progresses, including difficulty with executive functioning (e.g., planning, organization), difficulty with attention and memory, and slowed processing speed. Visual-spatial abilities also decrease. Psychologically, depression, apathy, and anxiety are common comorbidities. The symptoms of Parkinson's disease are triggered by the death of dopamine-producing cells in the substantia nigra. The cause of the cell death is unknown, although smoking, genetic heredity, and exposure to some pesticides are risk factors. As the dopamine-producing cells die, there is too little dopamine (D_2 again) in the nigrostriatal pathway that is associated with motor control. Pharmacological treatment attempts to increase the amount of dopamine in the system. However, the delivery systems for medication are difficult. The medicine may be intended for the nigrostriatal dopamine pathway, but it can also affect the mesolimbic dopamine pathway (associated with schizophrenia, addiction, and impulse control behavior). So pharmacological treatment of Parkinson's disease is a delicate balancing act between controlling the symptoms of the disease and the unintended side effects of treatment.

Research for each of these disorders is ongoing. Particularly exciting is the potential use of stem cells to slow down or stop disease progress. It may be possible to regenerate neurons in the central nervous system (something thought almost impossible only 20 years ago) to slow the progress of the disease. Research also continues to focus on identifying the etiology of these diseases, because if researchers do not understand the cause of the cell death, they may not be able to stop the same process from occurring with the new neurons. Regardless, stem cells show great promise in future treatment of these diseases. Even if stem cell use only slows the progress of the disease, it would provide significantly improved quality of life for patients.

Autism spectrum disorders (ASD) have gained increased attention in the past 20 years and have become the focus of many educators, researchers, and child advocates. They are a combination of developmental disabilities that affect communication abilities, social interactions, and stereotypic or repetitive behaviors. In the past, ASDs were referred to separately as pervasive developmental disorder, childhood disintegrative disorder, autism, and Asperger's disorder. The Centers for Disease Control and Prevention (CDC) estimates that approximately 1 in 68 children will be born with ASD, with a five times greater prevalence in boys (1 in 42) than girls (1 in 168). The exact cause of ASD is unknown, though it is believed to have a combination of environmental and genetic causes. Some research has found structural irregularities in the brain, and other research has implicated neurotransmitters (e.g., serotonin) or hormones (e.g., oxytocin). ASD is known to have a heritable component, and an identical twin's likelihood of diagnosis when the other twin was diagnosed is up to 90 percent. However, research is preliminary and ongoing. Treatment for ASD is usually a combination of educational or behavioral interventions (such as applied behavioral analysis), family psychotherapy, and medications such antidepressants, antianxiety drugs, anticonvulsants, antipsychotics, and stimulants. Some early research supports the use of nutritional or dietary interventions to address disruptive or aggressive behavior.

MOTIVATION

A number of theories attempt to explain what motivates people to achieve certain actions. The theories range in coverage from basic motivations to more complex ones, and they are not necessarily mutually exclusive. As has been seen in other areas of research, often each theory contains a piece of the truth, which is then folded into newer theories as a field develops.

Instinct is the most fundamental motivator. It may be completely unconscious, but it impels humans to act and respond in specific ways. Evolutionary psychologists often point to genetics and evolutionary pressures to identify the role of instinct in human behaviors. The human sexual drive may be considered an instinct. The fight-or-flight response may also be instinctual. Both of these instincts push people to preserve their lives and propagate their genes.

Beyond basic motivation, **drive reduction** serves as a higher-level motivator for human behavior. A **drive** is an internal state of discomfort. A person who wants to relieve that discomfort will set out to accomplish the tasks necessary to reduce the discomfort. Discomfort may occur at a basic level (e.g., "I'm cold, so I need to find my coat."), or it may be more complex (e.g., "I need to achieve X level of productivity so I'll feel comfortable that I won't lose my job."). Discomfort may be related to elevation in the hypothalamus-pituitary-adrenal axis, with increases in stress hormones (e.g., adrenaline, cortisol) applying some of the biological pressure.

Positive arousal may also serve as a complex motivator. Increased goal-directed activity resulting in a positive outcome is likely to release a dopamine cascade in the brain (e.g., the "reward pathway"). Thus an individual experiences significant neurochemical arousal as a reward (along with possible social and psychological rewards) that reinforces the goal-directed behavior. This pathway may also be hijacked and used for drug or alcohol abuse. If the goal-directed behavior produces an artificial flood of dopamine due to drug use, the goal-directed behavior "get more cocaine" will be reinforced.

Other aspects of motivation also need to be considered. The presence of possible **incentives** (external rewards that can motivate behavior) can motivate a person to achieve certain tasks (e.g., "If I win that scholarship, I will be able to go to the school I want."). There may be **affiliation motivators** (e.g., "I don't want to go to that movie, but my friends want to go and I want to be with my friends.") and **cognitive motivators** based on active processing and weighing information from past experiences (e.g., "I know that if I eat a candy bar now, it will just be unhealthy quick energy and I will be hungry and uncomfortable again soon. So I will wait until dinner.").

Some theories attempt to explain human needs and motivations on a larger scale. One of the most famous was developed by the American psychologist Abraham Maslow and is known as **Maslow's hierarchy of needs** (see Figure 4-9). Maslow postulated that a person's ultimate motivation is for self-actualization, but self-actualization cannot occur if more fundamental needs are not fulfilled first. The needs listed in Maslow's hierarchy move upward from basic physiological needs (food, water), to safety concerns, to social connections, to self-esteem, and finally to self-actualization. Only when a lower level of the pyramid is attained can an individual focus on progressing to the next step.

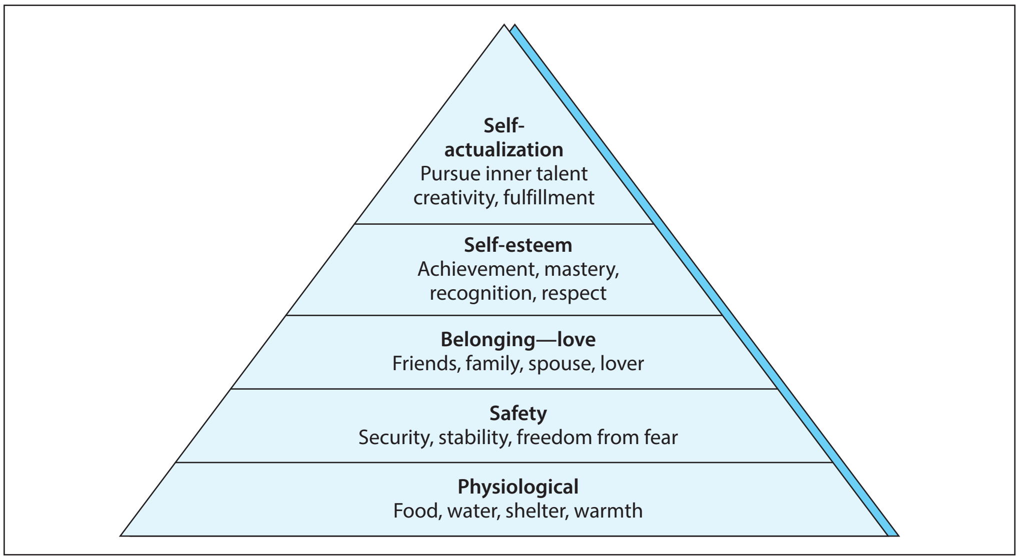

FIGURE 4-9 Maslow's hierarchy of needs.

Many of these motivators have biological underpinnings. The biological drive for food is located in the hypothalamus. In rats, when the lateral hypothalamus was lesioned, the rats showed no interest in eating. However, when the ventromedial nucleus of the hypothalamus was lesioned instead, the rats ate constantly regardless of calorie need. There are also a number of hormonal feedback loops that govern hunger levels and energy usage. Three hormones appear to have the strongest influence on food intake and fat storage: **insulin** (energy usage/storage), **leptin** (satiety hormone), and **ghrelin** (craving hormone).

Sexual activity and mate seeking are basic goal-directed behaviors that are strongly influenced by biology. Attraction to a sexual partner is at least partially related to pheromones and genetics. Research has shown that women during the fertile phases of their menstrual cycles prefer genetically different partners (e.g., nonfamily), but during pregnancy, they prefer genetically similar men (e.g., family), a preference that may be evolutionarily related to safety during pregnancy. However, the advent of modern hormonal birth control may cause some difficulties. Hormonal birth control causes the female body to mimic pregnancy and may change the focus of attractions. The scientific study of sexuality was initiated by the research team of William Masters and Virginia Johnson in the 1950s. Their groundbreaking research into human sexual behavior broke many taboo rules that existed at the time.

Many sociocultural factors also affect the expression of these motivational behaviors. For example, culture affects not just food choices, but also people's perceptions of what foods are palatable, their eating patterns (e.g., frequency, portion sizes), and their social interaction during meals. Culture also affects sexual expression. Culture may identify sexually taboo partners (e.g., a person married to someone else), influence sexual behavior (e.g., encourage or discourage kissing in public), or govern what behaviors are permissible (e.g., in approaching potential partners).

SLEEP

The biological rhythms of the body affect behavior and physiology. The **circadian rhythms** cause changes in the body based on the light and dark portions of the typical 24-hour day. The brain's "timekeeper" for these rhythms is the **suprachiasmatic nucleus**, which responds to light/dark information from the environment. Cognitive functions such as alertness and attention, as well as physiological functions such as the release of growth hormone and body temperature, are affected by circadian rhythms. Today those natural rhythms may be disrupted by electric lighting and by the light from television and computer screens. Circadian rhythms are also disrupted when people fly rapidly across multiple time zones. Research with rats even suggests that repeated or constant "jet lag" can cause premature death because of the elevated stress on the body. All of these artificial shifts in circadian rhythms create sleep difficulties and increased physiological stress on the body. They cause the body and brain to think that they should be awake, even when the nighttime goal is sleep. That causes confusion across a wide variety of physiological systems including cardiac functioning, digestion, hormone release, and other body functions.

The second system that affects sleep is the **neurochemical-homeostatic system**. When humans are awake, they use adenosine-triphosphate (ATP) for energy by breaking the bond of the adenosine molecule. When adenosine builds up in the body, it affects the suprachiasmatic nucleus and humans get sleepy. Further, caffeine is an adenosine receptor blocker, so the sleep messages cannot reach the suprachiasmatic nucleus. Adenosine continues to build up in the body, but there are no feelings of sleepiness until the "caffeine crash." The sleep researcher William C. Dement is the founder of the field of sleep medicine.

Within sleep there are four stages:

- The first stage is a light "cat nap" type sleep.
- The second stage is a deeper stage of sleep.
- The third stage is a critical stage called **slow wave sleep**. It is characterized by **delta wave EEG readings**. In this stage the body slows as much as possible, and achieves the slowest heart rate and lowest body temperature. It is during this stage that the greatest release of growth hormone, the most effective wound healing, and the most active immune responses occur. The third stage is critical to help maintain the body system. In the sleep laboratory, when this stage is disrupted, symptoms of nausea, muscular-skeletal pain, and headaches can occur. After the slow-wave

sleep stage, the body appears to begin to start waking up with increased blood pressure and heart rate.

- The fourth stage is **REM stage sleep (rapid eye movement)**. This final stage of sleep is characterized by active (and occasionally bizarre) dreaming, **sleep paralysis** for the major muscle groups of the body, and quick darting movements of the eyes behind closed eyelids. This stage is thought to be particularly critical to memory consolidation, and the active dreaming experienced by the sleeper is part of this process.

Each sleep cycle takes 90 to 120 minutes on average, with more time spent in slow-wave sleep early in the night and more in REM stage sleep as the night progresses. In infancy, newborns will go through six to eight sleep cycles in a 24-hour period, and REM sleep accounts for 50 percent of the time in those sleep cycles, with an increased amount of time also spent in slow-wave sleep. As the individual grows to adulthood, 20 percent of sleep is spent in REM sleep and 20 percent is spent in slow-wave sleep.

Sleep deprivation is often underrecognized as a critical component to psychological and physiological well-being. Most humans need 7 to 9 hours of sleep per night. It is important to understand that not just sleep quantity, but sleep *quality* and coherent sleep architecture are critical to well-being. Most modern pharmaceutical sleep aids can be problematic in this regard because they may increase the quantity of sleep but decrease the quality of sleep. Sleep deprivation can have both psychological and physiological consequences. Psychologically, the individual experiences fatigue, irritability, decreased memory functioning, difficulty with decision making and problem solving, and increased stereotyping of others. Physiologically, there is an increased risk of obesity and type II diabetes, risk of heart disease, impaired immune response, and diminished growth or healing.

Insomnia is one cause of sleep deprivation. Stress is the most common culprit, with approximately 32 percent of Americans losing sleep at least one night per week due to stress. Other common etiologies of insomnia include caffeine overuse, late night electronics use with bright lights (e.g., TV, computer, smart phones), and sleep disorders. Polysomnography testing, psychotherapy (cognitive behavioral therapy for insomnia, or CBT-I), and sleep hygiene can each be useful for assessment and treatment of insomnia and other sleep disorders. Pharmacology can be useful in some instances but can cause sleep architecture disruption and should be monitored closely for potential abuse and dependence.

ATTITUDES

Attitudes can also be a large influence on behavior. An attitude is not a single factor. It is made up of three components. The **cognitive component** is made up of one's beliefs and ideas about the world. The **affective component** is the emotional reasoning that affects an attitude. The **behavior component** is made up of habits and activities that result from the attitude. It is important to note that behaviors derived from attitudes may be unconscious (or habitual) or they may be intentional.

Advertisers have long taken advantage of these attitude-behavior connections. They have used them to develop effective advertising techniques. One such technique is called **foot in the door**. In this technique, the prospective customer is first asked to accept a small and obvious proposal (e.g., "Do you want a nice car?"). A customer who accepts that proposal is then more likely to accept a greater (and more costly) proposal (e.g., Would you be willing to pay $50,000 for a Brand X car?). Another popular technique is called **door in the face**. In this technique, the prospective customer is first presented with an outrageous demand. Once the customer rejects the demand, he or she is then more likely to accept a lesser (and seemingly more reasonable) request. Even the offer of "free samples" to create a feeling of obligation to make a purchase (or provide a donation) is often used to encourage customers to buy. An additional frequently used technique is **body language**. Decreasing the amount of personal space between two individuals can increase an individual's persuasive power, so sellers may stand closer to prospective customers to persuade them to buy. These types of techniques can create changes in both attitudes and behaviors without customers realizing that they are being manipulated by their own cognitive defenses.

Cognitive dissonance theory was developed by the American social psychologist Leon Festinger. According to Festinger, individuals prefer to view themselves as acting in line with their beliefs (this is known as **self-perception theory**). When there is a disconnect between a person's beliefs and actions, the person will often change those beliefs or attitudes to align them with the actions. In the classic study exemplifying this theory, individuals were paid either 1 dollar or 20 dollars to tell other participants that a boring task is fun. Because people do not like to view themselves as misleading others, they searched for reasons for their behavior. Individuals who were paid a lot of money were able to point to the money as the reason for their behavior. But individuals who were paid only 1 dollar showed significant attitude changes, and during the post-experiment interview they reported they actually thought the task was fun. These people did not show any awareness of the influence of money on their change in attitude. This same effect has been shown repeatedly in multiple other studies.