

danger, or potential pain is no longer perceived to be imminent. The parasympathetic branch is responsible for counterbalancing the body's sympathetic activity, which restores calm, promotes relaxation, and facilitates digestive functions, energy storage, and tissue repair and growth.<sup>1</sup> Breathing is slow, as is the heart rate. Blood pressure and body temperature drop. In general, muscle tension decreases. During parasympathetic activity (general relaxation), the body regenerates and restores for future activity.

The autonomic nervous system is controlled by the **hypothalamus**, located in the **diencephalon** area of the brain. The diencephalon is the central portion of the brain and is responsible for regulating emotions, among other things. The hypothalamus plays a key role in the stress response because it is the chief region for coordinating sympathetic and parasympathetic activities. When the hypothalamus receives the message of danger from the higher-order thinking part of the brain, it is like an alarm system going off deep in your brain, which delivers a message through the nervous system that connects to every other system of the body.

The hypothalamus also delivers a message to the endocrine system to initiate the secretion of hormones. The stress hormones, including epinephrine and cortisol, flood the bloodstream and travel throughout the body, delivering information to cells and systems that will aid in generating the body's ability to be more speedy and powerful, as demonstrated in Sarah's story in the opening vignette.

These stress hormones are produced by the **adrenal glands**, two triangle-shaped glands positioned on top of the kidneys. **Epinephrine** (adrenaline) and **norepinephrine** (noradrenaline) are released into the bloodstream from the **adrenal medulla**. **Cortisol**, the other key stress hormone, is released from a portion of the adrenal glands called the **adrenal cortex**. Together, these hormones flood every cell in the body with the specific message to prepare for the fight-or-flight response—for more power and speed—when we are faced with an imminent threat. The dual response of the nervous and endocrine systems constitutes the stress response. In an instant, with the interpretation of a stimulus as potentially threatening, your body leaps into alert mode. This reaction gave early humans the energy to fight aggressors or run from predators, helping the species survive.

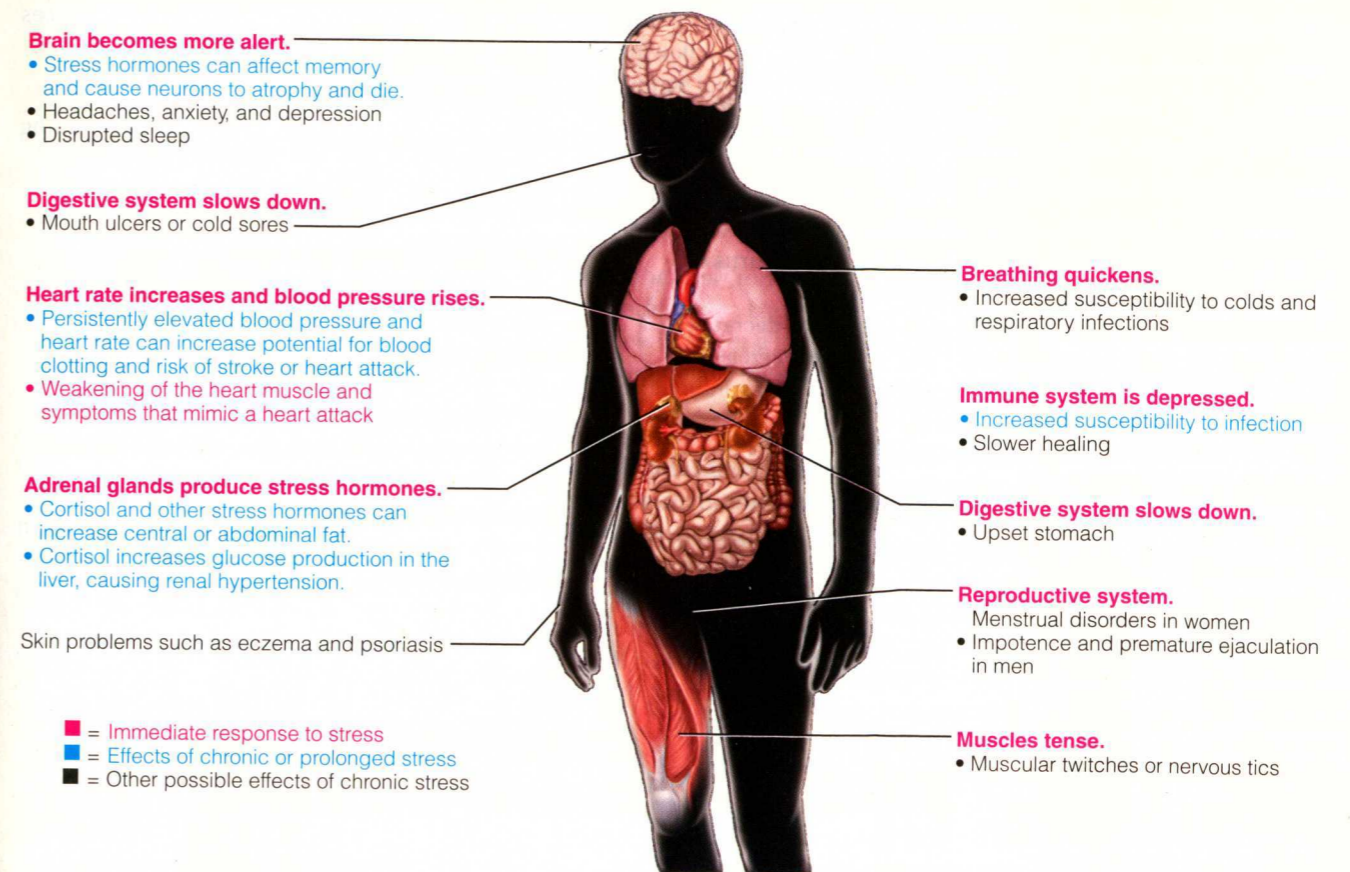
Consider this scenario:

A dry twig in the jungle snaps and our common ancestor—your father, my father, 1,500 generations ago—leaps into alert mode. Adrenaline floods his system, causing lipid cells to squirt fatty acids into his bloodstream for quick energy. His breathing becomes shallow and rapid, and his heart beats faster, increasing the flow of oxygen to his muscles, enhancing his strength and speed. His blood vessels constrict, minimizing bleeding if he's injured, and his body releases natural coagulants and painkillers. His sweat glands open, leaving his skin slippery and hard for a predator to grasp. His hair stands on end, making him appear larger and more threatening. His pupils dilate, increasing his ability to scan dark jungle terrain. All this happens in less than a second, and—zip—Dad's off and running, far enough ahead of the tiger to ensure that your bloodline, and mine, makes it to the next generation.<sup>2</sup>

This scenario demonstrates some of the physiological changes that prepare the body for emergency action. Our ancestors developed this response to help keep them alive. This precise and automatic protective reaction remains with us still today.

**Autonomic Nervous System Responses** Figure 3.2 shows the effects of stress on the human body. The immediate physiological changes that result from activating the sympathetic nervous system are as follows:

- Increased central nervous system (CNS) activity
- Increased mental activity
- Increased secretion of adrenaline (epinephrine), noradrenaline (norepinephrine), and cortisol into the bloodstream and to every cell in the body



**FIGURE 3.2** Effects of Stress on the Body

Source: "The Effects of Stress on Body," Figure 4.2 in *An Invitation to Health*, 16th Edition, by Dianne Hales, (Stamford, CT: Cengage Learning, 2015), p 87.

- Increased heart rate
- Increased cardiac output
- Increased blood pressure
- Increased breathing rate
- Dilation of breathing airways
- Increased metabolism
- Increased oxygen consumption
- Increased oxygen to the brain
- Shunting of blood away from the digestive tract and directing it into the muscles and limbs
- Increased muscle contraction, which leads to increased strength
- Increased blood coagulation (blood-clotting ability)
- Increased circulation of free fatty acids
- Increased output of blood cholesterol
- Increased blood sugar released by the liver to nourish the muscles
- Release of endorphins from the pituitary gland
- Dilation of the pupils of the eyes
- Hair standing on end
- Blood thinning
- Increased brainwave activity
- Increased secretion from sweat glands
- Increased secretion from apocrine glands, resulting in foul body odor
- Constriction of capillaries under the surface of the skin, which consequently increases blood pressure

When the fight-or-flight response is activated, the nervous system decreases processes throughout the body in the following ways:

- Immune system is suppressed
- Blood vessels are constricted, except the vessels that go to the muscles used for running and fighting
- Reproductive and sexual systems stop working normally
- Digestive system stops metabolizing food normally
- Excretory system turns off
- Saliva dries up
- Pain perception decreases
- Kidney output decreases
- Bowel and bladder sphincters close

To enable us to escape from threatening situations, we do not need this last set of functions and systems to operate at high capacity. Their work, therefore, is suppressed to divert energy to the vital systems involved in increasing speed and power.

In contrast to the fight-or-flight response is a principle called the rest-and-digest response. In short, if you are required to run from a mugger, both nap time and digesting lunch—the rest-and-digest response—can wait. The SNS and PNS often operate simultaneously in response to stress. For example, the heart rate increases (SNS) while the digestive system shuts down (PNS). Understanding the nervous system's response to stress is important in explaining the stress-related diseases and conditions covered in the next chapter.

## The Stress Response in Today's World

You now understand that when faced with threats, our bodies respond with a series of physical reactions that mobilize internal forces and ready us to act. Researchers caution us, however, about possible consequences of this response. Dr. Robert Eliot, former director of prevention and rehabilitative cardiology at St. Luke's Medical Center in Phoenix, explains: "When stress was primarily physical, people really did have to fight or flee. For the most part, modern stress is of a different nature, and we end up pumping high-energy chemicals for low-energy needs. The price is high: over the long haul you turn the energy inward and burn out."<sup>3</sup> Harvard cardiologist Herbert Benson remarked, "The fight-or-flight emergency response is inappropriate to today's social stresses."<sup>4</sup> Many situations other than imminent physical danger can trigger the stress response. This is because *our bodies are unable to distinguish between life-threatening dangers and more mundane problems, such as a disagreement with a friend, credit card debt, or a major exam.*

Today we face traffic jams and deadlines, loneliness and lack of money, arguments and exams—different types of challenges, none of which demand that we run or fight. Most situations today benefit from a calm, rational, controlled, socially sensitive approach. Essentially, our fight-or-flight response is an outdated mechanism to which our primitive

### Author Anecdote

#### Self-Induced Fight-or-Flight

When I was a teenager, I lived in an area of town with nothing but homes and parks for many blocks. During the winter months my friends and I assembled behind a four-foot high hedge and prepared for oncoming cars. When they drove by, we unloaded a barrage of snowballs on the unsuspecting drivers. (This was how we kept our arms in shape for baseball season during the off-season!) The person who was awarded the highest honors was the one who could make the best "dent" sounds in the pegged car or truck. Even more exciting than the dent sound was the rare occasion when the car or truck would stop and the driver would jump out and start chasing after us.

Of course, nobody knew our neighborhood like we did, so the possibility of our getting caught by even the swiftest of pursuers was remote. As we were being chased through our neighborhood, down the streets, and across the parks, it was obvious that in those times of pursuit, we suddenly were gifted with incredible speed and power. We were able to jump over high fences with ease, and run down streets and through parks with the velocity of Olympians. We even noticed that during those times, our ability to see where we needed to go to make it to safety (this activity always took place at nighttime) improved dramatically. I am not proud of those days and find myself irritated at teens who do the same thing to my car nowadays, but I learned some powerful lessons about the fight-or-flight response in those early years.

—MO

systems have not yet adapted. We are 21st-century minds living in our primitive ancestors' bodies.

In the short term, we need to control our stress response to be effective in our daily life. In the long term, we need to keep it under control to avoid the consequences of burnout and poor health. Understanding the way our bodies work in response to our thoughts validates the importance of being proactive, rather than just reactive, in coping with the effects of stress.

**Acute Stress** The way the stress response works in the short run helps us generate great strength, focus more clearly, increase our speed, and perform at a higher level when a threat is present. Acute stress creates maximum power or speed, but for a very short time—probably little more than 30-90 seconds. Our bodies simply don't have the energy reserves to support maximal energy output for much longer than that. Occasionally we can use this source of immediate energy to help us when we do find ourselves, or others, in actual danger, facing potential pain or even death. Sarah demonstrated this acute stress response in the Real People story at the beginning of the chapter. You probably can think of times when your body has responded to a danger in a manner similar to Sarah's response.

The following scenarios are a sampling of circumstances of acute stress in which the demand, danger, or threat is immediate and very real:

- Being chased by an angry dog
- A blown tire on the highway
- A trip and fall down a steep hiking trail
- An earthquake
- A lightning strike

You get the point. Occasionally we experience acute stress. Activation of the stress response at these times is beneficial and may even save your life. In reality, however, these types of experiences are rare in everyday life. Unless you work in a high-risk occupation such as being a police officer, soldier in combat, firefighter, or whitewater rafting guide, your days rarely involve threats to your life.

Contrary to how our world may appear from watching the evening news, our society today is not one in which *real* acute threats or dangers are a daily occurrence. An upcoming exam or being late to work may make us feel like we are in danger, but in reality we don't need our primitive survival forces of the fight-or-flight response to manage these situations. What we will recognize, in upcoming chapters, is that the way we perceive the events of our lives is the primary factor that activates the stress response.

### Research HIGHLIGHT

#### Surprise Attack

**M**yocardial stunning refers to a unique medical condition in which severe emotional stress causes heart abnormalities, including heart failure. A small, descriptive study was conducted to identify possible causes for myocardial stunning. The subjects were previously healthy patients presenting to a medical center with chest pain or heart failure following an episode of acute emotional stress. The most common emotional stressor that initiated cardiac stunning was the news of an unexpected death, although some subjects had experienced the condition following an event such as a surprise party or a surprise reunion.



Surprise! You might think twice about surprising Grandpa Joe. Sudden emotional stress can damage the heart.

Authors of the study propose the following as possible causes for myocardial stunning: 1. coronary artery spasm from increased sympathetic tone due to mental stress and 2. microvascular spasm within the heart in response to a sudden release of stress hormones.

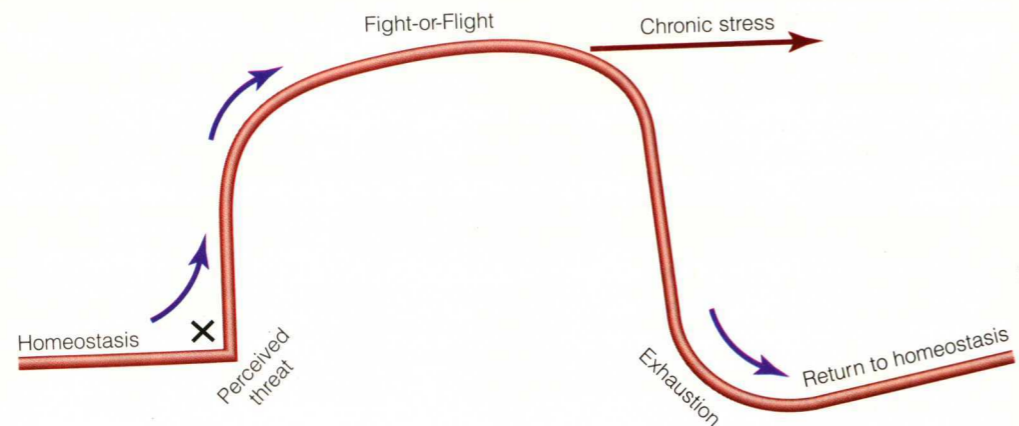
This study provides objective measures showing that emotional stress can injure the heart. Studies such as these can help us understand the powerful effect of stress on the body. You might want to think twice before you plan the surprise 90th birthday party for Grandpa Joe!

**Source:** "Emotional Stress May Precipitate Severe, Reversible Left Ventricular Dysfunction," by L. Barclay and C. Vega, *Medical News*, February 9, 2005. Retrieved November 10, 2009 from <http://www.medscape.com>.

The irony is this: Our bodies react to stress in exactly the same way whether or not we have a good reason for being stressed. The body doesn't care if we're right or wrong. Even in those times when we feel perfectly justified in getting angry—when we tell ourselves it's the healthy response—we pay for it just the same.

—DOC CHILDRÉ

FIGURE 3.3 Chronic Stress



FYI

Women's Stress

In similar circumstances and at similar stages of life, women consistently report feeling more stress than men do. Some researchers attribute women's greater stress to the many roles they play—spouse, mother, homemaker, employee, supervisor, and caregiver. We do know that women's stress hormones and blood pressure, unlike those of men, tend to remain elevated at the end of the workday.

Source: "Three for 2003: Reducing the Burden of Stress," *Harvard Women's Health Watch*, 10(5) 2003.

**Chronic Stress** If the stress response is allowed to stay in the "on" position longer than necessary to escape danger, the result can be damaging to health. If stressful situations pile up one after another, the body has no chance to recover. *Chronic stress* is the term we use to describe this state of continued sympathetic nervous system activation. Instead of returning to homeostasis, the fight-or-flight response is activated for an extended time. This long-term activation of the stress-response system can disrupt nearly all body processes. Figure 3.3 illustrates chronic stress.

Your body is a wise instrument. It is designed to give feedback about the choices you make. Consider the person who deliberately gets drunk during an evening of partying. When he wakes up in the morning hung over from the excessive alcohol, his body sends messages of

discomfort, including headache, nausea, unclear thinking, and muscle pain. This feedback provides a clue that drinking was not a healthy decision. Or when someone eats too much sugar at one time, she may experience feelings of nausea, tiredness, and irritability. By contrast, a jog or walk can result in your feeling balanced, alert, refreshed, and energized. The body is sending messages that running was a healthy decision. The body lets us know what is good and what is bad for us—what is healthy and what isn't.

Our body gives us feedback about unhealthy chronic stress with a host of signals or symptoms indicating imbalance. These symptoms of stress provide warning signs for more serious health problems. Listen to the messages your body sends. Although stress is not listed among the top 10 causes of death in the United States, it is linked to many illnesses. This does not necessarily mean that stress *causes* problems, but it does mean that stress contributes to problems. We will explore these problems associated with chronic activation of the stress response more thoroughly in the next chapter.

Pressure and stress is the common cold of the psyche.

—ANDREW DENTON

The General Adaptation Syndrome

One of the best known biological theories of stress is the **general adaptation syndrome** (GAS), a process by which the body tries to adapt to stress. The general adaptation syndrome provides a summary of the physiological changes that follow stress as the body attempts to return to homeostasis.

**History of the General Adaptation Syndrome** Stress pioneer Dr. Hans Selye developed the GAS theory as a result of his research on the physiological effects

of chronic stress on rats. Whenever he injected an animal with a toxin, he observed the following specific responses:<sup>5</sup>

- The animal's adrenal glands enlarged.
- The animal's lymph nodes shrank.
- Eosinophils (white blood cells) dropped significantly.
- Severe bleeding ulcers developed in the animal's stomach and intestine.

Ten years earlier, as a medical student, he had noticed similar responses in people. Selye theorized that the same pattern of changes occurs in the body in reaction to any kind of stress and that the pattern is what eventually leads to disease conditions such as ulcers, arthritis, hypertension, arteriosclerosis, or diabetes. Selye called the pattern the general adaptation syndrome. For decades, researchers have studied the syndrome, and Selye's theories have held up to scientific scrutiny.<sup>6</sup> Figure 3.4 depicts the stages of the general adaptation syndrome.

Stages of the General Adaptation Syndrome

Dr. Selye identified three stages of the general adaptation syndrome:

1. **Alarm stage.** When a stressor occurs, the body responds in what has been described previously as the fight-or-flight response. Homeostasis has been disrupted. Several body systems are activated, especially the nervous and endocrine systems, to prepare the body for action. If the stressor subsides, the body returns to homeostasis.
2. **Stage of resistance.** If the stressor continues, the body mobilizes its internal resources in an effort to return to a state of homeostasis, but because the perception of a threat still exists, the body does not achieve complete homeostasis. The stress response stays activated, usually at less intensity than during the alarm stage, but still at a level to cause hyperarousal. For example, if you learn that your mother has been diagnosed with cancer, you may respond intensely and feel great stress at first. During the subsequent weeks, you struggle to carry on, but this requires considerable effort.
3. **Stage of exhaustion.** If the stress continues long enough, the body can no longer function normally. When chronic stress persists, organ systems may fail and the body breaks down in a variety of ways. Continuous stress that causes the body to constantly adapt can negatively impact your health. A state of wellness is difficult to maintain over time when our body energy is channeled into coping with stress.

**Application of the General Adaptation Syndrome** In their book *Lifetime Physical Fitness and Wellness*, Werner and Sharon Hoeger provide this excellent application of the GAS to college test performance.

As you prepare to take an exam, you experience an initial alarm reaction. If you understand the material, study for the exam, and do well (eustress), the body recovers and stress is dissipated. If, however, you are not adequately prepared and fail the exam, you trigger the resistance stage. You are now concerned about your grade, and you remain in the resistance stage until the next exam. If you prepare and do well, the body recovers. But if you fail once again and can no longer bring up the grade, exhaustion sets in and physical and emotional breakdowns may occur. Exhaustion may be further aggravated if you are struggling in other courses as well.<sup>7</sup> Stressors, whether they are threatening or exhilarating, require adaptation. If you watch closely for manifestations of the exhaustion stage, you can take action to return to a state of homeostasis.

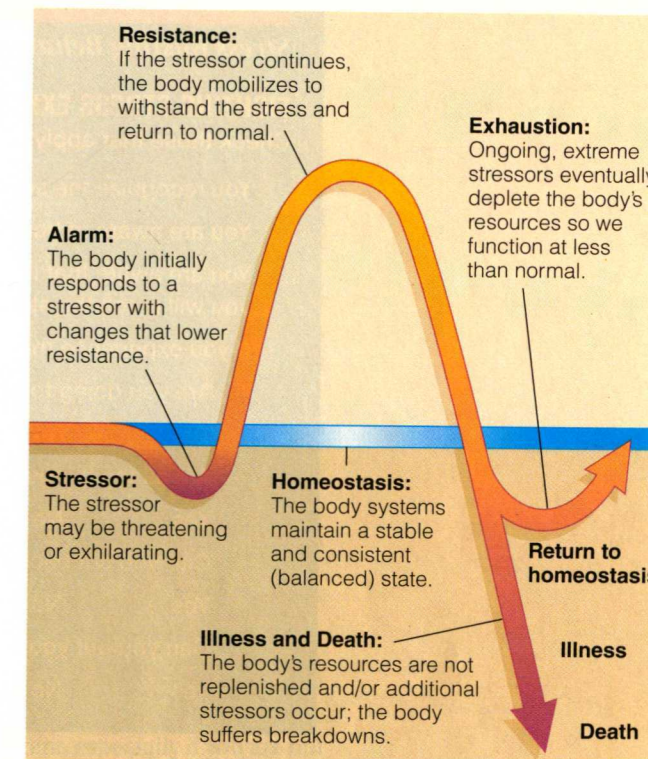


FIGURE 3.4 The Three Stages of Selye's General Adaptation Syndrome

Source: "General Adaptation Syndrome," Figure 4.1 in *An Invitation to Health*, 16th Edition, by Dianne Hales (Stamford, CT: Cengage Learning, 2015), p. 85.

## Stress Busting Behavior

### FIGHTING STRESS EXHAUSTION

Check those that apply to you.

- You recognize the symptoms of the fight-or-flight response.
- You are aware of how often this response is triggered in you.
- You are aware that if the stress continues long enough, or the stress is habitual, you will reach the stage of exhaustion.
- If you experience the stage of exhaustion, you take action and reprioritize:
  - Are you doing too much?  
Yes  No
  - Are all the things you “need to do” REALLY necessary?  
Yes  No
  - Can you cut back on your commitments?  
Yes  No
  - Can you put your health first, and plan a schedule that is lower in stress?  
Yes  No

## The Stress Response and You

So how does all this relate to you? You may have never been chased by a big bear, or any other wild animal for that matter. Still, tuning in to your body’s fight-or-flight response and to the three stages of the general adaptation syndrome can help you understand how to prevent the ill-effects of chronic stress.

As you think about the effects of stress in your life, think about the FIT formula. FIT stands for the following:

- Frequency—How often is your stress response triggered?
- Intensity—How severe or strong is your stress response when it is triggered?
- Time or duration—How long is the stress response activated?

In terms of your health and well-being, the most important of these three is duration. Chronic activation of the stress response will result in decreased quality of life. Physician Dan Beskind wrote:

There is no doubt that the human body is exquisitely adapted to deal with stress in brief doses. Our fight-or-flight response is one example of the way that short bursts of heightened energy and vigilance can actually save our lives. But we aren’t well adapted to deal with surges of adrenaline and cortisol day

after day. In evolutionary terms, traffic jams, two-career marriages, and kids involved in six after-school activities were not part of the plan.<sup>8</sup>

The bottom line is don’t underestimate the immediate consequences of stress to drain the joy from life and the long-term consequences of serious health concerns. Take responsibility for your health and begin to slow down and carefully assess your choices for living wisely. This book is filled with strategies to help you.



### TIME TIP

“I practice the 10-minute rule. Some tasks and homework assignments I dread doing, so I start by doing 10 minutes. I can always psych myself up for just 10 minutes. Then, if I want to, I can come back later for another 10 minutes. Most of the time, I end up finishing the project after I start, and this stops some procrastination.”

—Sandi J.

## Five Myths About Stress

This is a good time to review some of what you have learned in the first three chapters by examining common myths about stress. See if you agree with these myths.

**Myth 1: In an ideal world, there would be no stress** Stress is not always bad for us. Too little stress leads to boredom and can make us miserable. Stress can be the spice of life if we learn how to manage it. Managed stress makes us productive and happy.

**Myth 2: What is stressful to me is stressful to you** Absolutely not true. Stress is different for each of us. Situations are rarely stressful in and of themselves. What causes one person to totally lose it might not even ruffle another. Stress is something we create and depends on how we interpret situations. The good news is that if our mind creates our stress, then our mind can decrease our stress.

**Myth 3: Only unpleasant situations are stressful** Falling in love can be just as stressful as breaking up, and winning the lottery can be as stressful as losing your job. Change, whether positive or negative, is the key ingredient in causing stress.

**Myth 4: No symptoms, no stress** Not so. Absence of symptoms does not mean the absence of stress. While symptoms are the warning signs that stress is at work in the body, stress can be taking its toll even before symptoms are apparent, especially if you are not tuned into the messages your body is sending. Camouflaging symptoms with medications, other drugs, or alcohol may deprive you of the signals you need to begin reducing physiological and psychological stress.

**Myth 5: Stress is inevitable, so you can’t do anything about it** Not true. You can change the ways you approach your life so that stress does not overwhelm you. You can learn specific techniques that not only help you cope with stress, but actually prevent some stress from ever happening in the first place.

## Conclusion

Your body is designed to respond to acute stress in a predictable manner for one outcome—your survival. This response, the fight-or-flight or stress response, is critical to your ability to survive life-threatening situations throughout your life. Through the actions of the autonomic nervous system, your body is programmed for a response that will protect you from harm.

In today’s world, many of our challenges are not acute, physical challenges. Today our stressors are primarily psychological and social, such as having too much to do, financial debt, concern for a loved one, loneliness, or unhealthy relationships. The stress response is not well suited to deal with these types of stressors. When our bodies stay in a state of physiological hyperarousal without release, negative health consequences accumulate.

Take a few minutes to think about the connections between the concepts presented in this chapter. Consider the relationship between the fight-or-flight response, acute and chronic stress, and the general adaptation syndrome. Relating these concepts to events in your life will help you see the relevance of the science of stress to your understanding of how stress affects you. This knowledge will also give you a foundation for understanding how relaxation techniques have the potential to interrupt the stress response. In Chapter 4 you will learn more about the powerful mind/body connection and its impact on health and disease.

### 3.1 Fight-or-Flight

#### ACTIVITY

- Review the immediate physiological effects of the fight-or-flight response. Think about how each of the responses is designed to help a person survive physical danger. List one reason why each of the following immediate physiological responses would happen when we need to deal with a real threat:
  - Increase in heart rate
  - Increase in breathing rate
  - Large (fighting and running) muscles become tense
  - Increase in tolerance for pain
  - Increase in blood sugar levels
  - Suppressed immune system
  - Digestive system stops metabolizing food normally
- Clearly, the stress response becomes your best friend when you find yourself in a dangerous situation. The immediate speed, power, and quickness that come from fight-or-flight activation can save your life. Write down a situation in which your life or the life of someone you know was really in danger; where the only desire was to stay alive by escaping.
- Describe how your body reacted in ways that are similar to those described in this chapter with immediate activation of the stress response.
- Consider the following situations that people commonly perceive to be stressful. Take a moment to evaluate whether the event is one that warrants activation of the stress response in order to escape from it to stay alive. First, list the situations in which there is no real physical threat involved. Next, list the potentially life-threatening situations.
  - Taking a test
  - Having an argument
  - Escaping from a house fire
  - Arriving late for a class
  - Being chased by a mugger
  - Giving a prepared speech to a crowded room of people
  - Sliding down a steep mountainside while hiking
  - Being rejected when asking someone out on a date
  - Getting a bad score on a test
  - Getting ready for a very important ball game
- How do you explain the fact that you feel stressed in situations where there is no real danger involved? What can you tell yourself in these situations in order to put the stressful event in perspective and keep your stress response in proportion to the actual risk?

### Key Points

- The fight-or-flight response is the body's way of helping us survive physical danger.
  - The fight-or-flight response involves a complex interaction of many body systems and organs. This response activates needed functions and minimizes unnecessary functions during times of danger.
  - The autonomic nervous system (ANS) is responsible for a large number of commonly occurring functions in the body that occur involuntarily, such as digestion, heart rate, blood pressure, and body temperature.
  - The two branches of the ANS are the sympathetic nervous system and the parasympathetic nervous system. The sympathetic branch is responsible for expending energy.
- The parasympathetic branch is responsible for conserving energy.
- The autonomic nervous system is controlled by the hypothalamus.
  - Although the fight-or-flight response is essential to our survival during times of acute physical danger, this response can have unhealthy consequences during times of ongoing social or psychological concerns.
  - The general adaptation syndrome describes a process in which the body tries to accommodate stress by adapting. This process consists of three stages: alarm, resistance, and exhaustion.

### Key Terms

fight-or-flight response  
homeostasis  
tend-and-befriend response  
autonomic nervous system  
sympathetic nervous system  
parasympathetic nervous system

hypothalamus  
diencephalon  
adrenal glands  
epinephrine  
norepinephrine  
adrenal medulla

cortisol  
adrenal cortex  
myocardial stunning  
general adaptation syndrome

### Notes

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### Online Activities CENGAGE <sup>brain</sup>

Additional activities to enhance what you have learned in this chapter can be found at the CengageBrain website by logging in to [www.cengagebrain.com](http://www.cengagebrain.com).

Resources and Activities that relate to this chapter include the following:

- Critical thinking/discussion questions
- Chapter 3 activities